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Research Article

Revitalization and landscape design of the park in Stari Mikanovci, Croatia; role of existing vegetation in generating new landscape solutions

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In this paper, the procedures and indicators of systematic inventorisation and analysis of the existing vegetation of urban landscapes are presented and applied. The analysis of the vitality of existing trees was performed using the Visual Tree Assessment (VTA) method on the location of Park in Stari Mikanovci, Croatia. The results of these analyses were used as a basis for the protection and care of existing vegetation, but also their implementation in the design. For this purpose, four different conceptual solutions for the park design were formed. The process of generating different concepts tried to answer the questions: whether the maximum preservation of vegetation elements is a limiting factor in the creative phase of the design process, and whether consistent preservation of vegetation elements will generate similarities of design solutions. Four conceptual solutions were developed by four different authors who were given the same project task: (a) maximum possible preservation on the basis of analysis of the determined values of existing vegetation, and (b) uniform basic residential and recreational content of the park. All other components and features of the landscape are left as variable, arbitrary and author-determined parameters. Multi-criteria descriptive analysis of the proposed design solutions showed that the existing vegetation is not a limiting factor for the typology, diversity, disposition and degree of intervention in the creative phase of the design process.

Keywords: vegetation, analysis, valorisation, landscape solution, park

1 Introduction

Designing open urban areas, especially typical urban landscapes such as parks, is a common design task. Although it follows the established principles and procedures that make up the design methodology, certain segments of this process are insufficiently connected, emphasised, and presented within the final design. Although each project task declaratively includes inventorisation, analysis, and protection of existing features and elements of the landscape but especially natural elements, new design solutions often present in insufficiently clear ways to what extent existing plant valorisation is included in the design solutions. The focus is often on the description, presentation and visualisation of design, and less on systematic and clear indicators of the manner and degree of preservation of existing natural qualities. Also, simplified and unsystematic analysis of existing natural elements can lead to deterioration of natural qualities, unreasonable or premature removal of vegetation, as well as reckless design decisions that perceive existing vegetation and other natural elements as "obstacles" to new design or technical execution. In these cases, the justification for the removal of existing vegetation and other natural elements lies precisely in the insufficiently analysed or argued values of these components of the landscape. The focus of this paper is to connect inventory and landscape analysis with the generation of new design solutions. Emphasis is placed on the existing vegetation of the landscape.

The first part of the paper presents the procedures and indicators of systematic inventorisation and analysis of existing vegetation that precede the design of open

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space. Derived procedures and indicators were applied in the valorisation and analysis of a specific example – Stari Mikanovci Park, as a basis for protection and treatment of existing vegetation and generating guidelines for new landscape design of the park. In the second part of the paper, the possibilities of maximum implementation of previously derived data within the design process, i.e. designing a new park solution, are examined. In this sense, it was examined whether different design solutions can consistently preserve and implement all the values of existing vegetation without compromising the quality and diversity of newly designed solutions. It was also examined whether different types of landscapes, such as a park, beach or square, require different treatment of existing vegetation.

1.1 The role and value of vegetation in shaped landscapes

Vegetation elements, along with other elements in the landscape, are used to organise space, solve spatial problems, and achieve design goals (Colvin, 1990). The use of plants as formative elements is conditioned by natural laws, as well as visual and spatial phenomena of the urban environment (Dunnett & Hitchmough, 2004; Beck, 2013; Hirschfeld, 2001; DOE, 1996). At the same time, the use of vegetation elements varies greatly depending on man's intentions, needs or simply the attitude towards nature at a certain point in time (Doick et al., 2018). The many roles of vegetation in the city landscape can be divided in different ways. According to Pereković and Kamenečki (2016), they can be: (a) spatial-structural and functional roles, (b) perceptual and visual-aesthetic roles, (c) ecological and technical roles, and (d) "recovery" roles via impact on human health. Vegetation as a spatial – structural and functional element defines the basic spatial relationships and proportions in the landscape ("plants as a spatial phenomenon", "vegetation architecture"), as well as its purpose by encouraging or discouraging certain behaviours and uses of the landscape. Perceptual and visual – aesthetic roles of vegetation elements refer to the use of plants to achieve certain effects that we perceive with all our senses. The ecological role of vegetation elements is inherent in its vegetation (e.g. oxygen production, increase in air humidity, pollution absorption, etc.) but also in the needs of remediation or mitigation of certain spatial problems (e.g. slope stabilisation, wind protection, noise protection). Nowadays, the ecological roles of vegetation in dealing with climate change are especially relevant. Usually, all the mentioned roles of vegetation are taken simultaneously, in the earliest stages of the design process, since each local landscape has certain existing vegetation characteristics, and due to the fact that possible roles of vegetation elements are numerous and often interconnected. Acceptance and systematic analysis, as well as consistent implementation of the value of existing vegetation are one of the important tools for improving the landscape and the environment as a whole. Within inventory urban trees are usually categorised through their vitality and their ecological aspects, but their role in the shape of urban character is often left out. The results of the research on the role of individual trees in urban image (Nádasy, Sándor & Illyés, 2019) show that the trees with the highest ecological value are not the ones that do not influence the local community and their memory of space.

1.2 Characteristics and condition of the park Stari Mikanovci, Croatia

The park is located in the central part of the settlement, and it is an important point of gravity with its historical centre (Nesek Ltd., 2005) along with an archaeological site close by (Ministry of Culture and Media). The research area was chosen because it is the only public park in the settlement around which all municipal institutions and a church are positioned and it also represents the centre of all social events of the community. The central open area of the settlement does not have the characteristics of a recognizable and representative open urban space. Existing space content does not provide diverse and meaningful use for the local community and it does not promote environmental value. The park has the characteristics of a transit space that allows movement and easy access to public facilities, but not additional features that allow or encourage hold and stay. The total area of the park is 2,920 m^2, of which 1,539 m^2 are green areas and 1,318 m^2 are paved areas (Fig. 1). The park is bordered on three sides by roads, so there is a direct visual and physical connection which prevents quality use of space. The northern edge of the park is defined by the municipal building, which requires a dense network of communications in the northern part of the park. Currently, the park has only elementary uses – movement and use of benches. The composition of the park seems random and unrelated, which is due to the diverse materials, shapes and colours of the structural elements of the park upgraded through the decades of use. The basic spatial features of the park include a large proportion of tall trees with broad canopies that exceed almost the entire area of the park. The temporal trees of the park also make a kind of memory of the place. For these reasons, a detailed analysis of existing vegetation is envisaged as a prerequisite for future spatial intervention. The result of such an analysis is the vitality of the tree, conservation guidelines, determination of maintenance measures and guidelines, and the production of unambiguous data on

Figure 1 Park Stari Mikanovci, Croatia (2019)

the potential and limitations of the existing vegetation of the park.

2 Material and methods

2.1 Analysis of the roles, characteristics and vitality of vegetation

The assessment of the health status of existing trees in the park was performed using the Visual Tree Assessment (VTA) method, according to Mattheck and Breloer (1994). Use of the VTA method is not innovative but in Croatia it is used as a main approach in systematic inventorisation and its results are the main input in deciding which trees can be included in new design. This method is based on: (a) assessment of the vitality of the tree with regard to the condition of the canopy (dry branches, leaf dryness, discoloration, etc.), tissue injuries (trunk, roots, bark) and the presence of secondary pests (fungal diseases and insects) and (b) on the basis of symptoms of diseases and errors of wood determines the possibility of breaking or falling of the tree (mechanical aspect). In the analysis of existing vegetation, the degree of vitality of plants is divided into 3 categories (Table 1).

The results of the analysis of plant vitality are made with the aim of assessment and giving recommendations for further undertaking of appropriate interventions such

Table 1 Categorization of the degree of vitality of plants

Degree of vitality	Description
(1) healthy plants	– no damage is noticeable or minor damage is visible, which does not pose a danger to the survival of the individual without the application of appropriate care procedures
(2) damaged plants	– medium to severe damage is noticeable, which needs to be paid attention to and appropriate care procedures applied
(3) very damaged plants	– severe damage that requires urgent remediation or removal is noticeable, as it poses a danger to visitors, other plants in the park or property

Table 2 Categories of plant care for pruning

Pruning measures	Description
(1) cleaning and thinning the canopy	– removal of dry, diseased, dying or broken branches, removal of branches to increase light and air permeability and reduce the weight of branches, removal of climbers, etc.
(2) raising the canopy	– removal of lower branches that obstruct the passage of pedestrians or vehicles, branches that are too close to buildings
(3) canopy reduction	– removing part of the canopy or large branches if they exceed the desired size, too much interfere with the canopy of neighbouring trees, interfering with their photosynthesis or disturbing the surrounding facilities and infrastructure

as: 1) gradual removal of old trees 2) plant protection and 3) a maintenance plan for the park. The range of recommended interventions, which is made after the vitality analysis, is divided into two basic forms of interventions: (a) removal of plants or (b) maintenance measures/pruning. Pruning as a form of recommended care is categorised into three groups (Table 2). Following the implementation of these measures, further regular inspection of the tree is recommended at least once a year.

Assessment of plant health (vitality) and plant conservation guidelines in Stari Mikanovci Park were conducted on two occasions, in September and October 2019. During the field visit and assessment of the condition, each individual plant was numerically marked, cartographically documented (GIS) and photo-documented. Valorisation of each individual plant was carried out through a tabular presentation for each individual plant, which included: plant numbering, species determination; crown diameter (cm); canopy height (m); canopy tilt (>20%); root damage; canopy damage; bark damage; cavities in the trunk; fungi; infrastructure damage; vitality assessment; required procedure; other notes.

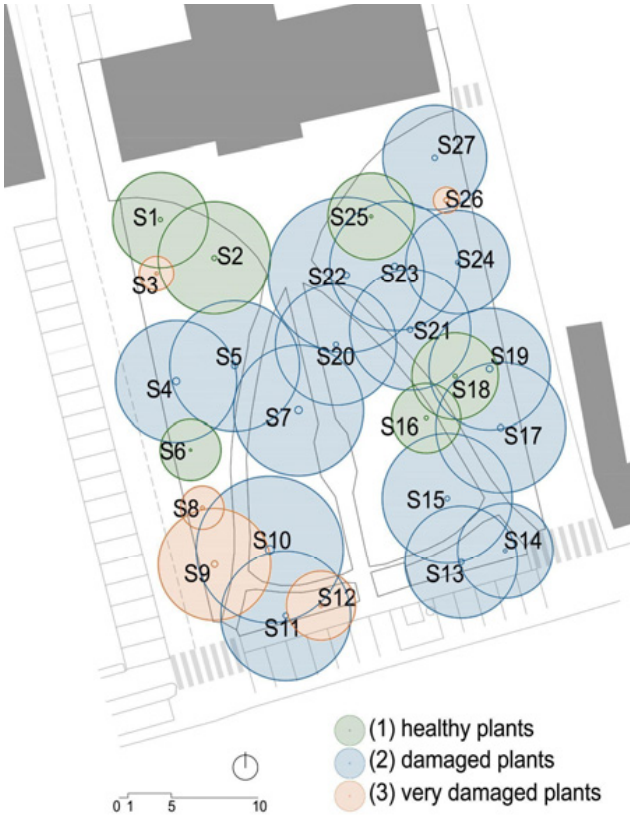

Figure 2 Inventarisation and analysis of existing vegetation, the degree of vitality of plants is shown in 3 categories

Plant health indicators (vitality) are described with detailed visual, spatial, structural, functional, and ecological characteristics of existing plants in the park: functional (e.g. shade, separation, protection from dust and/or noise, honey properties, edible species for humans and animals, etc.), visual and structural (e.g. accent role, visual protection, flowering properties, directional gaze, etc.), toxicity, allergenicity, and maintenance requirements (Franjić & Škvorc, 2010). The assessment of the condition of each individual plant is the result of an overall assessment based on all the above indicators, whereby existing plants are classified into several basic categories: 1) plants that has to be removed immediately; 2) plants that will be removed or replaced over period of time (plants that carry positive qualities but due to health conditions or other unfavourable conditions should be monitored and replaced or removed at a certain time); and 3) plants that require care and maintenance measures.

2.2 Development of conceptual solutions for the park

The project guidelines of the Park were derived from spatial and social inventories and analyses of space and inputs given by the municipality and local community. Based on the project guidelines, a conceptualization of variant solutions for the new design of the park was made. The usual landscape design of the park is made as a product of the process of designing urban landscapes (inventorisation and analysis of landscapes, defining the project program, making diagrams and conceptual sketches). However, the conceptualization of the solution is conditioned by the principle of preservation of all existing vegetation whose vitality is assessed, respecting the principles of protection and improvement of urban habitats, preservation of features and existing or potential functions of vegetation. The project guidelines included uniform elements (resting area, contemplation and relaxation space for municipal, cultural and educational events and other). Four conceptual designs were generated by four different authors (Kamenečki et al., 2020). Variable and distinctive features of the concepts were analysed by descriptive multi-criteria analysis and comparison of solutions according to given criteria: typology of open space (park – plaza – green square), the ratio of paved and green areas ("soft landscape" – "hard landscape"), defining the edge of the park immediate environment (open – closed), compositional basis (formal – informal), philosophy of solution (reinterpretation of historical symbols of the place – modern reinterpretation), the relationship of the open area and to the municipal buildings (separate units – integrated units) and disposition of basic contents (zoning). The given parameters were applied and tested

on four variant solutions that were developed and presented at the level of the conceptual landscape design.

3 Results and discussion

3.1 Results of analysis of plant characteristics and vitality

In the park Stari Mikanovci, three groups of vegetation have been singled out – trees, shrubs and perennials. General visual-spatial features indicate the dominance of trees that with vertical habitus, massive and horizontal dimensions of the canopy exceed almost the entire surface of the park (Fig. 2). Their lifespan also indicates the value of trees as bearers of the memory of a place. Detailed insight and analysis show the need to carry out the necessary arboricultural interventions, which were not carried out adequately and regularly in the past. Landscaping work on existing vegetation must be taken as protective measures in order to ensure safe and undisturbed communication and use of visitors, as well as the safety of the vehicles in traffic and those parked. Maintenance is necessary to establish a smooth development and balance of canopies between individual trees, most of which have reached their biological maturity and shape. If maintenance measures are not applied continuously, trees will begin to lose their vitality, and will become more susceptible to the harmful effects of biotic and abiotic factors. Trees of impaired vitality are more susceptible to attack by secondary pests; rot and insect fungi, which seriously impair mechanical stability and lead to drying of individual branches and the entire tree. Extreme and sudden climate changes such as those recorded in recent years can cause additional stress, death or major mechanical damage for the trees.

The results of the analysis point to the fact that most of the trees in the park are of good vitality, while impaired biological and mechanical condition occurred mainly as a result of poor planning of planting plan and irregular or

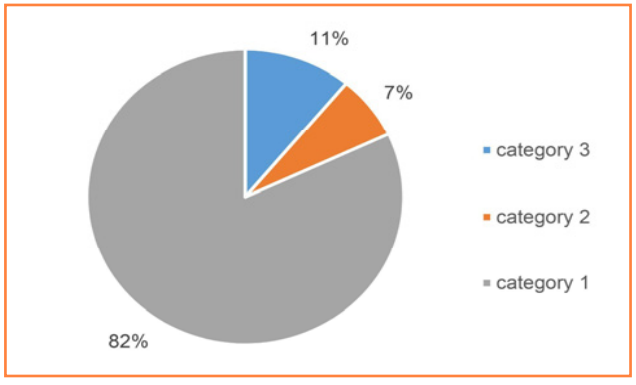

Figure 3 Distribution of trees by vitality category

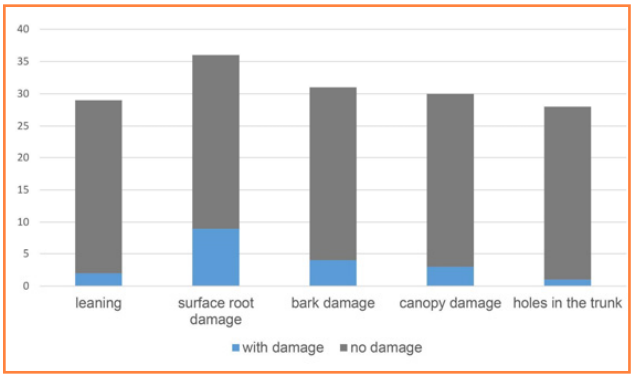

Figure 4 The amount of damaged trees according to the type of damage

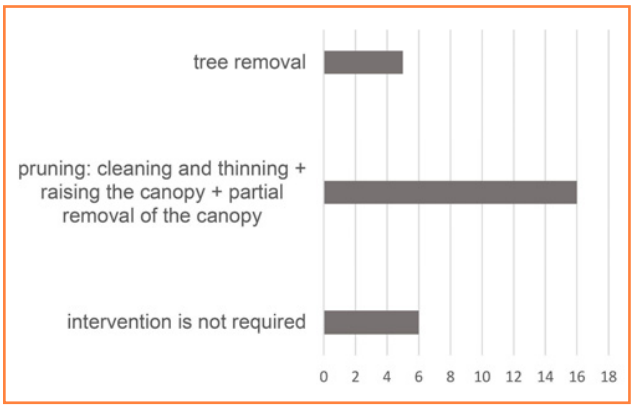

Figure 5 Number of trees on which certain arboricultural interventions need to be carried out

inadequate maintenance. Only five trees, out of 27, have weaker or significantly impaired vitality (Fig. 3).

Tree canopies are very large in diameter, which is often characteristic of trees in parks and urban areas. Average values of crown diameter range from 4 to 15 m. The widest crown is 18 m which is also the tallest tree in the park with a height of 24 m. Although average heights range from 9 to 21 m, more than a half of the trees reach heights above 20 m. Since the canopies are large in diameter, the competition for light conditions in the upper story is much more pronounced, which is manifested in the numerous interference of branches in adjacent canopies so the maintenance cost is increased by frequent cycles of trimming. The largest trunk diameter measured was 1.02 m.

The most common type of tree damage in the park is superficial root damage (Fig. 4). Most of these damages, as well as those on the bark, are quite common for trees that have lived in urban conditions for years and most often do not pose a great danger to plant life. Such damage usually calluses properly, so the rot of fungi is prevented from entering the interior of the trunk, which confirms the result that most of the trees in the park are still of good vitality. Trunk holes and trunk rot were

significantly observed in only one individual (S9). On two trees (S8 and S24) higher slope of the trunk is pronounced and could impair the static safety of the tree.

Some of the arboricultural interventions need to be carried out on 78% of the trees in the park, most often in the form of pruning, but in some cases also removal. Pruning in the form of canopy reduction is the most common form of intervention; removing part of the canopy or large branches if they exceed the desired size, or if they encroach too much on the canopy of neighbouring trees; interfering with photosynthesis or disturbing surrounding facilities and infrastructure (Fig. 5). When pruning in the form of reduction, raising or thinning of the canopy should be carried out in order to establish as symmetrical and as natural habitat as possible (Balder, Reuter & Semmler, 2010; Shigo 1991). Due to weakened physiological conditions, combined with impaired mechanical properties and due to the competition shortened survival prospects, it is recommended to remove a total of 5 individuals, one of them urgently, due to the risk of fracture.

3.2 Results of landscape design and analysis of conceptual solutions

The conceptualization of the park defined four designs that were based on the same project guidelines (Figs. 6 to 9). All design proposals have included the existing valuable vegetation (trees) defined by VTA method, valorisation, and analyses of the park area. The variability of the solution was achieved and analysed according to parameters: typology of open space, ratio of paved and green areas, definition of park edges, environmental aspects, composition/design basis, philosophy of solution, disposition of content, and relationship of open area and the building within the scope (municipal building).

Figure 6 Concept 1 – design basis

Figure 7 Concept 2 – design basis

Concept 1 "Geometric archaeology of place" (Fig. 6). The solution finds inspiration in the locality itself, connecting the existing morphology of space and trying to reinterpret it into a new set of values. The design proposal establishes a connection between the existing building and the rhythm of its porch with the natural rhythm of the existing vegetation. The concept introduces a regular grid that alternates paved zones with areas of ground cover and perennials. The concept opens and integrates the northern and southern surroundings of the park while closing the eastern and western edges.

Concept 2 "Superposition of grids" (Fig. 7). The proposed design generates its geometry from the need to organize and by evading the given existing geometry of the surrounding urban elements. The squares are formed by overlapping two regular square surfaces. The northern square is proposed for festivities and events, and the southern square provides a living area for everyday stay in the park. The entrance is placed in the same direction of the new geometry. The connection to the south-western

Figure 8 Concept 3 – design basis

Figure 9 Concept 4 – design basis

and south-eastern border of the park and immediate surroundings is established by the seemingly irregular geometry of higher and lower vegetation, and elongated rectangular surfaces of ground cover and shallow volumes of evergreen and aromatic plants.

Concept 3 "Symbolic expression" (Fig. 8). The design is derived from an archaeological find – a double vessel (jug) of the Vučedol culture, which is the basis of the artistic form of expression of the park itself. The memory of the existing communications has been preserved, and the central square-like space of the park has been created, which is further divided into irregular trapezoidal surfaces with planted perennials, ground cover and shrubs. Two larger residential zones and two sub-zones intended for events and residential activities have been established. The relationship to the park edge is completely uniform, a structure overgrown with climbers

Concept 4 "Abstraction of landscape elements" (Fig. 9). The design is a modern reinterpretation of the urban landscape in which a clear distinction is lost between the boundaries of individual functional elements: path, lawn, square, park. This design transfers the landscape pattern of the plain field by abstracting the wider environmental context into the park experience. The elongated surfaces with perennial plantations divide the space into fields and images of experience.

The comparison and analysis of the proposed design shows the diversity of design approaches. They are manifested through diverse typology of open space (square – park – beach – green square) as well as in a diverse spatial edge of the park (openness/closedness of the park edges according to the urban matrix of the settlement). Despite the dense distribution of high vegetation and maintaining all existing vegetation, the proposed designs achieved a very diverse open public area, as well as a ratio of green areas and paving (Table 3). All designs have successfully integrated the existing quality vegetation and are diverse in amount

Table 3 Comparison of concepts design

Conceptual proposal	Low vegetation area (km²)	Lawn area (m²)	Paved area (m²)	Type of open space
Concept 1	141	1,384	1,395	park
Concept 2	350	1,527	1,043	square
Concept 3	349	1,589	982	plaza
Concept 4	323	1,401	1,197	green square

of existing and newly planted trees but none of the solutions preserved the existing shrubs and perennials. The authors see the justification of this approach in the low vitality, poor maintenance but also due to the fact that the shrubs and groundcover have not been completely formed.

4 Conclusions

The results of this paper indicate that consistent conservation and implementation of existing vegetation should not be taken as a limiting factor to the creative phase of the design process. The density of preserved existing vegetation did not prove to be a limiting factor for the diversity of proposed design, the disposition of the content or the basic typology of space. It should be borne in mind that the value of individual trees can have a significant impact on the perception of the local community and their memory of place. For this reason, the inventorisation, valorisation and analysis of existing vegetation elements at the location should be systematic, detailed and comprehensive in the initial stages of project development. So, random and partial decisions on the removal of existing vegetation can greatly miss the meaning, goals and potentials of design. This paper showed that using a single method such as VTA can be deficient in solving the problems that are desired or can be achieved in the urban landscape, so it is advisory to use holistic approach.

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