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Review paper

NATURE-BASED SOLUTIONS IN LOCAL STRATEGIC AND PLANNING FRAMEWORKS: THE PERSPECTIVE OF THE CITY OF NIŠ, SERBIA

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Abstract

Nature-based Solutions (NbS) are increasingly recognized as important elements for addressing environmental, social, and climate-related challenges in urban areas. By integrating green and blue infrastructure into the urban fabric, NbS contribute to climate adaptation, human well-being improvement and biodiversity benefits, particularly within public open spaces (POS) in multi-family residential neighbourhoods. Successful implementation of NbS, however, depends not only on physical interventions but also on supportive governance, planning, and regulatory frameworks.

This paper examines the treatment of NbS within the local governance and urban development framework of the City of Niš, Serbia. The study analyses key strategic and statutory planning documents, including the Urban Development Strategy, Development Plan, General Urban Plan, and Plans of General Regulation, with a particular focus on their implications for the (re)integration of POS in multifamily residential areas. The research aims to identify the opportunities and limitations that the existing local framework creates for NbS implementation.

The findings indicate that NbS principles are increasingly embedded in local strategic and planning frameworks through measures promoting green and blue infrastructure, green roofs and facades, minimum green-space requirements, and common-use open spaces in residential developments. At the same time, implementation is constrained by weak monitoring systems, the absence of a functional green-space cadastre, insufficiently elaborated planning standards, and market-driven development. The study highlights the need for stronger institutional capacities, improved monitoring mechanisms, clearer implementation guidelines, and greater public awareness to support the effective integration of NbS into urban development. The findings also point to the importance of further legislative and policy support at the national level to ensure a more consistent and sustainable application of NbS in Serbian cities.

Key words: *Strategic Development Documents, Urban Plans, Integration of Nature-based Solutions, City Level*

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1. INTRODUCTION

Nature-based Solutions (NbS) is the umbrella concept of ecosystem-based approaches that addresses crucial societal and environmental challenges of urban development. According to the International Union for Conservation of Nature (IUCN), NbS are “actions to protect, sustainably manage and restore natural and modified ecosystems, which address societal challenges effectively and adaptively, providing human well-being and biodiversity benefits” [1]. These solutions are also considered to be one of the key measures of disaster risk reduction and climate change adaptation and mitigation in the New Urban Agenda [2].

NbS imply restoring natural elements of blue and green infrastructure into the urban landscape, as well as renaturing paved surfaces. Therefore, NbS play a vital role in designing public open space (POS) within multi-family residential areas, offering sustainable, resilient and affordable solutions to challenges such as climate change adaptation [3] and improving public health and well-being [4]. The application of NbS can help minimize vulnerability to risks such as heat stress, air pollution and urban flooding [5,6], while also creating safe, inclusive and ecologically diverse environments. Such resilient and vibrant communities with NbS elements are favoured in contemporary urban planning and design concepts for reclaiming POS in residential areas [7].

Regarding the treatment of NbS in national legislation of the Republic of Serbia, it can be stated that the existing general framework fits well into the context of NbS, and provides good grounds for their application in POSs. The standing *Law on Planning and Construction* [8] does not explicitly mention "Nature-based Solutions" but refers to “Biodiversity-based solutions" and “Green infrastructure”, while the *Law on Environmental Protection* provides a framework for the management of green areas [9]. Furthermore, the *Rulebook on the Content, Method and Procedure of Creating Spatial and Urban Planning Documents* [10] mandates incorporation of green space regulations into urban planning documents of lower rank, as well the inclusion of green areas data into urban design projects. This conceptual commitment is further supported in the *Sustainable Urban Development Strategy of the Republic of Serbia until 2030* [11], which prioritizes NbS within its framework for urban development, and proposes certain priority measures that are directly or indirectly linked to NbS implementation in POSs within multi-family housing.

This paper investigates how NbS concept is incorporated into local planning and governance frameworks in Serbia through the case of the City of Niš. By analysing the city’s regulative and strategic framework related to NbS, the overall objective of this research is to explore the treatment of NbS in strategic and planning documents of the city, in order to determine the potentials and limitations for the implementation of NbS in POS (re)integration at the neighbourhood level.

This study employs empirical research and a review of relevant literature, with a methodological framework based on descriptive and analytical approaches. The research involves a comprehensive review of local-level data, including strategic frameworks and statutory planning documents, to examine how the concept of NbS is addressed within residential areas of the City of Niš. The analysis of these policy and

planning documents provides insight into the contextual factors influencing NbS implementation, and assesses the extent to which the existing planning framework supports the sustainable development of POS within multifamily housing areas. The synthesis of study findings is used as a basis for discussing the opportunities and constraints for NbS implementation in residential POSs within the specific context of Niš, and in the broader planning and governance framework of the Republic of Serbia.

2. NATURE-BASED SOLUTIONS IN STRATEGIC DEVELOPMENT DOCUMENTS

2.1. Urban Development Strategy of the City of Niš and the Municipalities of Svrljig, Merošina and Gadžin Han

When reviewing green infrastructure in the Analytical part, the *Strategy* [12] acknowledges the issue of the lack of greenery in urban blocks, which is devastated and used as parking. Furthermore, it points to the planned increase in green areas and open spaces at the level of the entire urban settlement (to 15.7% of the construction area).

By harmonizing the goals and measures from the EU and national policies, a framework for sustainable and integral territorial development of urban areas was established, with a set of localized goals suited to the local context. Goals, specific goals and measures relevant for NbS are summarized in Table 1.

Table 1. Goals and measures relevant for NbS in the Urban Development Strategy of the City of Niš and the municipalities of Svrljig, Merošina and Gadžin Han

Goal 2. Promoting clean and fair energy transition, green and blue investments, climate change adaptation and mitigation, risk prevention and management, and sustainable urban mobility	
Specific goal 2.4. Adaptation to climate change and disaster risk prevention, strengthening resilience to climate change, taking into account an ecosystem-based approach	
Measure 2.4.5.	Developed or improved green infrastructure to adapt to climate change
Specific goal 2.7. Strengthening the protection and preservation of nature, biodiversity and green infrastructure, and reducing all forms of pollution	
Measure 2.7.1.	Green and blue infrastructure

According to the Map of priority areas of intervention in the *Strategy*, the green infrastructure appears to be planned outside the urban area, while no NbS elements are discussed for zones of multi-family housing. Furthermore, none of the established strategic projects in the document relate to the NbS. However, a list of priority ideas is given in the Annex of the Strategy. One of them refers to NbS, and includes roof gardens and gardens in neighbourhood greenery. Another idea includes a project to reduce the carbon footprint of buildings and create green roofs and facades in Niš.

2.2. Development Plan of the City of Niš 2021-2027

The *Development Plan* [13] establishes four priority development directions tailored to the local context. The importance of NbS is acknowledged within “Development direction 2. Territorial development and environmental protection”. Table 2 summarizes the relevant priority goal and measure dealing with the NbS.

Table 2. Goal and measure related to NbS in the Development Plan of the City of Niš 2021-2027

Development direction 2. Territorial development and environmental protection	
Priority goal 2.5. Preserve the potential of adaptation and mitigation measures established at the national level until 2030, by increasing resistance to climate change in priority sectors and establishing response in risky and emergency situations in urban and rural settlements	
Measure 2.5.4.	Prescribes the creation of green and blue infrastructure in Niš territory, and emphasizes the investment in green infrastructure in public spaces.

Within the framework of this measure, it is planned to create interconnected ecosystems and incorporate green infrastructure, as well as prepare guidelines for defining green and blue infrastructure and nature-based infrastructure. In line with these guidelines, two studies will be prepared: (1) a study of the initial condition of the green areas of the urban and rural core with the cadastre (including protected properties), and (2) a study of adaptive measures to climate change for greenery, green and blue infrastructure and nature-based infrastructure, with ecosystem management measures to increase resistance and reduce the sensitivity of people and the environment to climate change (EbA approach), and strategic planning of the network of natural and semi-natural areas. These results will serve as a basis for the preparation of the Plan of General Regulation, and the integration of the obtained Plan into the cadastre, which is one of the services of the Geographical Information System of the City of Niš. Following that, this measure implies investments in green infrastructure (vertical gardens, green roofs, city parks, green network, green bridges, green corridors for wildlife, underground parks, urban wetlands, public spaces, streets and squares...).

Two performance indicators are provided to measure the results in the application of this measure: the number of study-planning-analytical documents that define blue and green infrastructure, and the number of pilot projects with blue and green infrastructure. As no monitoring of the achievement of goals defined in the *Development Plan* is carried out in the City of Nis, the effects of this measure are unknown even five years after the *Development Plan* was adopted. The cadastre of green areas has also not been formed to date.

3. NATURE-BASED SOLUTIONS IN URBAN PLANNING DOCUMENTS

3.1. General Urban Plan of Niš 2010-2025

Although this *General Urban Plan* (GUP) [14] and its four amendments and supplements do not mention the term NbS, greenery is discussed in detail within the framework of spatial and environmental protection. GUP states that the importance of greenery in Niš is reflected in the function of satisfying sanitary-hygienic-recreational conditions. According to the GUP, greenery in residential areas, in addition to greenery involving individual single-family plots, includes block greenery as an integral part of extended housing function. GUP states that the use of block greenery allows for close and everyday contact between residents and vegetation. In addition to aesthetic and decorative significance, landscaping of open space must also have functional significance.

3.2. Plans of General Regulation of City Municipalities

3.2.1. Plan of General Regulation of the City Municipality Medijana

Given the extreme densification of urban fabric in the post-socialist period, particularly in the most densely developed territory of the city municipality Medijana [15,16], attempts were made to improve the quality of urban living by increasing the share of green surfaces. In 2021, in the *Third Modifications and Additions of Plan of General Regulation of the City Municipality Medijana* (PGR) [17], all prior provisions in the Plan relating to green areas were repealed, and new regulations were provided. In Chapter 2.0. Building Rules, Section 2.3. Individual Building Rules, the minimum percentage of green areas is set at 25% of the plot area, out of which 10% of the plot area is green areas in direct contact with the ground. This applies to all land uses with a share of green areas smaller than 25%. Soon afterward, additional PGRs of city areas also introduced the same rule concerning the share of green areas in residential zones.

This was the first PGR to initiate the implementation of NbS and further elaborate the term "green areas", which was later applied in PGRs of other city municipalities. The term "green areas" refers to all types of green surfaces and tall greenery, and aside from ground-connected greenery also involves green roofs, green facades as well as greenery above underground floors. However, only green spaces with direct ground contact are evaluated as 100% contributing greenery, while the Plan prescribes that other types of green surfaces are to be assessed at a reduced percentage:

- Green roof: 50% of the roof area covered with greenery is valued in the calculation;
- Green facade: 50% of the facade area covered with greenery is calculated;
- Greenery above underground floors: 50% of the required green area in the calculation.

Regarding tall greenery, it is defined that one tree is valued as 5.0 m² of greenery, but it is not precisely stated whether tall greenery also needs to be in direct contact with the ground, or not. This implies that this rule is open to misinterpretation, and may even result in trees with smaller canopy span that are placed in planters. Additionally, in the PGR of Medijana city municipality, the type of tall greenery is not pre-defined and may refer to any tree species. This issue was addressed in following PGSs of city municipalities Pantelej and Palilula.

3.2.2. Plans of General Regulation of City Municipalities Pantelej and Palilula

The analysed PGRs of city municipalities Pantelej and Palilula involve: *Sixth Modifications and Additions of the PGR of the City Municipality Palilula – Phase I* [18], *Second Modifications and Additions of the PGR of the City Municipality Palilula – Phase II* [19], *Second Modifications and Additions of the PGR of the City Municipality Pantelej – Phase I* [20], *Third Modifications and Additions of the PGR of the City Municipality Pantelej – Phase II* [21], and *Third Modifications and Additions of the PGR of the City Municipality Pantelej – Phase III West* [22].

These planning documents take on a comprehensive approach to implement various types of green infrastructure in POSs in the area covered by the Plans.

Regarding the overall landscaping of neighbourhoods, it is advised to use a large number of autochthonous (native) and allochthonous (exotic) species, both conifers and deciduous species in the form of trees, ornamental shrubs, climbing plants, hedges, flowerbeds and lawns. The PGRs of the city municipality Pantelej go a step further to provide a table "Typology of Greenery" that defines the type and density of particular greening elements that are implemented in parterre greenery, green roofs, vertical greenery and tree lines. Regarding the type of trees, the two PGRs for city municipality Pantelej even define the type of seedling, its diameter and the spacing of the trees, as well as the ratio of trees and shrubs on the plot.

All PGRs for Pantelej and Palilula also state that in the case of new construction, vertical extension of structures and reconstruction, resulting in the increase of more than three single residential units, one tree sapling should be provided for each apartment within the plot/complex, or on public and other land within the boundaries of the Plan, in line with the conditions of the relevant public utility company.

The PGRs for city municipalities Pantelej and Palilula further elaborate on the construction of green roofs and define the greenery that is to be used when implementing this type of green infrastructure. The use of extensive green roofs is prescribed, which are primarily designed as decorative surfaces that also provide environmental benefits, have limited access for maintenance only, and do not enable recreational activities. This type of green roofs is selected because they are easier, cheaper and faster to install, and require very little maintenance. Regarding the type of greenery that may be planted, it involves low plants that are highly resistant to dry climate conditions, such as grass, dwarf shrubs and flowering plants, and even some medicinal and perennial herbs, depending on the accessibility of the roof area. Regarding green facades, the PGRs for city municipalities Pantelej and Palilula define climbing plants as the type of greenery to be used, at a density of three seedlings per meter long.

It is also important that the *PGR of the City Municipality Pantelej – Phase I* was the first plan to introduce a new land use "Mixed-use Zone with Larger Green Areas", where business and residential uses are dominant urban functions. The PGR states that many important building rules for this land use, such as the share of POS, will be determined through further elaboration, implying elaboration at the lower levels of urban planning. Regarding green areas, building rules prescribe mandatory share of greenery of at least 30% of the plot/complex area, which is also to be determined through further urban elaboration of the site in lower-ranked planning documents.

3.2.3. Management Solutions and Digital Solutions in Plans of General Regulation

The intent to implement green infrastructure has revealed the crucial weakness of all Niš's PGRs, which relates to the provision of POS that would accommodate such green surfaces. Therefore, the PGRs for city municipalities Pantelej and Palilula prescribe mandatory provision of "undeveloped area in common use" of all residents where various leisure activities are carried out, for plots containing more than three independent housing units. These undeveloped areas do not include green areas, traffic areas, parking lots and pathways. The minimum share of undeveloped area in common

use is prescribed at 20% of plot area, of which 15% should be in open space. The remaining 5% of undeveloped area in common use are related to common rooms within building volume, which can be located on any floor.

This rule could provide good grounds for setting up building-oriented POSs and common POSs for a cluster of buildings, if it referred to open spaces at the parterre level. However, aside from areas in direct contact with the ground and areas in the parterre, it is envisioned in the Plans that the "undeveloped area in common use provided in open space" should also involve open terraces and walk-through roofs. Open terraces and walk-through roofs as options for areas in common use are preferred by the developers as they enable higher index of plot occupancy and more lucrative investments, but such design solutions limit public access. Areas in common use involving open terraces and walk-through roofs mostly imply shared spaces that enable access to local tenants only, resulting in semi-public or semi-private character of open space, and reducing the role of such spaces to environmental benefits alone. This issue gains importance in light of the next rule defined in the Plans, which refers to shaping of these spaces. Namely, it is suggested that undeveloped area in common use should be functionally defined as zones for relaxation, children's play, socializing, recreation, etc., and, if planned at the parterre level, should be connected to green areas, traffic areas and pathways. This rule clearly indicates the need to implement POS in residential developments having both social and environmental function, but in market-driven residential schemes it actually leads to privately owned public space (POPS) models having only environmental function.

Niš is characterized by a low share of parks and recreational areas available to citizens. The creation of a cadastre of green areas is necessary in order to provide a more detailed insight into the typology, structure and extent of green areas in the city. In this regard, the development and implementation of a unified geographic information system (GIS) in public and utility companies and the city administration is recommended, as digital solutions can help improve the city's green areas and overall environmental protection.

4. DISCUSSION: POTENTIALS AND LIMITATIONS FOR THE IMPLEMENTATION OF NATURE-BASED SOLUTIONS IN NIŠ

At the local level of Niš, the importance of NbS is acknowledged in the *Development Plan* as the strategic document of urban development, within a measure that promotes the creation and of green and blue infrastructure, as well as the investments in green infrastructure in public spaces. The proposed development of the cadastre of green areas for the urban and rural core is a noteworthy initiative, but its realization needs to be accelerated. The creation and use of such digital solution within the city's GIS system would be a great enhancement for NbS implementation. The measure relating to green infrastructure is further supported at the strategic level, as the *Urban Development Strategy* also prioritizes roof gardens and gardens in neighbourhood greenery.

Enhancing urban planning at the local level in PGRs by increasing the share of green surfaces to 25% for residential land use, out of which 10% in direct contact with the

ground, is a step forward in creating quality POS with NbS elements. These efforts are further enhanced by prescribing mandatory provision of "undeveloped area in common use" for multi-family housing.

Although the significance of NbS implementation is highlighted in the strategic document of urban development, effects of the measure related to green and blue infrastructure is unknown. Monitoring on the progress of goals defined in the strategic documents is identified as a one of the key issues impeding progress of NbS implementation at the local level. It is therefore necessary to begin the process of monitoring and evaluation grounded in the *Development Plan*, and further incorporated in other legal acts. This requires a significant shift in perception of local decision-makers and institutional departments that are the carries of implementation actions, as well as the improvement of inter-departmental cooperation.

Despite the efforts to increase the minimum percentage of green areas in PGRs of the City of Niš, in residential zones and in mixed-use zones with larger green areas, which favour the implementation of various NbS elements, this regulation needs to be further elaborated depending on the particular urban context in order to avoid misuse. The share of green areas that is in direct contact with the ground of only 10% of plot area may be suitable for the regeneration of highly urbanized areas, but must be significantly higher in new developments. Furthermore, setting the context properly will also help with the choice of NbS elements that would be appropriate for a particular urban area.

When reviewing the management solutions to accommodate NbS in POSs, the PGRs mandate a minimum share of undeveloped common-use areas, including open spaces. However, the inclusion of terraces and roofs into these open spaces limits accessibility, making them semi-private. While the rules emphasize both social and environmental functions of common-use areas, in market-driven developments they primarily result in privately owned public spaces (POPS) with only environmental benefits.

Finally, an important limitation deals with low awareness of general population on the significance of NbS in local communities in cities such as Niš. Further educational actions and raising awareness are needed at city level, to promote the benefits of NbS implementation to all relevant stakeholders in reclaiming neighbourhood's POSs: decision-makers, carries of implementation actions, residents, users and the general population, as an instrument for the broad adoption of NbS.

The example of Niš also reveals that some enhancements of the legislative, strategic and planning frameworks are needed at the national level. Although the national legislative framework favours NbS implementation, it is necessary to introduce this globally-known term into Serbian legislation and regulations on urban development in order to enable the sustainability and permanence of NbS elements. Furthermore, it is essential to set criteria and standards for NbS application, and establish clear guidelines for implementation, which would streamline the process for all stakeholders, particularly urban planners and carriers of implementation. Additionally, local governments in the Serbia must be legally bound to monitor performance indicators in achieving the goals defined in the *Sustainable Urban Development Strategy*. In terms of NbS implementation, the key performance indicator is the surface of urban area

designated for POSs or parks, which is linked to the “Indicator 11.7.1. Average share of the built-up area of cities that is open space for public use for all, by sex, age and persons with disabilities”. The calculation of SDG Indicator 11.7.1. is not yet being monitored in Serbia at the national level due to the lack of local data.

5. CONCLUSION

The analysis of the strategic and planning framework of the City of Niš indicates that the principles of NbS are increasingly being incorporated into local urban governance and planning, although their application remains partial. Strategic documents recognize the importance of green and blue infrastructure, climate adaptation, and ecosystem-based approaches, while planning documents provide concrete mechanisms for the implementation of NbS elements, including green roofs, green facades, increased green-space requirements, and common-use open areas within multifamily housing developments. These provisions demonstrate significant potential for the (re)integration of POS at the neighbourhood level through NbS.

However, several limitations continue to hinder their effective implementation. These include the absence of systematic monitoring and evaluation, the lack of a functional green-space cadastre, insufficiently elaborated planning standards, and the tendency of market-driven development to prioritize semi-private open spaces over accessible public spaces. The findings suggest that, while the existing local framework provides a solid foundation for NbS implementation, stronger institutional capacities, clearer implementation guidelines, improved monitoring mechanisms, and greater public awareness are needed to fully realize the environmental and social benefits of NbS in residential neighbourhoods.

Furthermore, the case of Niš highlights the need for additional legislative and policy support at the national level to ensure a more consistent and effective integration of NbS into urban development practice across Serbia.

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