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# TOWARDS ADAPTIVE MODEL OF SCHOOLYARDS: A CASE STUDY OF THE CITY OF BANJALUKA

***Abstract:***

This paper examines planning possibilities for adapting semi-public schoolyards into a network of open public and green spaces which contributes to urban resilience in the context of reduced public areas and exacerbated urban microclimate. The aim is to provide new understanding of resilience in the context of urban planning of schoolyards as open public spaces. The adaptive schoolyard model is defined through five key attributes: multifunctionality, greenness, safety, accessibility and connectivity. Three schoolyards in Banjaluka (Republic of Srpska) are selected to examine the feasibility of applying the model and to evaluate the flexibility of planning requirements in terms of their capacity to be upgraded in accordance with the specific needs of the defined model.

*Keywords: urban resilience, urban planning, adaptive model of schoolyards, Banjaluka.*

# КА АДАПТИВНОМ МОДЕЛУ ШКОЛСКИХ ДВОРИШТА: ГРАД БАЊАЛУКА

***Сажетак:***

Овај рад преиспитује планске могућности адаптације полујавних школских дворишта у мрежу отворених и зелених простора, која доприноси урбаној отпорности у условима смањене површине отворених јавних простора и погоршане микроклиме. Циљ рада је да омогући ново разумијевање отпорности у контексту планирања школских дворишта као јавних простора. Дефинисан је адаптивни модел школских дворишта на основу пет кључних карактеристика: мултифункционалност, озелењеност, сигурност, приступачност и повезаност. Могућност примјене модела и евалуација флексибилности планских захтјева у смислу надоградње у складу са специфичностима дефинисаног модела је испитана на примјеру три школска дворишта у Бањалуци (Република Српска).

*Кључне ријечи: урбана отпорност, урбано планирање, адаптивни модел школских дворишта, Бањалука.*

# 1. INTRODUCTION

The contemporary city is considered a place of density and physical, functional, social, and symbolic complexity [1]. In the context of accelerating urbanization, urban sprawl, and globalization, contemporary cities are facing different environmental, economic, social and other unexpected changes. Cities are exposed to many multifaced risks such as climate change, unsustainable patterns of production, land use, consumption, population growth [2], and resource limitation [3]. The crisis triggered by the extensive consumption of resources has made cities increasingly fragile and vulnerable ecosystems [4]. Due to their inflexibility in keeping pace with unexpected changes, cities suffer from their inability to achieve quality of life [5].

During the rapid urbanization, neoliberal urban development is qualified as a "growth-oriented by means of liberalization, deregulation and privatization of public goods and space and the outsourcing of public services" [6, p. 97]. The established capitalist principles of private ownership and market-lead economy have significantly influenced changes in the urban management, which is mainly driven by short-term goals and private interests. The emerging practice of developers is based on strict profit principles that are usually opposed to proclaimed public interests and "usually do not take care of social justice requirements, subject to which all citizens are entitled to have access to basic urban services and resources and to enjoy a good quality urban environment" [7, p. 49]. Thus, in pursuit of competitiveness, cities worldwide fail to menage urban development effectively and preserve social justice and sustainability. Moreover, in such uneven balance of power, public interest is violated and needs of citizens are neglected [8].

Urbanization at unprecedented pace puts pressure on urban infrastructure and resources, contributing to the fragmentation of natural territories and exacerbating issues related to climate change [2]. The changes in land use result in loss of agricultural and natural lands, habitat destruction, and uncontrolled expansion of urban areas, leading to the deterioration of air and water quality. Moreover, consequences of an increased urbanized lifestyle affect the general wellbeing and the quality of urban areas [3]. The expansion of surfaces, such as roads and parking lots, coupled with the reduction of green areas, limits the land's ability to absorb water, causing water accumulation and potential floods [2]. On the other hand, as a result of urban densification and competing land-use, open and green public spaces are shrinking, their quality is decreasing [9], which threatens access to recreational areas, environmental sustainability and public health. Public spaces in cities are a common good and key enabler for the fulfillment of human rights, while green spaces have a positive impact on cities' climate, human health and well-being [9]. Moreover, green areas and public open spaces are places of aggregation and relationships that stimulate social cohesion, reduce crime rates and promote the use of sustainable mobility and pollution reduction [1]. The network of streets, public spaces, and greenery frames cities' image and forms a structure of the city upon which all else rests. Therefore, the disappearance of cities' open public spaces and green areas has major consequences for how we live and experience our surroundings [9].

The above-mentioned changes test the resilience of urban communities on everyday basis underscoring the need for innovative planning solutions to ensure sustainable quality of life for all residents [2]. In this context, the concept of resilience has been considered one of the most promising approaches to ensure the survival of urban systems, by making them adaptive and transformable towards changes [10]. Resilience represents the ability to adapt and transform in response to stress while maintaining its essential functions and identities. However, in many cities, complex and long-term planning processes make it difficult to adapt to the urban environment quickly enough to keep pace with changing needs. Old disciplinary paradigms, based on tools like zoning and formal planning, have proven inadequate in addressing the speed of progress and environmental challenges [2]. Regarding this, the evolution of urban planning must entail a shift from the logic of static, predetermined forms to dynamic vision, with an emphasis on development strategies rather than rigidly defined forms [11]. However, planning solutions are means of integrating different disciplines and responding to new social needs while simultaneously maintaining the defense of collective interests [11]. Therefore, cities need to adopt innovative and low-impact planning solutions to address current and future challenges and to rapidly target several systemic risks and crises that are causing significant environmental and socio-economic impacts. This involves integrating adaptability into urban planning and formulating strategies that promote resilience and sustainability and foster continuous and fast environmental improvements. In literature, the most common strategies for such improvements are temporary use and tactical urbanism which refers to short-term and medium-term interventions, usually in public spaces or vacant buildings and land. Research has shown that these projects aim to make sites people-friendly or economically active by

providing new amenities or community infrastructure, supporting climate actions that promote walking and cycling, complete neighborhoods, urban greening and the adaptive reuse of buildings [12].

This paper deals with the potential of semi-public spaces owned by the city of Banjaluka to become part of the city network of open public and green spaces intended for sport, recreation and social interaction and thereby contribute to a better quality of life, climate change mitigation and urban resilience. As a result of intensive construction and loss of green areas in the last three decades, Banjaluka has become a city that faces increasingly pronounced consequences of microclimatic extremes. Therefore, there is a need to reexamine the usage of existent plots that have potential to mitigate these negative consequences and foster cities' resilience through their extended utilization. Concerning this, affirmation of schoolyards as a network of public areas is recognized as an effective urban planning tool that can quickly respond to challenges, bearing in mind that these are areas managed by the city. The schoolyards are publicly owned land that could engage a significant and diverse proportion of the city's population [13]. Moreover, schoolyards are dense network of semi-public spaces, evenly distributed, accessible to everyone and without ownership burdens. Previous research has shown positive environmental, economic and social effects of using schoolyards as public and green spaces. Utilization of schoolyards as public spaces, especially during summertime and after school hours can provide cooling areas accessible to vulnerable populations [14, 15]. The greening of schoolyards is considered a natural-based solution which contributes to children's well-being, improved learning capacities, increased social diversity in playground usage, and urban cooling [15]. Among these research, spatial aspects of schoolyard adaptability and planning aspect of improving schoolyard adaptive capacity remain underexplored. Therefore, the aim of this paper is to provide new understanding of the concept of resilience in the context of urban planning of open public spaces, and the role of schoolyards in the urban network of open and green public spaces based on their adaptive capacity.

The research is structured to address two key questions: which aspects of resilience can define an adaptive model of schoolyards as public spaces, and what is the current attitude of urban planning practice towards implementing such a model? The paper proceeds as follows. First, it establishes a theoretical framework for urban resilience and its representation in planning documents. The method employs a critical content analysis of scientific literature within the field of urban resilience to establish a framework for the adaptive use of schoolyards. Additionally, the method includes a content analysis of regulatory plans to identify urban parameters that influence the possibilities for adapting schoolyards into open public spaces. Based on this, a new theoretical model of adaptive schoolyards is developed to bridge the gap between the increasing demand for green infrastructure and the limited availability of suitable city facilities. Further, the feasibility of implementing this model is investigated through the example of three primary schools in Banjaluka. The qualitative analysis is supported by data collection from three actual regulatory plans and site visits. These regulatory plans are adopted between 2005 and 2008 and prepared according to a unified methodological framework. The analysis specifically focuses on land-use designation and land-use regimes as key urban parameters, interpreted through graphic annexes and textual guidelines. While primary land-use is identified from the spatial organization and green-space development plans, complementary and prohibited uses are extracted from the textual sections of the regulatory documents. The research showed that schoolyards were examples of semi-public spaces, which with minimum planning interventions might be part of the network of open public and green spaces of the city. Finally, the network of schoolyards might be efficient urban planning tool for reaching urban resilience in the context of climate and social changes.

## 2. URBAN RESILIENCE AND ADAPTIVE USE OF SCHOOLYARDS

The concept of resilience has drawn attention in science to address multifaceted challenges and uncertainties that cities are facing today. The amount of literature on resilience and urban uncertainty in contemporary societies has increased greatly over the last two decades. As a very complex theoretical concept, resilience has a variety of social, economic, cultural, environmental and spatial dimensionalities, and it has been in focus of various scientific fields, ranging from engineering and materials science to psychology and ecology. Different fields of research describe resilience at different levels, from the more general to the more specific, referring to resilience as an approach or a property of a system.

According to the broadest definition, resilience refers to the ability of a system, e.g. city, environment, individual or element, to adapt to changing conditions provoked by external stresses. A simple definition of resilience is the ability of a system to absorb disturbance while maintaining

its functions and structures [16, 17]. Some authors supplement this definition by claiming that resilience of a system represents the capacity for adaptation and transformation in response to stress while maintaining its essential functions and identities [18]. Accordingly, the matter of change is a pivotal dimension of resilience, regarding the resistance to change and recovery from it. In other words, resilience refers to readiness to reduce disturbances and actions to deal with disturbances once they have occurred. On the other hand, another key dimension of resilience is the speed of return to a new stable or fully functional state [19, 20]. Therefore, resilience is considered a continuing process of reshaping, reorganizing and developing new adaptive strategies [21].

The roots of modern resilience theory lie in ecology and Holling's studies of ecological equilibrium in the 1970s [22]. Holling [22] defines resilience as the amount of disturbance that a system can withstand before it shifts into an alternative stable state. In the social sciences, the growing interest in the notion of resilience can be seen as a consequence of increasing complexity, uncertainty and insecurity in the search for new approaches for adaptation and survival [23]. Moreover, resilience is the capacity of the system to cope with „*uncertainty in all ways*" [24, p. 5]. Social scientists employed the concept of resilience in analyses of the capacity of a self-organizing system (e.g., a person, settlement or society) to resist changes (e.g., disaster, disease, crisis natural hazard) without being devastated [21]. In another words, resilience is the ability of a social system to withstand disturbances and to reorganize itself as a response to disturbance-driven changes [25].

According to the first extensive definition provided by the United Nations Office for Disaster Risk Reduction (UNDRR) the resilience of urban habitats is "the ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management" [26]. Similarly, the European Union has defined resilience as the „ability not only to withstand and cope with challenges but also to undergo transitions, in a sustainable, fair, and democratic manner" [27].

The concept of social-ecological resilience emerged in the late 1990s and gained attention in urban planning and environmental management [28]. Conceptualizing nature and society as an integrated, interconnected, co-evolving system, Berkes and Folke [29] began to use the concept of social-ecological systems (SES) and link them to the concept of resilience. In this approach, the term 'social' refers to people, communities, and societies in their various aspects (economic, political, institutional, cultural), and the term 'ecological' refers to the biosphere that contains human life [30, p. 5]. Socio-ecological resilience refers to the "ability of a system to absorb disturbances and reorganize itself during change to maintain essentially the same function, structure, identity, and feedback" [31, p. 2].

Important features of the socio-ecological system (SES) resilience theory concern the dynamics of the system, its complexity and response to change. The socio-ecological system is not only an interconnected system of nature and society, but also a complex adaptive system (CAS) [32, 33] which "comprises many components that learn and adapt in the process of interaction" [34, p. 1]. Complex adaptive system is a system that is constantly evolving and improving. The CAS theory has developed through two main concepts that explain the behavior and dynamics of systems: the adaptive cycle (figure 1) and the panarchy (figure 2). A representation of an infinite curve indicates the four phases through which ecosystem functions operate within an adaptive cycle (the ∞ sign). According to Carpenter and colleagues [35], complex systems do not tend toward equilibrium; instead, they pass through four characteristic phases of an adaptive cycle: growth and exploitation (r), conservation (K), collapse or release ("creative destruction" (Ω)), and renewal and reorganization (α). Another important concept for understanding the dynamics of SES, introduced by Gunderson and Holling [36], is panarchy (figure 2). Nested adaptive cycles with bi-directional cross-scale feedback are called a panarchy [37]. Also, panarchy represents a "hierarchically arranged set of adaptive cycles, as well as their mutual relationships and connections that determine the sustainability of the system" [16, p. 396].

In urban planning, the concept of resilience is considered a response to the environmental threats of adjusting social and institutional frameworks [38]. Originally, the focus was on physical and infrastructure development to prevent disturbances and changes [21]. In the last twenty years, the issue of climate change has become more prominent. Moreover, urban resilience is the ability of cities to absorb, recover, and adapt to or transform in response to natural and manmade shocks and changes [21]. Therefore, the resilient city is an urban system capable of restoring its balance in response to changing surrounding conditions. As cities are complex adaptive systems that undergo evolutionary processes, urban resilience is entrenched in this evolution and cannot be limited to a static equilibrium state [39]. Furthermore, the adaptive capacity of cities cannot rely on static

urban development paradigms, since social, economic, and ecological challenges evolve over time and demand innovative planning solutions [40].

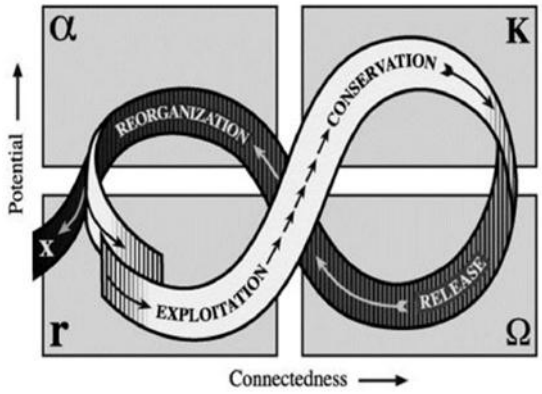


*Figure 1. Two-dimensional representation of the adaptive cycle [36].*

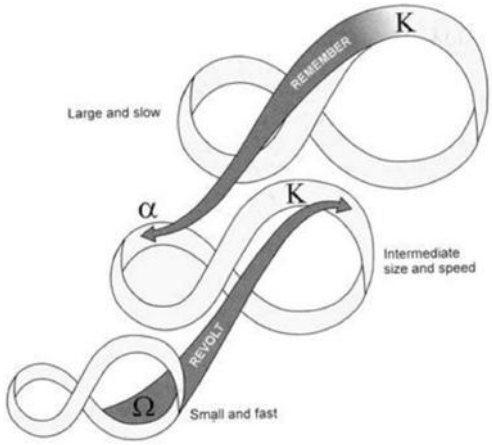


*Figure 2. The classic panarchy figure showing three nested adaptive cycles [36].*

The synthesis of the reviewed literature reveals a significant paradigm shift in urban planning: from a traditional, engineering-based focus on 'resistance' toward an evolutionary understanding of 'adaptive capacity.' In contemporary urban context, resilience is no longer defined merely as a city's ability to return to a pre-crisis equilibrium, but as its inherent capacity to reorganize and transform within a socio-ecological framework. By viewing cities as complex adaptive systems, urban planning moves beyond static infrastructure solutions toward dynamic, innovative strategies that account for the 'adaptive cycle' and 'panarchy'- the multi-scale interactions between social and ecological domains. Consequently, a resilient city is one that integrates social justice, environmental health, and institutional flexibility to navigate uncertainty, ensuring that urban evolution remains sustainable and equitable in the face of increasingly unpredictable global challenges.

By synthesizing the theories of panarchy and social-ecological resilience, this study proposes that adaptive use of schoolyards as public spaces serves as a vital node in the broader urban fabric, capable of absorbing disturbances while actively fostering new forms of social and ecological interaction. Adaptive use of semi-public schoolyards as public places, along with preserving their primary land use, is considered a new adaptive strategy to achieve urban resilience in the context of urban crises, such as intensive urban densification, competing land-use, microclimate changes, shrinking of open and green public spaces, and the decrease in their quality. Rather than being designed as a finished, static product, the schoolyard must possess the inherent flexibility to evolve alongside changing environmental and social pressures. In the context of this research, the schoolyards are considered a micro-scale complex adaptive systems, composed of nature and society. The main components of these systems are places, people and institutions. This means that resilience of semi-public schoolyards leans on environmental or physical, social and institutional resilience. Environmental resilience is determined by spatial elements, or urban parameters such as land use designation and regime of use. The characteristics of these elements and parameters mostly affect the adaptive capacity of schoolyards. Further, social resilience of schoolyards is determined

by the public participation in adaptive design. The main actors are pupils, representatives of the school administration, residents and city authorities or decision makers. Social resilience advocates for the collaborative planning approach for designing adaptive strategies which further facilitates approval of the design by all stakeholders. Finally, schoolyards are undergoing evolutionary processes of adaptive cycle, in which time of recovery matters the most. In this regard, institutional resilience refers to the flexibility and ability of planning practice to quickly implement adaptive strategies, with or without adjusting planning practices. As a basic condition for the short-term adaptation of schoolyards, institutional resilience is described in detail in the next chapter.

## 3. PLANNING POSSIBILITIES FOR ADAPTING SCHOOLYARDS INTO OPEN PUBLIC SPACES

In the Republic of Srpska, urban planning practice is governed by the Law on Spatial Planning and Construction and its accompanying by-laws, which define the methodologies for preparing strategic planning documents and their subsequent elaboration through implementation planning documents [41]. In practice, however, the development of most cities and urban settlements proceeds without the support of updated or operational urban plans. Implementation planning documents are frequently adopted based on outdated strategic objectives and are subject to varying interpretations of planning regulations, depending on the nature and intent of a given intervention. As a result, cities often rely on ad hoc urban remediation measures at the scale of entire urban districts or even individual parcels.

The vision outlined in the most recent urban plan of the City of Banjaluka, that was invalidated by the extensive reconfiguration of the political and economic order, has long ceased to be attainable. Until the long-awaited new urban plan is adopted, the city is compelled to address its infrastructural challenges through alternative and temporary solutions. Nevertheless, it is essential that these provisional measures remain anchored in the principles of strategic planning, thereby safeguarding the continuity of planning rationale in the absence of a contemporary strategic framework.

In Banjaluka, the principal urban center of the Republic of Srpska, 29 central primary schools are currently functioning, the majority having been constructed under the last operative urban plan or acknowledged as pre-existing conditions during its drafting. Subsequent interventions have been sporadic and minimal, without changes to the designated land use or to the regulatory framework governing access and use of these semi-public parcels. This is not coincidental, since school facilities represent one of the most consistently stable and resilient land-use categories, historically and at present [42]. This serves as a key starting point for the present research, leaving little doubt that the network of primary schoolyards can be considered a potential future network of open public spaces in the city, regardless of the status of strategic planning documentation. It is unlikely that any future urban plan will alter the designated use of most of these areas, nor is the city expected to relinquish its right to manage these parcels. For this reason, the adaptation of the schoolyard network into a network of open public spaces emerges as a particularly powerful and immediately available instrument.

In light of these considerations, it is deemed justified to once again examine, in a targeted manner, whether the existing regulations and methodologies for preparing spatial-planning documentation contain any obstacles to adapting the network of primary schoolyards into a network of open public spaces.

Urban resilience, when examined through the lens of its core principles, is reflected not only in spatial elements, particularly the urban parameters defined by implementation planning documents, but also in the spatial qualities that determine how these spaces perform in everyday use. Land-use designation and the regime of land use constitute the key urban parameters, interpreted through several graphic annexes and textual guidelines of the plan. The primary land-use designation is read from the graphic representations in the spatial organization plan and the green-space development plan, while complementary and prohibited uses are defined in the textual section.

The regulatory conditions of access and use, as defined by the regulatory line, determine whether a parcel functions as public, private, or semi-public space. This access and use regime are distinct from the land-use designation, which defines the functional purpose of the parcel but does not prescribe its accessibility. In regulatory plans, the position of the regulatory line therefore plays a decisive role in establishing the parcel's access status, irrespective of its designated land use. In the case of schoolyards, regulatory plans typically define a restricted regime of use for green areas, specifying how different categories of users may access the facilities and similar considerations.

A review of the relevant regulations shows that a constructive interpretation of these requirements does not encounter significant obstacles, provided there is a benevolent intention to address a given urban issue through the contemporary urban-planning concepts, such principles of urban resilience.

## 4. ADAPTIVE MODEL OF THE SCHOOLYARDS

Building on urban resilience theory and the principles of this concept as the guiding framework for adapting schoolyards into open public spaces, an adaptive schoolyard model has been defined. This innovative model is articulated through a set of spatial qualities that further elaborate the planning requirements of implementation planning documents, particularly regulatory plans. For the purposes of this research, the relevant requirements concern spatial organization with defined land-use designation, the arrangement of green areas and the resulting definition of the accessibility regime.

In the context of urban resilience principles, the adaptive schoolyard model is defined through five key attributes: multifunctionality, greenness, safety, accessibility and connectivity. With respect to the urban parameters established by implementation plans, multifunctionality and greenness refine the planned land-use of schoolyards and the design of green spaces. Meanwhile, the inherent safety of schoolyards, their accessibility to different categories of simultaneous or alternating users and their connectivity with the community and the natural environment specify the constraints and possibilities of the accessibility regime for these open public spaces.

In this research, the multifunctionality of schoolyards refers to the simultaneous or alternating use of diverse educational and recreational features, articulated through a spatial layout in which activity zones are arranged to function either independently or in overlapping sequences, thereby strengthening the resilience of both the community and the environment. In the absence of sufficient public green spaces, local communities increasingly rely on schoolyards to function as neighborhood parks, recreational areas, places for rest and social interaction and micro-centers of biodiversity.

Within the broader concept of multifunctionality, the compatibility of different features plays an important role, particularly in how adjacent or sequential spatial units are positioned to minimize functional conflicts. In this model, the primary functions of the schoolyard remain focused on education, sports, recreation and play, spatially anchored in clearly identifiable zones that structure the overall organization of the site. All other permitted uses must serve exclusively as support to these primary functions, typically placed in transitional or peripheral areas that do not interfere with core activities.

The potential of schoolyards to be transformed into public, multifunctional spaces is also highlighted in the work of Bosnian Herzegovinian authors [9]. Their study demonstrates that schoolyards can function as open public spaces, particularly in the context of increasing urbanization pressures and the lack of public green areas. They argue that schoolyards should be designed as multifunctional environments that serve as meeting places and shared community spaces, emphasizing the importance of community involvement in the transformation process. In conclusion, the authors assert that schoolyards can become an integral part of a broader network of open public spaces. Along this trajectory, the multifunctionality of schoolyards, that serve educational purposes while also supporting recreation, community life and environmental quality, is essential.

Beyond strengthening social cohesion, carefully greened schoolyards in compact, high-density urban areas also contribute to enhancing the city's resilience to climate challenges, with vegetation distributed in a way that creates a continuous ecological structure rather than isolated green fragments. Increasing the proportion of green areas beyond the minimum required standards, systematically arranging tall vegetation and tree lines to improve shading and replacing high solid fences with living hedges are measures that can directly increase the porosity of schoolyards and open these spaces for shared use, forming a spatial gradient from more densely vegetated edges toward open central areas that support multiple activities. For the detailed development of specific locations, the selective application of measures defined by various Nature-Based Solutions models [43, 44] is recommended, including those specifically developed for school environments. For example, the CoolSchools model [44], developed through the international research project of the same name, emphasizes the creation of climate shelters by transforming schoolyards into multifunctional green spaces with a strong social and educational component. The Climate Adaptation Model [44], a more broadly applicable urban-technical approach used by many cities, also highlights Nature-Based Solutions in the context of adapting school environments to heat and climate risks. While the CoolSchools model proposes solutions that operate across multiple spatial scales and extend from the schoolyard to the wider urban context, the Climate Adaptation Model remains focused on spatial and technical interventions at the scale of the schoolyard and its immediate surroundings [44].

Ensuring the safety of pupils during school hours is the primary reason for the restricted accessibility regime applied to schoolyards as green areas, including the installation of site enclosure. Within the adaptive model, however, the schoolyard is defined as an open public space, that is accessible to the community after school hours, as well as on weekends and during school breaks. Children, who are the primary users of open green spaces in urban environments, remain central to this concept. Opening schoolyards outside teaching hours further implies their integration into the wider network of open spaces at the city level. A prerequisite for this is ensuring accessibility for other categories of users as well. In the context of the schoolyard's primary educational function, safety is ensured not only through controlled access, but also through its gradation and spatial segregation in relation to the specific features planned for a given location, with child-oriented areas positioned closer to supervised or enclosed parts of the site, and more flexible or community-oriented spaces placed toward the perimeter where shared use is expected. Safety is therefore expressed spatially through clear sightlines, buffered transitions between active and quiet zones, and the placement of higher-risk activities in areas where natural oversight is strongest.

According to the Integrated urban development strategy (ISEK) approach, the schoolyard is considered part of the city's network of open public spaces, that is connected with the surrounding neighborhood and offers various opportunities for sports, recreation and play, not only for school users but also for residents of the immediate residential area [45], with its edges, paths and access points aligned to existing pedestrian flows, green corridors or nearby community facilities. Connectivity is therefore expressed spatially through continuous movement routes that extend beyond the school boundary, linking the schoolyard to adjacent parks, streetscapes or public squares and reinforcing its role within the wider urban fabric.

The adaptive schoolyard model requires that, prior to its application and the elaboration of planning requirements for a specific schoolyard location, the existing conditions be assessed at three scales: the schoolyard itself, its immediate surroundings and its position within the citywide network of open public spaces. The subsequent process of urban design, defining concrete measures for adapting the schoolyard into an open public space, should be based on collaborative planning, with particular emphasis on the active involvement of the community throughout the entire process: from the initial idea, through needs assessment, to the adoption of the final design solution. The relevance and importance of this approach is supported by a study conducted by Greek authors, which analyzes community responses to the transformation of schoolyards into community gardens. The results show that the community responded positively to the newly created open spaces [46].

The adaptive schoolyard model described above offers an innovative, rapid and efficient approach to addressing the persistent urban-planning challenge of diminishing green areas intended for public use in compact, high-density urban areas. The application of this model requires a prior assessment of its alignment with the existing planning documentation.

By synthesizing the theoretical framework of urban resilience with the methodologically examined planning basis for applying its principles, the adaptive schoolyard model has been defined as a dynamic system within the city's network of open spaces. Implementing the adaptive schoolyard model as a spatial construct enables a swift and effective response to the growing need for green areas in compact, high-density urban areas. Such transformation of schoolyards strengthens urban resilience by combining climate-resilient solutions with socially inclusive and educationally supportive spaces.

The following section presents a case study involving three primary schools in Banjaluka. These examples are used to examine the feasibility of applying the model and to evaluate the flexibility of planning requirements in terms of their capacity to be upgraded in accordance with the specific needs of the defined model.

## 5. CASE STUDY OF PRIMARY SCHOOLS IN BANJALUKA

This case study examines three primary schools in Banjaluka. All three are located in compact, high-density urban areas, each shaped by distinct typo-morphological characteristics in their immediate surroundings. Their planning treatment is comparable since all three school parcels are regulated by plans adopted between 2005 and 2008 and prepared according to a unified methodological framework.

The adaptive schoolyard model outlined in the previous chapter provides the methodological basis for evaluating the potential adaptation of these schoolyards into open public spaces. The model is structured around spatial qualities derived from the principles of urban resilience. Accordingly, the urban parameters defined in the plans for the selected schools are assessed through the lens of multifunctionality and the potential for adjusting the functional zones of the schoolyard, depending

on the rigidity of the restricted accessibility regime. Greenness is evaluated through opportunities for integrating Nature-based Solutions. Safety, accessibility and connectivity are examined in terms of the feasibility of establishing the schoolyard both as an individual open space and as part of the citywide network of open public spaces.

Examining the selected school locations and determining the applicability of the adaptive schoolyard model to real sites requires a constructive analysis of the existing regulatory plans, identification of potential spatial conflicts between the planned solutions and the spatial qualities of the model and the formulation of guidelines for refining planning documentation. The aim is to enable a rapid and efficient transformation of schoolyards without lengthy procedures for revising regulatory plans.

For each school and its corresponding parcel, a comprehensive review of the planning documentation was conducted. The full content of each plan was analyzed, with particular attention given to the urban parameters that correspond to the spatial qualities of the adaptive model. The most relevant graphic annexes for the final assessment include the spatial organization plan, the green-space development plan and the plan of building and regulatory lines. Certain graphic elements were further clarified through the textual components of the plans. For the purposes of this study, the most significant textual sections are those addressing the design of green areas and the restricted use of public green space within the schoolyard. Since the analysis focuses exclusively on the school parcel, without a detailed interpretation of the surrounding urban fabric, the case study presents the green space development plan, from which all relevant graphically defined urban parameters can be interpreted, accompanied by a concise explanation of the corresponding textual requirements.

### 5.1. BRANKO RADIČEVIĆ PRIMARY SCHOOL

The Branko Radičević Primary School is located in the Starčevica district. Rapid urbanization in this part of Banjaluka, combined with the effects of the 1969 earthquake, led to significant expansion of the school's main building and several major reconstructions over time. Although spacious, the schoolyard currently functions primarily as a sports ground dominated by concrete surfaces (figure 3). The site is regulated by the "Jug 3" Regulatory Plan adopted in 2005 [47].

The planning documentation designates the area surrounding the school as a public space with a restricted accessibility regime (figure 4). This designation prevents interventions incompatible with education, sports, recreation, or play. Therefore, commercial construction is therefore excluded. The plan also anticipates an extension of the school building to increase capacity, as well as the construction of a sports hall, interventions that have already been completed and now serve pupils, sport clubs and the wider community. These planning requirements indicate that multifunctionality, as defined in the adaptive model, is feasible and that no obstacles exist in this regard.

A closer analysis of the green-space development plan and the planned street-alignment lines reveals greater rigidity in relation to the adaptive model. Implementing the model would require transforming key spatial qualities (particularly greenery and site enclosure) to open the schoolyard to the community.

*Figure 3. A view of the school's sports yard at Branko Radičević Primary School, located in the southwest part of the property (photo by the Author).*

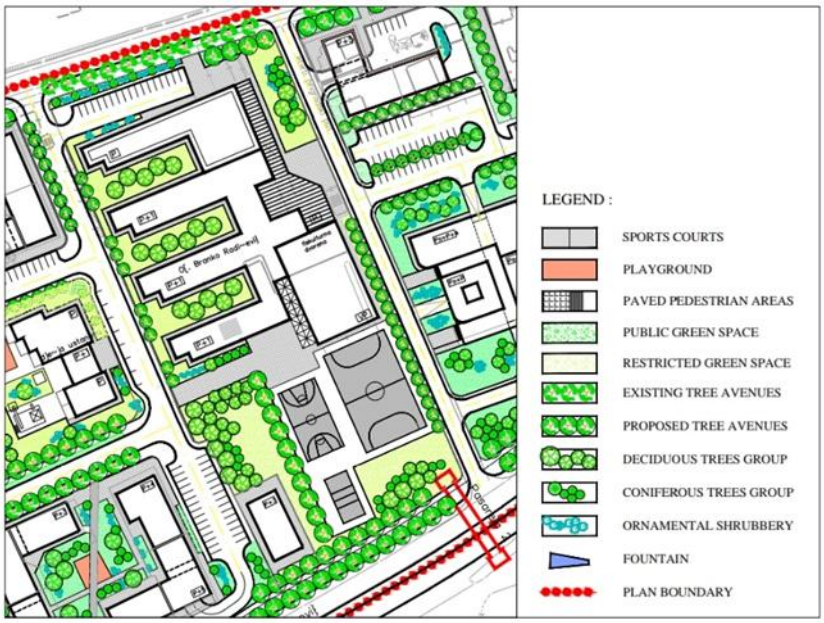


*Figure 4. Greenery Development plan: Regulatory Plan Jug 3 [47].*

## 5.2. VUK KARADŽIĆ PRIMARY SCHOOL

The Vuk Karadžić Primary School is one of the oldest in the city. The current building, located in the Borik residential area, was constructed in 1974 after the previous facility was destroyed in the 1969 earthquake. For its time, the school was designed according to the highest standards for large residential districts. Subsequent interventions have not significantly altered the physical structure or the features within the school parcel. The schoolyard is spacious and dominated by concrete surfaces (figure 5). As with the Branko Radičević schoolyard, multifunctionality as defined in the adaptive model is feasible according to the applicable plan.

The relevant regulatory document is the Revision of the Regulatory Plan for the Borik Residential Settlement, adopted in 2005 [48]. Under this plan, the area surrounding the school retains the character of a public space with a restricted accessibility regime (figure 6). The building footprint and its position on the parcel are preserved and the pedestrian paths and access routes remain unchanged. In recent years, several attempts have been made to initiate modifications to parts of this regulatory plan. Drafts of new planning solutions indicate a tendency to redefine the school's accessibility and connectivity with the surrounding residential area, primarily to enable the construction of multi-story residential buildings in the immediate surroundings.

As in the previous case, the analysis shows that the schoolyard continues to function as a designed public green space with a controlled access regime. For it to operate as an open community space, key spatial characteristics, particularly greenery, site enclosure and access points, would need to be reconfigured.

*Figure 5. A view of the school's sports yard at Vuk Karadžić Primary School, located in the northwest part of the property (photo by the Author)*

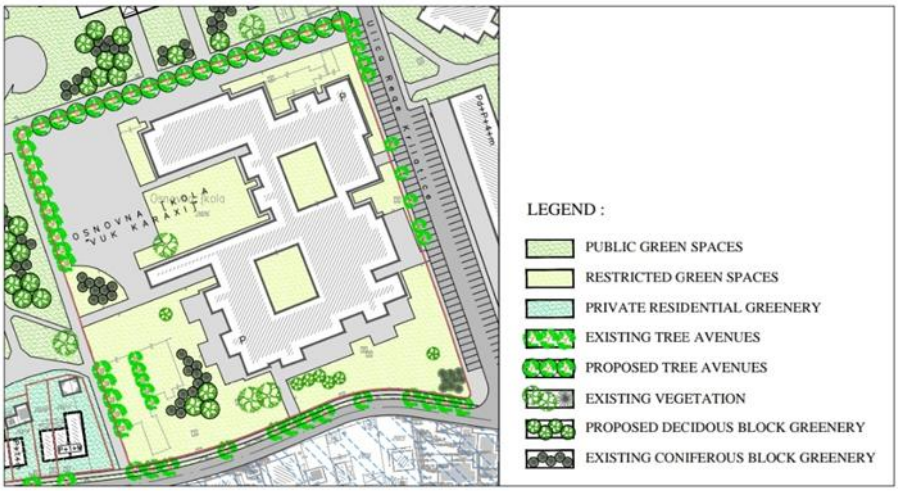


*Figure 6. Greenery Development plan: Revision of the Regulatory Plan for the Borik Residential Settlement [48].*

### 5.3. JOVAN CVIJIĆ PRIMARY SCHOOL

The Jovan Cvijić Primary School is located in the Kočićev Vijenac district. The physical structure of the school facilities has undergone numerous repairs and reconstructions since the original building was constructed in 1932, particularly after the 1969 earthquake. The school parcel is situated within a compact, high-density urban environment, which further reinforces the need to adapt the schoolyard into an open public space for the surrounding community.

The school site is covered by the "Jug 7" Regulatory Plan, adopted in 2008 [49]. A review of the planning documentation shows that the existing school building, with its articulated footprint, is retained, along with the addition of a single-story annex on the northwestern facade. The green-space development plan preserves the paved entrance area and the concrete sports courts. (figure 7 and 8) When interpreted through the lens of multifunctionality, no obstacles to implementing the adaptive model are identified and its realization would not require formal revisions to the planning document.

As in the previous cases, further examination confirms that the schoolyard retains the character of a designed public green area with a restricted accessibility regime. For this schoolyard to function as an open public space, it would be necessary to transform key spatial qualities – particularly greenery, site enclosure and access points.

*Figure 7. A view of the green, landscaped area of the schoolyard at Jovan Cvijić Primary School, located in the southeastern part of the property (photo by the Author).*

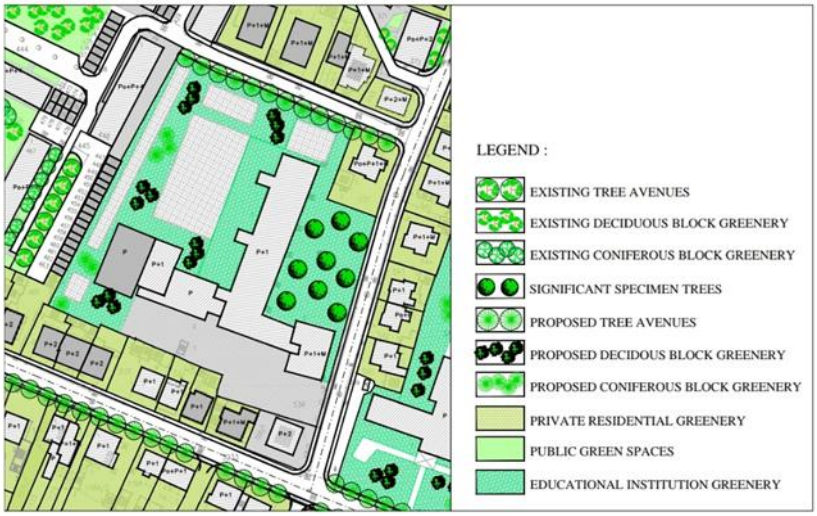


*Figure 8. Greenery Development plan: Regulatory Plan Jug 7 [49].*

## 6. DISCUSION

This research was guided by two main research questions: which aspects of resilience can define an adaptive model of schoolyards as public spaces, and what is the current attitude of urban planning practice towards implementing such a model?

The research findings indicate that the adaptive model for schoolyards is predicated not on resistance- the system's capacity to remain static- but on adaptive capacity, defined as the inherent ability of a system to evolve. The primary dimension of resilience underpinning this model is socio-ecological resilience within the framework of complex adaptive systems. In this context, the schoolyard is conceptualized not merely as a physical space, but as a dynamic system characterized by the interplay between anthropogenic, natural, and institutional components. Furthermore, panarchy theory and the adaptive cycle constitute the second pillar of resilience theory defining the model. From this perspective, the schoolyard is perceived as a micro-scale node that exerts influence on the urban macro-scale; its rapid adaptation can catalyze systemic transformations across the entire urban fabric. Ultimately, the model is governed by a tripartite resilience framework: a) environmental resilience, dictated by land-use designations and regimes, and determined by spatial attributes such as multifunctionality, greenness, safety, accessibility, and connectivity; b) social resilience, grounded in collaborative planning methodologies and co-design principles; and c) institutional resilience, which pertains to the agility of planning practices in facilitating and 'permitting' adaptive change.

The case study in Banjaluka demonstrates that there are no planning constraints that explicitly prohibit the adaptive model of schoolyards. The restricted accessibility regime applied to schoolyards still allows for the definition of various features within the school parcel, provided they remain compatible with the primary functions of education, sports, recreation and play. In all three analyzed schoolyards, it is possible to achieve functional multifunctionality and an adequate level of greenness alongside core educational uses. The main rigidity lies in the restricted accessibility regime, particularly in how it limits openness and connectivity with the surrounding area. Furthermore, practice currently favors safety through isolation, while the resilience model requires openness and connectivity. The sense of safety created by site enclosure and strict control of access would need to be reinterpreted and transformed, without compromising the actual safety of pupils. This underscores the need to reconsider and redefine the restricted accessibility regime of primary schoolyards defined by implementation plans, aligning it with the contemporary concept of the school as an open, community-oriented and resilient urban space. Finally, this means that the „bottleneck" of the model implementation lies more in interpretation and management than in the plan itself.

These results represent a step forward compared to existing literature which mostly praises green schoolyards for public health. Instead of viewing the schoolyard as an isolated "green dot," the paper defines it as an operational tool for urban resilience that directly responds to the failures of neoliberal urbanism such as loss of public space and prioritizing private capital. Moreover, the paper fills the gap in research that rarely addresses how administrative accessibility regimes directly impact the ecological and social resilience of a city.

## 7. CONCLUSION

Numerous cities worldwide are facing great uncertainty and fast environmental, economic and social changes, and therefore tend to develop innovative strategies to achieve urban resilience. Adaptation of schoolyards into network of open public and green spaces is one of the strategies to improve the city's resilience especially when it comes to negative consequences of accelerated urbanization, reduced areas of open public spaces and deteriorating urban microclimates. This strategy has short-term and long-term environmental and social benefits such as rainwater management, improvement of the air quality, reduction of air temperature, social integration, inclusion of isolated groups and empowerment of future generations through engagement [9].

In this paper, adaptive model of schoolyard is developed based on the theoretical concept of resilience and urban planning possibilities of implementation of this model is examined. The adaptive schoolyard model is defined through five key attributes: multifunctionality, greenness, safety, accessibility and connectivity. The model, as defined, serves as a tool for understanding schoolyards as a spatial network within the city and their role in urban resilience strategies. Ignoring the adaptive capacity of the schoolyards in the context of urban planning of the entire city is considered a missed opportunity to mitigate the adverse effects of urban densification and the loss of open spaces. The implementation of the model is examined in the case study of three primary schools in Banjaluka. More precisely, examples are used to examine the feasibility of applying the model and to evaluate the flexibility of planning requirements to meet specific needs of defined model. The research showed that the integration of the model into the urban network was hindered more by institutional rigidity (e.g., restricted accessibility regimes) than by formal planning constraints.

The prerequisite for implementing the adaptive model of schoolyard is the analysis of planning requirements and constraints, and assessment of the current state of the site and its surroundings, as well as the position of the site within the citywide network of open public spaces. In addition, implementation of the model implies application of principles of collaborative urban design with active involvement of the community, which contributes to the schoolyard design approval by all stakeholders. By involving community in the co-design of the adaptive schoolyards, the model contributes to community empowerment and fosters a sense of ownership and responsibility among local communities. Moreover, since there are not planning constrains, quick implementation of the model allows for rapid adaptation to changing urban needs. Considering the above, the model involves traditional methods and tools based on rational, analytical, and normative principles as well as innovative methods and tools based on principles of resilience. Finally, adaptive model of schoolyards promotes more responsible and future-oriented design, capable of adapting to ongoing changes, from environmental sustainability to social inclusion. Finally, the method used to create the model in this multiple case study research is transferable to other cities to be tested for further improvements.

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