

Green open-spaces and dendroflora of the Pula's Campus

Zeleni otvoreni prostori i dendroflora kampusa u Puli

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ABSTRACT

Campus of the University Juraj Dobrila in Pula is characterized by distinguished architectural and open space values. Open spaces represent more than 50% of the campus' area largely determining its aesthetics. Mapping dendroflora and categorizing green areas of the campus was conducted with an aim to provide basic knowledge for more efficient and cost-effective management of campus green space. Inventarisation of green open spaces was made by students of Landscape Architecture at the University of Sarajevo – Faculty of Forestry during the international student workshop CAMPULA in October 2019. The study resulted in clear information about functional assets of green elements in the Campus. The total number of 301 individuals (203 evergreen trees, 80 deciduous trees, 9 evergreen shrubs, 6 deciduous shrubs, 2 evergreen palm shrub and 1 evergreen palm) was mapped in the area of campus. The total number of the mapped species was 32 (20 evergreen and 12 deciduous). Improved management of the green open space in Pula's campus can result in exceptionally valuable environmental, social and aesthetic academic ambient.

Key words: *sustainable campus, tree species, student workshop, University Juraj Dobrila, mapping.*

INTRODUCTION – Uvod

Sustainable green campus

University of Pula was founded by the Law on the Foundation of the Jurja Dobrila University in 2006. The area of the Pula general hospital has been allocated to the public space with social purpose for higher education institutions, as contained in the General urban plan of Pula. Former hospital complex was built during the period of Austro-Hungarian rule, mostly in period

from 1896 to 1920. Although in medium to bad construction condition, most buildings in the campus are characterized with historical value. Also, St. Mihovil's fortress is located in the campus which was built in the period from 1851 to 1854. as part of the defense system of the Austrian war port. In addition to the mentioned historical layers, the area has a pronounced archaeological value because it is believed that it is the place of basilica of St. Mihovil and the burial chapel of St. Klement, built during the time of Emperor Justinian (VI century) (Kandler, 1875).

Although less emphasized, special valuable heritage of the campus in Pula is the green open space with its rich dendroflora introduced from all over the world. Due to its large surface area, which stand out in the city green network on spatial satellite photos (Figure 1), it may be suitable both for providing a learning environment and creating a complex and dynamic semi-natural ecosystem serving the neighborhood. Sustainable campus management has become important to many universities and is often considered as part of the institution's societal responsibility, in agreement with Agenda 2030 (UN General Assembly, 2015). However, any management and development strategy demand basic identification of green open space resources.



Figure 1. Position of the Campus in urban structure of Pula.

Slika 1. Pozicija Kampusa u urbanoj strukturi Pule

Being initially established as a hospital complex, today's green open spaces reflect a peaceful environment suitable for the work in healthcare. Interior space is protected against noise by buildings positioned along the driveways which can be seen in spatial documentation for the area of the Civil hospital complex in Pula. The existing greenery was formed in a way to provide favorable sanitary and hygienic functions for the patients through improving the insolation regime, wind, noise and dust protection. Many green elements serve also for delimitation of the interior space. The composition of the green space in the campus is connected with the character of the buildings. Small green spaces are predominantly geometric in style, while larger areas are landscaped more organically. In the area of campus three groups of green spaces are presented: horticulturally designed and built spaces, grass area around the fortress of St. Mihovil and a part of the Landonja tree line.

Study from German University of Bonn indicated student's four prevailing motives which are meeting with friends, taking a break between courses or at lunchtime to relax from everyday life, spending free time, and benefiting from time spent in nature (Föllmer et al. 2021). Also, according to the same study the other main reasons for using the academic green

space are proximity to university, easy access and relaxed atmosphere.

Regarding all mentioned characteristics of both built structures and open spaces, the area of campus appears as suitable to facilitate recreational activity, to restore attention, identity of one self, as well as a place of social encounter and exchange (Abercrombie et al. 1998).

The mapping of dendroflora and categorizing green areas is important for efficient and cost-effective management of campus green areas. Access to up-to-date data facilitates planning revitalization of campus greenery in temporally and spatially. According to our present knowledge, dendroflora map of the campus in Pula does not exist, which arguments the importance of publishing such data. Therefore, the main objective of this paper is to present green open space resources as a potential for developing sustainable student campus.

Vegetation characteristics of Pula and campus area

The inner continental area of the city belongs to the climatic zone of pubescent oak and Oriental hornbeam (*Quercus-Carpinetum orientalis croaticum* H-ić 1939) and the narrow coastal line (ca. 3 km) belongs to the climatic zone of evergreen oak (*Orno-Quercetum ilicis* H-ić 1958). These two plant communities are mixing and forming the *Quercus-Carpinetum orientalis quercetosum ilicis* (Španjol & Rauš, 1995). However, the frequent autochthonous or allochthonous trees spontaneously spreading in Pula are Aleppo pine (*Pinus halepensis*), Mediterranean cypress (*Cupressus sempervirens*) and evergreen oak (*Quercus ilex*). Many exotic allochthonous plants were introduced during the century – some of which did not tolerated climatic and pedological conditions (www.pulainfo.hr) (*Carica papaya*, *Copernicia* sp., *Dasyliion* sp., *Taxodium distichum*, *Coffea arabica*, *Cyperus papyrus*, *Musa × paradisiaca*, *Phoenix dactylifera*, *Sequoiadendron giganteum* etc.) while others have survived until today (*Sequoia sempervirens*, *Yucca filamentosa*, *Cedrus libani*, *Trachycarpus fortunei*, *Chamaerops humilis*, *Magnolia grandiflora*, *Pinus jeffreyi*). Some of the most important green areas in the city of Pula are: Šijana forest park, the Park under the Arena, Valerija's Park, the Park of Franjo Josip I, Park of the King Zvonimir, the Tito's park, the Park of King Petar Krešimir the IV, the Park of the Graz City, the Newlyweds park, the Hugues' park, the Naval park, the Montezaro Park, the Giardini park. Such parks have sociological, ecological and aesthetic roles, and further improve quality of living.

Historical context of the development of green open spaces

Fortifications surrounding the city, one of them being the Fort of St. Mihovil in Campus Pula, represent important cultural landscape elements. Many urban green open spaces in the city of Pula were planted at the end of the 19th and beginning of the 20th centuries during the rule of the Austro-Hungarian Empire and, later, Italy. Evidence about the origin and development of green areas are very scarce, and until the middle of the 19th century there are not many reliable data on Istria (www.istrapedia.hr).

Gardens in ancient times until the 19th century represented the privilege of the upper class and are found around villas or residential settlements (descriptions of villas at Brijuni). Rare medieval elements of landscape architecture were established next to monasteries or other sacral buildings. The architectural elements of the cloister of the monastery of St. Francis in Pula date the 13th century, but the park arrangement of the ground floor is of a more recent date. The continuity of the cloister as a park area is confirmed by the list of plants of Josip Vincent Host from the years 1801 and 1802, in which, in addition to medicinal plants and spices, ornamental species are also listed. With the development of the Pula district of Sv. Polycarp was created the first planned city park (Naval Park, 1863), followed by parks in undeveloped areas within the city center (Montezaro) and parks in undeveloped areas outside the city center (Francis Joseph I Park, King Zvonimir Park, Valerija Park). They are all decorated in the style of the late 19th century containing exotic plants, located on islands surrounded by hiking trails of free design, most often with one or more accents. Today, these are ornamental-utitarian gardens without significant remnants of the original landscaping.



Figure 2. View of Pula (Giuseppe Rosaccio, 1598)
(www.felbar.com)

Slika 2. Pogled na Pulu (Giuseppe Rosaccio, 1598)
(www.felbar.com)

In addition to public parks, city promenades are built in the late 19th century. The Šijana forest park in Pula, also known as the Imperial Forest (Kaiserwald) has been owned by the Austrian navy since 1860. It is located two km from the city center. Trails, centuries-old oaks, tree-lined avenues, and a central meadow with a pavilion and a tram connection with the city have made this city forest a favorite picnic spot. Tree lines are a common element of spatial design in the Istria peninsula and there is almost no place without a tree-lined access road or a square. Tree lines are mostly containing pine trees.

The first data on the origin and development of the Campus Pula and its dendroflora composition are related to the hill of St. Mihovil (Figure 2) where according to historical data there was a sacral Byzantine complex of a Benedictine monastery and a three-nave basilica with a tomb chapel from the 6th century, which was demolished in 1851 due to the construction of the fortress completed in 1854. From 1914 to 1945 it had been utilized for different purposes (a warehouse and barracks; Santorio Hospital; housing of homeless families). Today, the Fortress serves for keeping flammable liquids, it is in a poor condition, overgrown with weeds and neglected (repositorij.unipu.hr).

In 1896, the civilian hospital (Ospedale Civico) was opened at the hill of St. Mihovil, which became regional in 1904 (Ospedale Provinciale di Pola) (www.glasistre.hr). In 1918, with the cessation of Austro-Hungarian rule in this area, the hospital was turned into Ospedale Regio Marina. After the Second World War, Ospedale di Marina was transformed into a Military Hospital, for the needs of the Yugoslav Army (Figure 3), but also, gradually, for medical needs of the civilian population (www.glasistre.hr). In the period from 1974 to 1981, the military complex was revitalized and rebuilt. Pula's city parks are mostly preserved in their original size (except for King Zvonimir Park). In the post-war period from 1953-1957, numerous parks with indigenous plant species were built mostly on war-ravaged city areas in Pula.

Since 2017, the University of Juraj Dobrila has been allowed to use parts of the Naval Hospital for 50 years. There is no relevant data on the planting of the Campus' area.

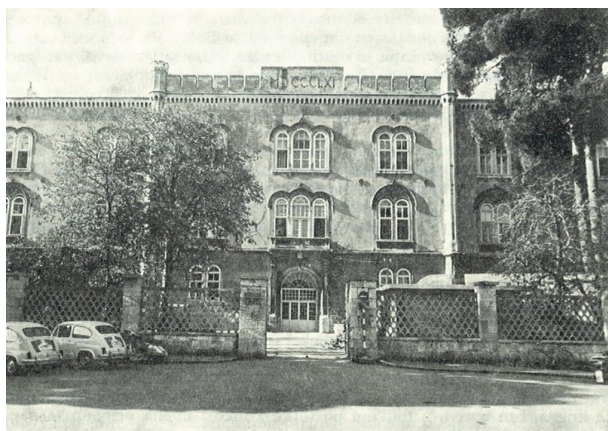


Figure 3. Entrance of the hospital from the Zagrebačka street 1977/1978 (jna-sfrj.forumbo.net)

Slika 3. Ulaz u bolnicu iz Zagrebačke ulice 1977/1978 (jna-sfrj.forumbo.net)

METHODS – Metode

Site surveys and mapping was done in 2019 during summer school Sustainable Development and Design of the Coastal University Campus in Pula, Istria, Croatia – CAMPULA. The object of the survey was Campus of the Juraj Dobrila University of Pula located between Zagrebača street (north), St. Mihovil (west), Petar Preradović street (west and south) and General hospital in Pula (east) (Figure 4).

Dendroflora was identified using Idžojtić M. (2009) and mapped using GPS device (Garmin GPSMAP 64sx). Mapped area was ca. four hectares. QGIS for Desktop 3.22.8 software was used to create database of mapped dendroflora. Satellite photos and spatial documentation maps were provided by the Institute for Urbanism of Pula.

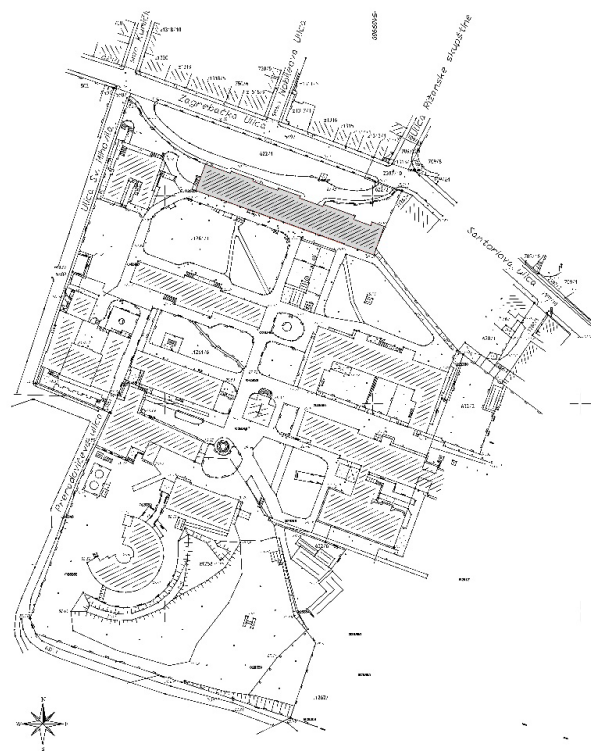


Figure 4. Campus Pula from Urbanistic plan of Pula

Slika 4. Kampus Pula iz urbanističkog plana grada Pule

Mapped features (Table 1) included species identification, species classification and partial valorization of dendroflora quality for the protection and management purposes, was done using Visual Tree Assessment - VTA method (Mattheck & Breloer, 1994), for chosen parameters. Also, categorization of green space and their functional roles was assessed based on how they are used. Mapping was performed by students of the Faculty of Forestry in Sarajevo, under supervision.

Table 1. Mapped features
Tabela 1. Mapirane značajke

No	Feature	Comment
1	Species	For all dendroflora
2	Species classification (evergreen tree-ET, evergreen shrub-ES, evergreen palm-EP, Evergreen perennial shrub-EPS, deciduous tree-DT, deciduous shrub-DS,	For all dendroflora
3	Depth at 1.3m height	For a part of dendroflora
4	Tree height	For a part of dendroflora
5	Vitality assessment and management requirements	For a part of dendroflora
6	Green space category	For entire Campus area
7	Green space function	For entire Campus area

RESULTS AND DISCUSSION – Rezultati i diskusija

Inventory of dendroflora

Self-growing dendroflora at the investigated area indicated the transition zone of the submediterranean vegetation of the oak and white-hornbeam (*Quercus-Carpinetum orientalis*) towards the eumediterranean vegetation represented by *Pinus halepensis* Mill., *Cupressus sempervirens* L., *Quercus ilex* etc. (Beug, 1967). Naturally the area contains wild Mediterranean plants and also continental species. The hardy Mediterranean flora, for example *Cedrus libani*, was introduced by artificial cultivation.

The total number of 301 individuals, i.e. 203 evergreen trees, 80 deciduous trees, nine evergreen shrubs, six deciduous shrubs, two evergreen palm shrubs and one evergreen palm tree, were mapped in the Campus' area (Table 2, Figure 5). The total number of the mapped taxa was 32, from which 20 evergreen and 12 deciduous taxa.

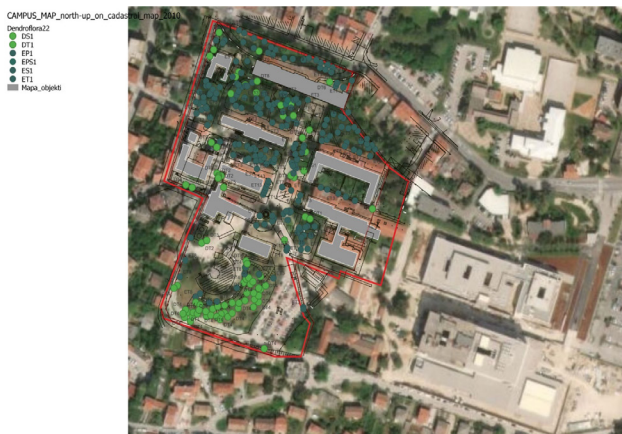


Figure 5. Map of dendroflora

Slika 5. Mapa dendroflore

The European nettle tree (*Celtis australis*) is the most abundantly occurring species spontaneously spreading through open spaces, such as the case in at the archaeological site around fortress St. Mihovil in the southwestern part of the Campus. Similar natural regeneration potential was also noted for the bay laurel (*Laurus nobilis*). Most common evergreens were cedars (*Cedrus libani*), pines (*Pinus halepensis*) and cypress (*Cupressus sempervirens*). Apart from the mentioned, a substantial number of species are introduced species vastly distributed across Adriatic coast.

Current challenges and potentials of green open-spaces of Campus Pula

Reduced aesthetics value and functionality of the green open-spaces of the Campus Pula was observed during field surveys. We assume that this resulted from an insufficient care and maintenance in longer time period. The different categories of green areas of Campus account for approximately 1.4 hectares. Although with reduced functionality, on most green spaces natural soil was preserved with valuable old trees.



Figure 6. Functions of green open spaces and positions of highly valuable trees (red), trees needing interventions (orange), and the rest of the trees with intermediate characteristics (light and dark green) in the Campus. Note: Please use Table 2 to identify species based on labels.

Slika 6. Funkcije zelenih otvorenih površina i položaji visokovrijednih stabala (crvena), stabala koja zahtijevaju intervencije (narančasta) i ostala stabala srednjih karakteristika (svijetlo i tamno zelena) u Kampusu. Napomena: koristite tabelu 2 za identifikaciju vrsta na temelju oznaka.

Delimitation green space accounted for an area of 0.3 ha and was characterized with aesthetic and sanitary roles, while green space near institutions, smaller and larger green spaces had social functions and were used mainly for walking, dog walking and social gatherings (Table 3).

We estimated that 31 trees belong into the category of the trees of high value and 38 needed some maintenance interventions (Figure 6). Such categorization of the trees was based on aesthetic and ecological characteristics (Figure 7). The rest of the trees (the majority) are considered as intermediate considering their overall aesthetics and condition.

Table 2. List of woody taxa of the Pula's Campus

Tabela 2. Popis drvenastih svojti Kampusu Pula

Taxa	Label	Number of individuals	Average height (m)	Average diameter (cm)	N	
Evergreen trees						
1	<i>Abies alba</i>	ET1	5	10	23	3
2	<i>Cedrus libani</i>	ET2	25	19	47	14
3	<i>Cupressus sempervirens</i>	ET3	75	17	41	29
4	<i>Eriobotrya japonica</i>	ET4	1	5	5	1
5	<i>Laurus nobilis</i>	ET5	19	6	5	41
6	<i>Ligustrum lucidum</i>	ET6	6	8	5	
7	<i>Olea sp.</i>	ET7	1			
8	<i>Pinus halepensis</i>	ET8	39	20	55	18
9	<i>Pinus nigra</i>	ET9	7			
10	<i>Quercus ilex</i>	ET10	2			
11	<i>Taxus baccata</i>	ET11	10	3.5	7.5	
12	<i>Thuja occidentalis</i>	ET12	2	10	20	1
13	<i>Thuja orientalis</i>	ET13	11	7	22	2
Evergreen shrub						
1	<i>Nerium oleander</i>	ES1	1			
2	<i>Pittosporum tobira</i>	ES2	3			
3	<i>Prunus laurocerasus</i>	ES3	3			
4	<i>Viburnum tinus</i>	ES4	1			
5	<i>Pyracantha coccinea</i>	ES5	1			
Evergreen palm						
1	<i>Trachycarpus fortunei</i>	EPI	1	10	28	1
Evergreen perennial shrub						
1	<i>Yucca sp.</i>	EPS1	2			
Deciduous tree						
1	<i>Aesculus hippocastanum</i>	DT1	4	20	48	1
2	<i>Ailanthus altissima</i>	DT2	7			
3	<i>Catalpa bignonioides</i>	DT3	1			
4	<i>Celtis australis</i>	DT4	54	13	45.5	4
5	<i>Ficus carica</i>	DT5	6	5	5	2
6	<i>Morus alba</i>	DT6	1			
7	<i>Prunus domestica</i>	DT7	1			
8	<i>Robinia pseudoacacia</i>	DT8	4	12.5	44.5	2
9	<i>Ziziphus jujuba</i>	DT9	2	5	10	2
Deciduous shrub						
1	<i>Forsythia x intermedia</i>	DS1	3			
2	<i>Philadelphus coronarius</i>	DS2	1			
3	<i>Spiraea sp.</i>	DS3	2			
	Total		301			

Table 3. Functions, current use and propositions for using green open-spaces in Pula's Campus

Tabela 3. Funkcije, trenutna namjena i prijedlozi za korištenje zelenih otvorenih površina u Kampusu Pula

No.	Category	Count of Category	Area (ha)	Functions
1	Delimitation of the interior space	16	0.207	Aesthetical and sanitary
2	Green space near driveways	3	0.112	Aesthetical and sanitary
3	Green space near institutions	3	0.227	Aesthetical, sanitary and social
4	Larger green space	7	0.751	Aesthetical, sanitary and social
5	Small green space	3	0.069	Aesthetical, sanitary and social
	Total	32	1.367	

Because the idea was to improve health and general quality of student life, students' perspective was used to explore the open space of the Campus. The overall conclusion of the study is that the general condition of dendroflora of the Pula's Campus is at a satisfactory level. Also, dendroflora is crucial factor determining open space quality. Most of the individuals show good vitality, but also the lack of appropriate and regular care measures. Negligence and degradation in certain parts of the Campus, greatly affect its current condition. In this way, the accessibility and ambient value of the space is reduced. Based on students' opinion the Campus of the University of Pula can develop into model health-promoting setting. The concept, from the healthy city to the healthy university is described by Tsouros et al. (1998) and it can be considered for the Campus development. Implementation of the appropriate renovation, reconstruction, and revitalization of Campus' greenery are needed.

The urban infrastructure of the Campus has the potential for interconnection with the other greenery of the city of Pula - as a part of urban green network. This is supported by the immediate vicinity of Pineta Park as an urban green area of a recreational character, but also the proximity of other local city parks (Naval Park, Montezaro Park, Tito's Park, Frane Josipa I Park). Another connection of the urban greenery of the Campus and the greenery of Pula is of a historical character - the greenery of the Pula's forts (Fort Castel, Monsival, Casoni Vecchi, Monvidal, Monte Ghiro).

CONCLUSIONS – Zaključak

Campus of the University Juraj Dobrila in Pula present valuable area of distinguished architectural and cultural values as well as open green space values. After conducted survey and dendroflora mapping, overall conclusion is that general condition of the dendroflora of the Pula

Campus is at a satisfactory level. The biggest challenge is evident lack of appropriate and regular maintenance and care. Most of the woody individuals show good vitality but lack of care. We conclude that Campus' open green spaces should offer more pleasant life for residents and visitors by comprehensive plan that will implement an appropriate method of renovation, reconstruction and revitalization of urban greenery.

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Figures 7. Selected trees of high aesthetic value located in the Campus Pula (*Cupressus sempervirens*, *Pinus halepensis*).

Slika 7. Odabrana stabla visoke estetske vrijednosti smještena u Kampusu Pula (*Cupressus sempervirens*, *Pinus halepensis*).

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SAŽETAK

Kampus Sveučilišta Jurja Dobrile u Puli karakteriziraju istaknute arhitektonske vrijednosti i vrijednosti otvorenog prostora. Otvoreni prostori čine više od 50% površine kampusa i uvelike određuju njegovu estetiku. Kartiranje dendroflora i kategorizacija zelenih površina kampusa provedeno je s ciljem pružanja temeljnih znanja za učinkovitije i isplativije upravljanje zelenim površinama kampusa. Poticanje zelenih otvorenih površina napravili su studenti Pejzažne arhitekture na Univerzitetu u Sarajevu – Šumarski fakultet tokom međunarodne studentske radionice CAMPULA u listopadu 2019. Studija je rezultirala jasnim informacijama o funkcionalnim svojstvima zelenih elemenata u Kampusu. Na području kampusa kartirana je ukupno 301 jedinka (203 zimzelena stabla, 80 listopadnih stabala, 9 zimzelenih grmova, 6 listopadnih grmova i 3 zimzelene palme). Ukupno su kartirana 32 taksona (20 zimzelenih i 12 listopadnih). Poboljšano upravljanje zelenim otvorenim prostorom pulskog kampusa može rezultirati iznimno vrijednim ekološkim, društvenim i estetskim akademskim zelenim prostorom.

