ArcGIS StoryMaps

Monitoring environmental changes through satellite imagery

Elementary school Šime Budinić Zadar, Croatia

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The city of Zadar is in the central part of the Croatian Adriatic coast. It is the fifth largest city in the Republic of Croatia and the third in Coastal (Primorska) Croatia, making it one of the most important urban centres in the Adriatic region. The city of Zadar is the cultural, economic and development centre of Zadar County. The mainland hinterland consists of a large flat area of Ravni Kotari, which allows it to expand freely and distinguishes it from most other coastal cities in Croatia. The specific features of the geographical position of the city of Zadar are reflected in maritime openness, proximity to the fertile soils of Ravni Kotari, large gravitational area of islands, coastline and hinterland, the shortest maritime connection with neighbouring Italy, good transport connections and large water supplies.

Zadar area belongs to the geologically young Dinaric system, which extends in a northwest-southeast direction.

The Mediterranean climate prevails in this area, with dry and hot summers and mild winters.

The soils in the Zadar area are red soil on limestone and dolomite and brown soil on limestone. However, a large part of the soil has been anthropogenically modified by human activity.

Vegetation in this area is forests: holm oak, downy oak, black ash, white hornbeam, Aleppo pine, black pine and stone pine.S

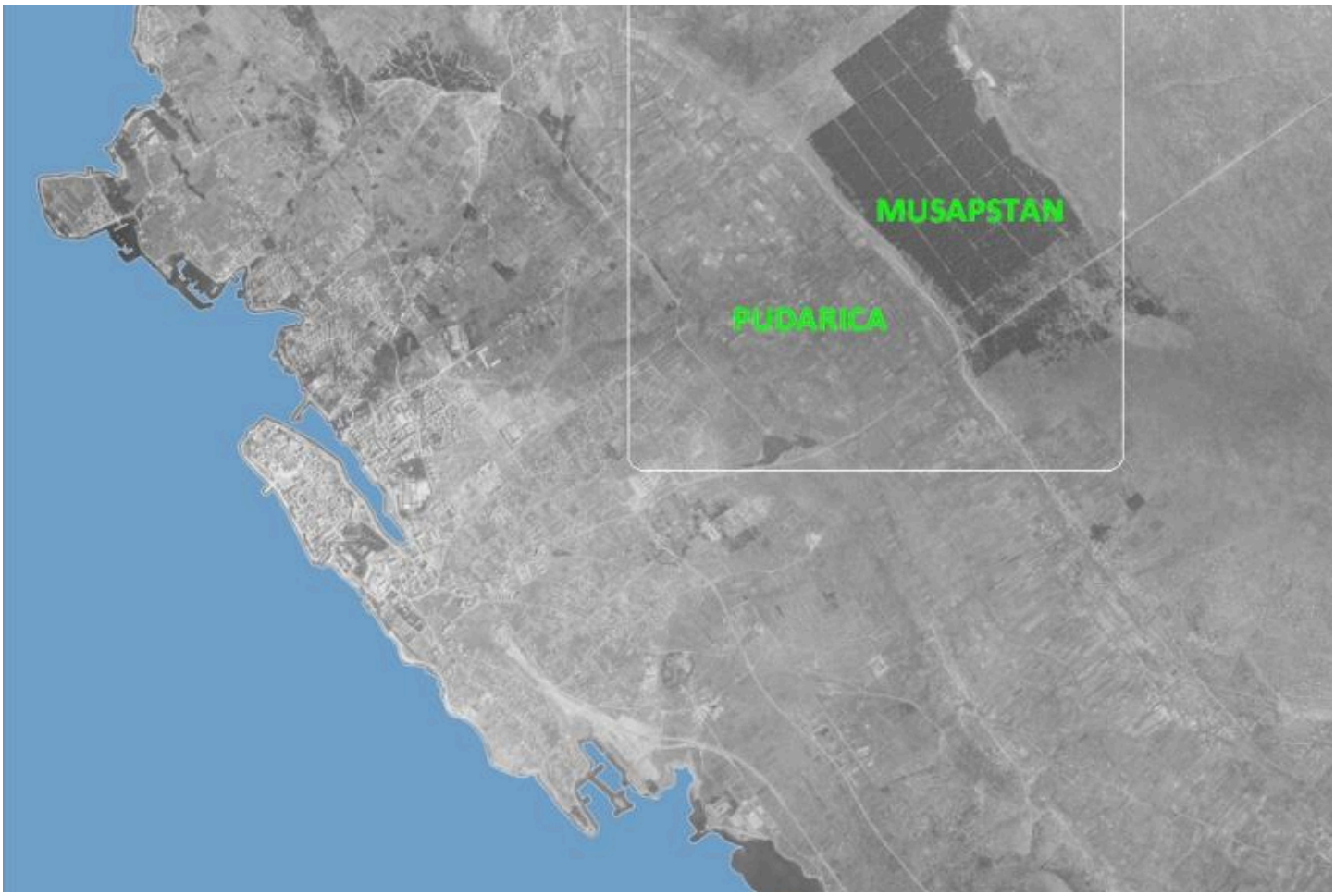
Zadar has a rich heritage and today is one of the most popular Croatian destinations, mentioned in The Times magazine as a major tourist centre in the Mediterranean.

Zadar was once the largest fortified city in the Republic of Venice, and its city walls were an important part of the defence system. Zadar City Walls have been included in the UNESCO World Heritage List since 2017.

The aim of our research is to compare the cover on two locations. Location Station 1 - Pudarica, 44° 07'38"N 15° 15'03"E, 57 m and Station 2 - Musapstan Forest Park, 44° 08'18"N 15° 17'00"E, 61 m (Figure 1). Both stations are located NE of Zadar at a distance of 3 km. The total area on which the research was conducted is 4.04 km².

Figure 1 - Research area - Station 1 - Pudarica, Station 2 - Musapstan Forest Park, 2024

The map of Zadar from 1968 shows that the highest density of construction in Zadar is in the area of the peninsula and the coastal area. In the hinterland of Zadar, low construction density is observed, a large number of plots for agriculture, bare soil, garrigue, macchia, forests...



Station 1 - Pudarica

In 1968, the area of Pudarica was an area of private plots intended for agriculture. Agricultural products such as potatoes, cabbage, tomatoes and Swiss chard were used to feed the inhabitants of Zadar and the islands.

In the following decades, agriculture was slowly abandoned and the plots were overgrown.

"The process of Zadar expansion and reducing the agricultural land during the 1970s can be considered as a typical urbanization trend that occurred throughout the world during that period."

Station 2 - Musapstan Forest Park

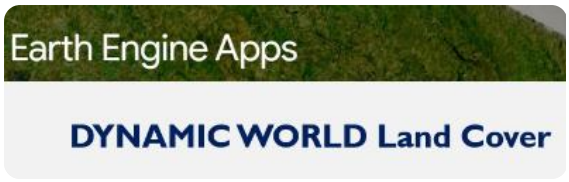
Musapstan Forest Park is one of the largest pine forests in the Mediterranean, covering 250 ha.

Pine tree, pine or domestic pine (lat. Pinus pinea) is a tree from the pine family (Pinaceae), or the conifer group.

"The forest in Musapstan, which is a state property, is now under the use and care of Hrvatske šume, which is a state enterprise responsible for forest and woodland management. It was planted by the Italian rulers from 1932 to 1936 and intended as a defensive shield against the bora wind."

(published in Zadarski list).

31.10.2012., Zadarski list



Earth Engine platforma

A comparison of the land cover of Station 1 - Pudarica and Station 2 - Musapstan Forest Park was conducted for the period from 2015 to 2024 (Figure 2). The comparison of the land cover was conducted using the **Google Earth Engine** computer platform for processing satellite images. The satellite program allows the observation of environmental changes with access to a large database of satellite images from Landsat.

The Dynamic World satellite image shows a set of Earth cover data at a resolution of 10 meters in almost real time.

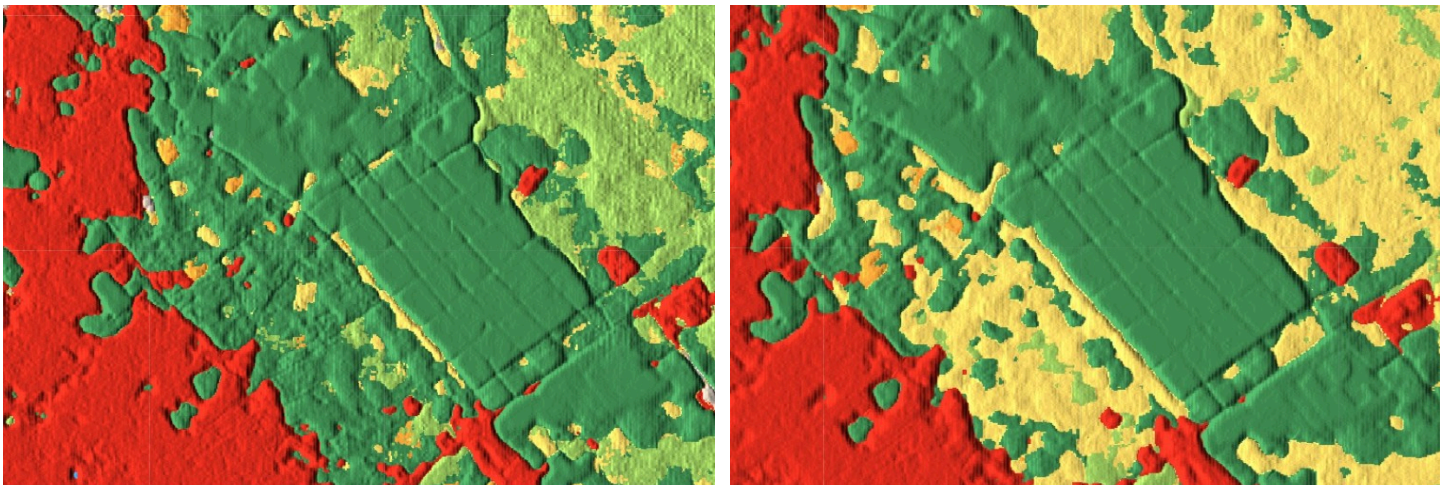
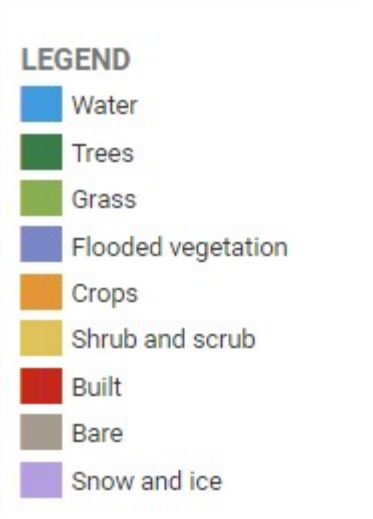


Figure 2 Satellite image of Dynamic World, Station 1 - Pudarica and Station 2 - Musapstan Forest Park on 1.4.2015 (left) and 1.1.2024 (right)



Legend; Dynamic World color display of the cover

Station 1 - Pudarica

- Figure 2 (left) shows the area of Station 1 - Pudarica on April 1, 2015. A predominance of green and light green colours is observed, which tells us about the presence of trees and grass. However, on January 1, 2024, a predominance of yellow is observed, which indicates changes in vegetation. The appearance of yellow indicates less lush vegetation and the appearance of shrubs or undergrowth.

Station 2 - Musapstan Forest Park

- Figure 2 (right) shows the area of Station 2 - Musapstan Forest Park on April 1, 2015. The image shows regular green plots, which

indicates the presence of trees and an organized forest area. On January 1, 2024, regular green plots still prevail, which indicates the preservation of tree vegetation in the area.

On satellite maps in the colour infrared (Color IR) spectrum, red represents the vegetation. This type of satellite imagery is used to study and analyse vegetation cover on Earth. The red colour in Color IR images reflects the radiation emitted by healthy vegetation.

Figure 3 Ersi Landsat - Color IR video projection of the area of Station 1 - Pudarica and Station 2 - Musapstan Forest Park from 1984 to 2024.

Figure 3 shows a video projection of 30 Color IR satellite images taken in the time range from 1984 to 2024 with recording dates during July or August, with cloud cover up to 5%.

In the area of Station 1 - Pudarica, a change in the intensity of the red colour is observed from 1984 to 2024, which tells us about a change in vegetation. Gradual thinning of vegetation in the area is visible, which is a consequence of human activities. Agricultural areas from 1968 (Figure 1) were abandoned over time and were overgrown with macchia and individual trees. In the last decade, in the area of Station 1 - Pudarica, we witness active clearing of vegetation on private plots, in order to build vacation houses and plant gardens.

In the area of Station 2 - Musapstan Forest Park, there are no major changes in the intensity of the dark red colour from 1984 to 2024, which points to a healthy, dense forest. We can confirm this by the condition of this area from 1968 (Figure 1). In the last decade, in the area of Station 2 - Musapstan Forest Park, the city has invested many financial resources from various projects to turn this area into a city park with various sports and recreational offers for the residents of the city of Zadar.

“Musapstan Forest Park near Zadar is a rare example of a preserved forest in Dalmatia and as such is undergoing a process of renovation to make it accessible and useful to the public, with the adequate use of such a natural resource."

Figure 4. Musapstan Forest Park

Students of our school dealt with the issue of the importance of green spaces for the residents of Zadar. They designed and created a project called **"Urban City Garden"** which is located partly in the area of Musapstan and Pudarica. In the project, students became

aware of the importance of preserving natural green spaces, but also of ways to integrate human activities with the least damage to the environment.

Image 5. "Urban City Garden", a project by students of Šime Budinić Elementary School, Zadar, 2023.

Zlatko Lazarin, seaman (retired)

A comment of a Zadar citizen on the changes in the appearance of the city of Zadar:

„Every time I look around, I see even less green spaces and more concrete. This is not the city where I grew up and where I spent my days in parks and by the sea. Our parks and green spaces are not just an adornment to the city, but are important for our health and quality of life as well."

CONCLUSIONS

Given the growth of the city of Zadar and the changing spatial environment, it is important to maintain a balance between urban needs and environmental protection.

It is important to ensure the preservation of existing green spaces such as parks, forests and agricultural areas and to protect them from further urbanization pressure.

Natural areas and ecosystems need to be protected in order to preserve biodiversity.

It is crucial that changes are implemented in cooperation with local communities, environmental experts, urban planners and city authorities, and that citizens participate in the decision-making process.

Sustainable development of the city of Zadar requires an integrated approach that takes into account economic, social and environmental aspects in order to ensure the quality of life of current and future generations.

Literature and sources

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