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## Landscape planning and green infrastructure in Serbia: From national to Belgrade city planning

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### Introduction and backgrounds

The development of landscape planning in Serbia began in the middle of the last century. The principles and objectives of landscape planning were modeled on European trends and developed within the academic framework of the School of landscape architecture at the Faculty of Forestry of the University of Belgrade.

The General Plan of Landscapes (1995) was a failed attempt to "introduce" landscape planning from the framework of academic and scientific debate to institutional spatial planning in Serbia (Vasiljević, 2008). After the ratification of the European Landscape Convention in 2011, a more favorable climate for landscape planning was created in Serbia. As a result of defining a landscape policy, which harmonized the contemporary conceptualization of landscape planning with planning trends in Serbia, ensued the chapter Protection and Arrangement of Landscapes, as part of the Spatial Plan of the Republic of Serbia 2020. For the first time, the spatial concept included all landscapes – urban and rural/ natural, whereas planning principles integrated the principles of landscape ecology (e.g. landscape connectivity) with the principles of aesthetics of landscapes as systems. Landscape character was defined as the target quality and spatial development was supposed to be aligned with it (Vasiljević, 2013).

The landscape-ecological approach in the planning of cityscapes, advocated by many authors had little influence on the planning of Belgrade in the past. As the final stage of the project „Green regulations of Belgrade“, the Program for elaboration of the urban plan of the green spaces system of Belgrade is the first bigger shift towards landscape-ecological planning of the City (Cvejić and Teofilović, 2010). The Plan of General Regulation of Green Spaces of the City of Belgrade (2014) was developed as a result of the project in which green infrastructure and its elements were observed through the core, inner and outer ring of the green spaces system. However, this plan has not been adopted yet, and the reason is the insufficiently grounded form of this planning document

for which there are no known and well-established planning mechanisms of implementation.

In contemporary academic research in Serbia, the concept of green infrastructure is observed through Turner's interpretation of the urban route that is "useful from the aspect of environmental quality in a city" (Turner, 1995), Ahern's strategy of landscape planning in which landscapes are designed as green infrastructure (Ahern, 1995), and the spatial planning strategy, which is considered the only way to a certain future of urban landscapes in the light of climate change (Fabos, 2001). The contemporary theoretical approach to planning at the landscape scale was created in such an atmosphere, based on the concept of landscapes as wholes, transdisciplinary approach to research and landscape character as a new value in spatial development planning (Vasiljević, 2012). This theoretical concept is based on unifying the principles of the multifunctionality of landscapes, redundancy and modularity of landscape functions, diversity of landscape structures and connectedness of landscapes at different levels and adaptability of landscapes (Ahern, 2011).

Given that the theoretical framework of landscape planning in Serbia is new, as well as its application within the framework of the 2020 SPRS, and that in terms of planning practice in Serbia the understanding of this theoretical concept is in the domain of socialization and cultural reproduction (Vasiljević, 2012 according to Faludi, 2004), it was necessary to find a principle – the idea that local interpretation of theories and their application can be assumed to be consistent with ideas operating at a higher (often national) scale (Allmendinger, 2002). The principle of connectivity, which is materialized through green infrastructure, was considered as a way to implement this theoretical concept at the local level. In order to achieve landscape stability, the principle of connectivity is applied to establish short-term goals, which are seen as long-term adaptation measures to climate change. However, the experience in the implementation of this principle through legal framework points to numerous problems. Although the criteria for establishing green infrastructure are defined through theoretical and strategic research, the existing landscape policies are limited (European Communities, 2008).

### **Goals and objectives: Integrating connectivity as a landscape (green infrastructure) planning concept from national to city planning**

There are many problems in the implementation of green infrastructure in Serbia. At the national level, green infrastructure is recognized as one of the ways of applying the landscape-ecological principle of connectivity in order to

increase landscape stability. The modalities of its implementation at the local level, as well as the effects of implementation, represent a specific research object in this paper.

The city of Belgrade has had a long tradition of planning the green spaces system as part of urban planning. The present situation of incoherence and discontinuity of green spaces in Belgrade and the increasing problem of urban environmental load, as well as the occupation of green spaces by other land uses, put-upon the need for research and analysis of the existent state and potentials for the introduction of a new Plan of the city green spaces system (Cvejić and Teofilović, 2010). In this plan, green infrastructure is defined as a system of green city spaces. However, there is an obvious problem of implementation of this planning document at the local level due to a lack of legislative mechanisms for its implementation.

While the need for an analysis of green infrastructure as a broader concept of landscapes is indisputable, there is skepticism among planners that it is possible to express its measurable (plannable) value. Leitao et al. (2002) defined a series of indicators, measurable characteristics of landscape pattern that can determine phenomena such as *loss of biodiversity*, *fragmentation* and *disorders* being the results of fundamental ecological processes. The assessment of the ecological stability of landscape structure in terms of the level of connectivity represents a specific investigation within landscape metrics. At the same time, assessment of the effects of application of the landscape-ecological principle of connectivity as a planning concept in the sectoral plan of reforestation is particular objective of this paper. Finally, in order to make application of this principle part of the method of spatial and sectoral plan development at different scales, it was necessary to define (create) the parameters of landscape metrics, which "indicates that we can predict landscape connectivity using only a small sample of the landscape" (Tischendorf and Fahring, 2000).

## **Materials and Method**

The research area of this study is located in the Belgrade metropolitan area (the suburban area of the Municipality of Voždovac (15034ha)). As the aim of the research is application of the principle of connectivity at the local planning, it was necessary to define the method that will determine the level of existing connectedness between landscape elements as the research subject of the local sectoral Afforestation Plan for Belgrade City - Voždovac Municipality (2011), in order to prioritize the afforestation objectives at the next stage of plan development. In order to make the results of landscape ecological research

available in the planning process, the research method resulted from the theoretical concept of reading the landscape structure through its composition and configuration (Leitao et al., 2006). The parameters of landscape metrics that indicate the degree of connectivity between landscape elements were particularly studied.

The metrics metadata are a set of landscape elements presented in two time sections. The current condition of landscape structure was generated using vectorization of a raster orthophoto from 2011 using the patch-corridor-matrix model (Forman, 1995). Since the high resolution raster shots conditioned rationalization of the level of details in the data base, a categorical map with a spatial resolution of 100 m was determined for the purpose of this research, which enabled a hierarchical organization of elements based on the CORINA method. Within the planned condition of landscape structure in the Afforestation Plan of the Municipality of Voždovac, new landscape elements were geometrized by geodetic survey and represent the vector data of 2015 with the level of accuracy adapted to the resolution of the Corina land cover raster data of 2011.

The application of metrics that quantifies the degree of spatial isolation of landscape elements and responds to the change of distribution of small landscape elements of forests, regardless of the share of existing indigenous large landscape elements (Gustafson and Parker, 1994), showed respectable results. Mean Nearest Neighbor (MNN) is a parameter at class level that expresses the average shortest distance between landscape elements belonging to the forest type recognized as a significant ecological fragmentation factor (Tischendorf and Fahring, 2000; Leitao et al., 2006). The defining of study area parts that showed the highest degree of distance between landscape elements of forests served as the basis for establishing green infrastructure as the planning concept of the Afforestation Plan for the Municipality of Voždovac (Figure 1a).

## **Results and discussion**

Serbian planning policy has no identification and legislation pertaining to green infrastructure. In contemporary academic research in Serbia, green infrastructure is interpreted as the concept of urban and planning strategies in which landscapes are conceptualized as green infrastructure. In line with global trends, green infrastructure is increasingly used as a strategic response to climate change. However, the understanding of this concept as the application of the landscape-ecological principle of connectivity, which at the same time integrates ecosystem services and provides greater landscape

stability at different scales, is part of the landscape-ecological approach to spatial planning taught at the School of landscape architecture. The contemporary theoretical approach to planning at the landscape scale was created in such an atmosphere based on the concept of the landscape as a whole, transdisciplinary approach to research and landscape character as a new value in the planning of spatial development (Vasiljević, 2012).

According to theoretical background, the Spatial Plan of the Republic of Serbia up to 2020 has identified the value of landscapes, as well as the realization of landscape connectivity as one of the planning principles from the national to the local level of planning. As part of the broader concept of landscapes, SPRS 2020 identified green infrastructure as a method of increasing the long-term sustainability of landscapes, whilst simultaneously protecting their character, as a reflection of ecological, aesthetic and social values.

In the conditions of planning practice in Serbia, the understanding of this theoretical concept and maintenance of its consistency should be looked for in the small steps of application at the local level. The results of such studies are part of the necessary process of socialization, i.e. the acceptance of this concept by the expert planning public that will be able to participate in its reproduction.

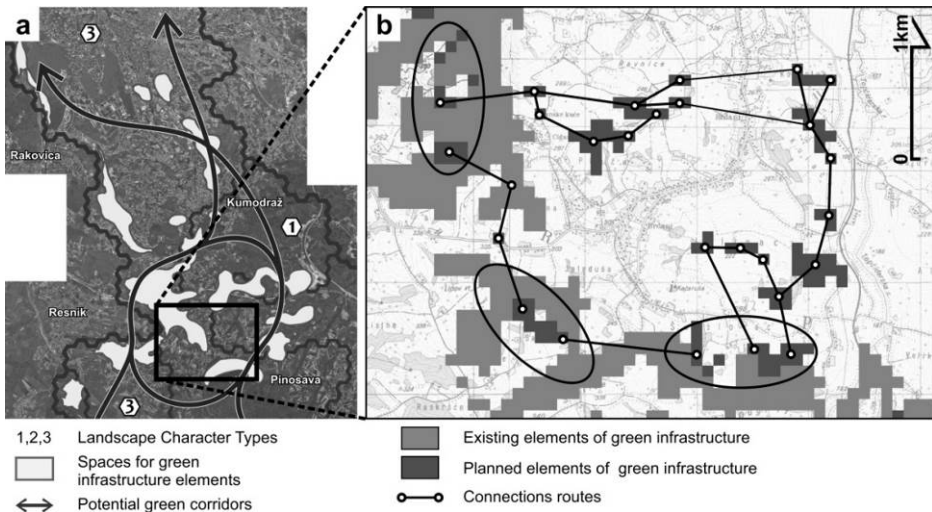
The application of new planning concepts by introducing new thematic plans into the planning system of Serbia has not shown good results. This is corroborated by the abolition of the General Plan of Landscapes (1995), which was an attempt to introduce ecological principles into the process of urban planning. Regardless of the modern landscape-ecological research approach that introduces the concept of green infrastructure based on connectivity, the Plan of General Regulation of Green Spaces of the City of Belgrade (2014), as the last one in a series of new plans, once again confirms the hypothesis that in the planning conditions in Serbia new plans are facing an uncertain future.

Studies have shown that, as a planning concept for the development of existing sectoral development plans (e.g. the afforestation plan), green infrastructure represents the most effective way of applying the principle of connectivity from the national to local levels.

The research of the degree of connectivity in the investigated area showed that landscape metrics, as an instrument for detecting the changes in landscape structure, quantifies the degree of landscape-ecological connectivity using certain parameters. Although other parameters of metrics from the domain of composition and configuration show evident changes in value after an increase

in the number of landscape elements (forest), the use of their results is not justified because of the significant spatial dispersion of small landscape elements planned in the relatively large area of the Afforestation Plan (Figure 1b).

According to the postulates of the Island theory (isolation vs. connectivity), the application metrics that quantifies the degree of spatial isolation of landscape elements is purposeful, when it responds to changes in the distribution of small landscape elements of forests regardless of the share of large landscape elements that can be considered indigenous (Gustafson and Parker 1994). On the basis of the established level of connectivity, the MNN parameter can be interpreted as an indicator of the motion of matter, energy and organisms. In this study MNN results indicated that the distances between indigenous LE forests increased under the long-term pressure of urbanization, i.e. that the level of connectivity decreased, which downplayed their ecological functions. While the 2011 landscape structure condition revealed the MNN parameter value of 145.73m, the 2015 condition resulting from the Afforestation Plan implementation showed the MNN parameter value of 128.85m. The increase in the value of the MNN parameter of 23.12% indicates a decrease in the isolation of forest fragments, i.e. an increase in their connectivity (Figure 1b).



**Figure 1. Concept of afforestation**

In order to ensure better acceptance of this planning concept, the research was directed towards the creation of an optimal quantitative model that will be applicable to plan development methodology. Mean Nearest Neighbor (MNN) is a parameter that can quantify the degree of connectivity in a landscape at class level and point to its stability.

## Conclusion

Despite its relatively long tradition, landscape planning in Serbia still has no firm support in legislation. Although there is a strong theoretical basis for the application of landscape-ecological principles in landscape planning, mechanisms for their implementation are still being investigated. In addition to theoretical reflection on the principles of the planning at the landscape scale, this paper describes the application of the principle of connectivity at different spatial levels, from national to local ones. The results suggest that planning at the landscape scale (the application of the green infrastructure concept and landscape metrics as a measure of landscape connectivity) can be one of the methodological approaches to spatial development planning which should be developed in adaptation to climate change.

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