

Proposal of single risk management plans in the HR test site - A -

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Risk Management Plan Concerning Risks of Coastal Floods Caused by Rising Sea Levels Due to Climate Change

Kaštel Kambelovac pilot location

1. Introduction

Major accidents and catastrophes occur due to a combination of various factors, and they primarily relate to natural phenomena and technical and technological processes that affect the economic and social burdens of a certain area. When we take into consideration the pronounced climate change, the occurrence of frequent major accidents and/or catastrophes is not surprising. In order to reduce accidents and catastrophes, it is necessary to work on prevention and reduction of the factors that influence their occurrence. Even though some accidents and disasters may be predicted, most natural disasters such as earthquakes, floods, droughts, fires and others are unexpected and unpredictable. Therefore, it is important to work on innovative prevention systems and develop measures to prevent, defend, and mitigate the consequences of possible natural disasters. Therefore, the project *Preventing, Managing and Overcoming Natural-Hazards Risks to mitiGATE economic and social impact* – **PMO-GATE** has been created.

The project was approved under the Priority Axis 2 *Security and resilience* of the cross-border cooperation program INTERREG V-A Italy-Croatia 2014 – 2020, which supports the European cohesion policy and contributes to the development of the European Union by strengthening economic, social and territorial cohesion while encouraging economic growth. Through this project, both sides seek to strengthen resilience and further develop a system of protection against natural disasters that are specific to the areas relevant for the project, such as floods caused by extremely high ocean waves, coastal floods caused by rising sea levels, and earthquakes. The main focus of cross-border cooperation is the integration of risk assessment, prevention, preparedness and response to natural disasters while using all available information and results of previous research in order to avoid repeating the research that has already been conducted. The project aims to develop contingency plans that would have the least possible impact on society and the economy by developing an early warning system for possible natural disasters in order to increase the resilience of the economy and safety of the population. Consequently, one of the project activities includes *Improved Early Warning Systems for Individual Risks*, whose goal is to implement smart communication systems. Visualization and communication of risk scenarios to end users and obtaining details on the spatial distribution of vulnerability levels in order for the authorities and other stakeholders involved to identify priority interventions in a timely manner will be enabled by implementing an early

warning system and a dynamic information system based on exposure to multiple hazards and vulnerabilities using understandable information tools. Such timely planning of interventions will ensure the safety of people and material resources. Kaštel Kambelovac is a pilot location of the project in Croatia, and it was chosen because of its features that are unique to the entire area of the Town of Kaštela. Therefore, in that sense it represents a sort of a *test bed*.

This document represents a plan for managing the risks of coastal floods caused by rising sea levels due to climate change for the Croatian pilot area, and it includes a description of the spatial coverage of the pilot location, analysis of the current situation, and analysis of the exposure of the pilot location to flood risk. The document also identifies key issues, vision, goals, and management measures.

2. Spatial coverage of the pilot location

The Town of Kaštela encompasses the central part of the Kaštela Bay basin. It borders the Town of Solin to the east, the municipalities of Klis, Prgomet and Lećevica to the north, the Town of Trogir to the west, and the City of Split at sea. The mainland part of the Town extends over 56.9 km², of which the length of the coast is 23 km. The town administratively encompasses seven settlements: Kaštel Sućurac, Kaštel Gomilica, Kaštel Kambelovac, Kaštel Lukšić, Kaštel Stari, Kaštel Novi, and Kaštel Štafilić. According to the first official reports of the 2021 census, there are 37,951 inhabitants in the Town of Kaštela, while in the urban agglomeration area of Split, to which the Town of Kaštela belongs, there are slightly over 275 thousand inhabitants. The pilot location for the *Risk Management Plan Concerning Risks of Coastal Floods Caused by Rising Sea Levels Due to Climate Change* is Kaštel Kambelovac. It is located between Kaštel Lukšić and Kaštel Gomilica at the foot of the Kozjak hill. The area of Kaštel Kambelovac is diverse enough to be a *test bed* for the entire area of the Town of Kaštela. The spatial coverage of the pilot location is shown in the figure below.



Source: www.geoportal.dgu.hr

Figure 1 Kaštel Kambelovac pilot location

3. Analysis of the situation in the area of coastal floods caused by rising sea levels due to climate change at the Kaštel Kambelovac pilot location

The analysis of the situation from the point of view of coastal floods caused by rising sea levels due to climate change encompasses the main characteristics of the area, as well as social, economic, natural, and cultural indicators and indicators of operational capabilities. Each of the said indicators enables insight into characteristic elements specific to the observed area.

3.1. Main characteristics of the area

3.1.1. Geographical indicators

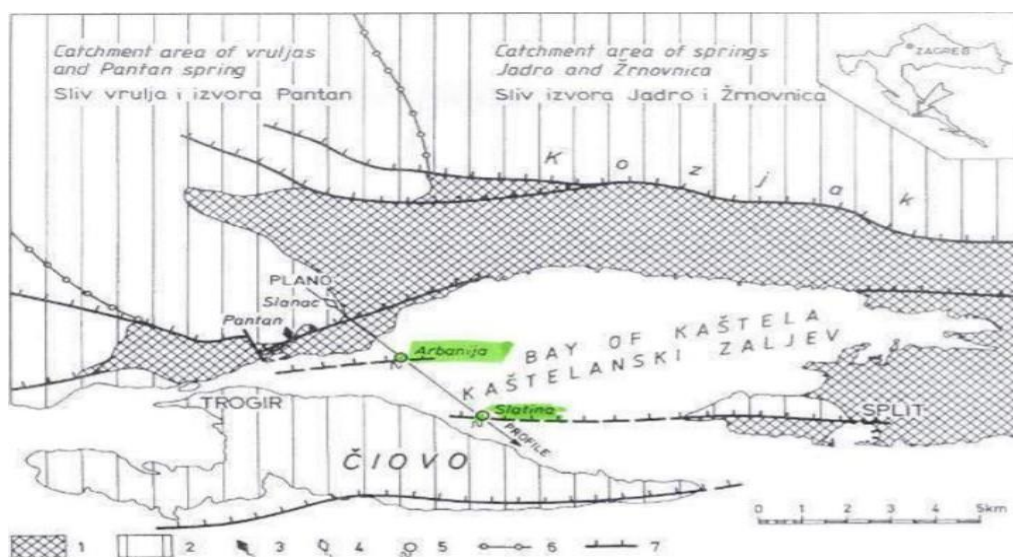
Kaštela is located in a relief-diverse area characterized by flat and slightly sloping parts in the central, coastal part, and steep and extremely steep parts located on the northern edges, i.e. under the slopes of Kozjak. The entire area is located on generally impermeable flysch deposits and is thus known for the large amounts of torrential waters that occur during heavy rains. The area is characterized by two basic hydrogeological units: highly permeable carbonate rocks, mostly calcareous limestones and watertight or poorly permeable rocks, clastic flysch deposits. Permeable calcareous limestones have high secondary porosity and permeability. Under the gravitational force, groundwater flows through them and moves in a well-developed network of cracks, caverns and canals. Therefore, rainwater quickly reaches the aquifer soil which is then discharged in multiple locations, springs and submarine springs. Flysch deposits are also responsible for the formation of smaller surface watercourses and springs at or below sea level. The figure below shows the entire area of Kaštela on a map of flood hazards with a high probability of occurrence.



Source: www.preglednik.voda.hr/

Figure 2 Flood hazard map with high probability of occurrence

In the area of the Kaštela Bay there are two underwater springs – Arbanija, approx. 800 m from the mainland, and Slatina, which is approx. 3,200 m from the mainland. The Pantan spring is a lake between limestone and flysch, in which water springs at a depth of 40 m. The occasional Slanac spring, which is active only during the highest groundwater levels, is also significant. The figure below shows the entire area of Kaštela on the hydrogeological map.



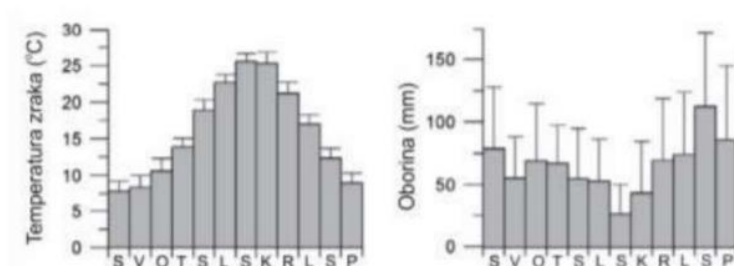
Source: Study on the environmental impact of the exploitation of architectural and building stone in the exploitation field of the “Duboka draga” architectural and building stone in the area of the Town of Kaštela

Figure 3 Hydrogeological map of the Kaštela Bay (Legend: 1. Impermeable rocks (Eocene flysch); 2. Permeable carbonate rocks from the Cretaceous and Paleogene period; 3. Brackish source, permanent; 4. Brackish source, occasional; 5. Underwater spring; 6. Watershed; 7. Reverse

The common favorable feature of Kaštela is the exclusive southern exposure of the terrain. Openness to the sea to a large extent determines the climate of Kaštela, and according to the Köppen¹ climate classification, the area of the Kaštela Bay belongs to the class of Mediterranean climate with hot summers (Csa). Temperature peaks are recorded in July and August, while it the coldest in January. Also, the total amount of precipitation is most pronounced in the autumn and winter months while, as anticipated, the least precipitation occurs during the summer months as shown in the figure below. Sea levels are highly variable throughout the year, with the highest values recorded during late autumn and early winter. This

¹ Climate classification according to air temperature and precipitation in five classes.

is due to the fact that the sea column expands due to heat transfer to deeper layers during autumn, which often leads to the occurrence of extreme flooding of the coastal area.



Source: Coastal Zone Management Plan of the Town of Kaštela

Figure 4 Annual course of mean air temperature and precipitation with the corresponding standard deviation

Due to climate change, there are changes in the hydrological system and all of its components, processes and impacts change, as well as the environment. There are also changes in the drought and flood regime, erosion processes, and other habitat characteristics. The state of the water is likely to worsen in the future due to the amount of rising pressures. However, in the *River Basin Management Plan 2016 – 2021*, this should be partially prevented and restored. The plan consists of two components: a) water status management, and b) flood risk management. The water status management component contains an overview of the water status, a monitoring system, and a program of quality management measures. The flood risk management component contains the conclusions of the *Preliminary Flood Risk Assessment*, the flood hazard maps and flood risk maps, the flood risk management goals, and the program and measures put in place to achieve the goals.

3.1.2 Population

According to the first results of the 2021 census, the Town of Kaštela has 37,951 inhabitants, and considering that the area of the Town is 56.9 km², the population density of the area is 666 inhabitants/km², which also places the Town of Kaštela among the most densely populated local self-government units in the Republic of Croatia. Data on the age and sex structure of the population from 2021 are still not available, therefore these data are analyzed in more detail below on the basis of the 2011 census when there were 38,667 inhabitants in the area of the Town of Kaštela.

Table 1 Population by settlements of the Town of Kaštela

Settlement	Population
Kaštel Sućurac	6,513
Kaštel Gomilica	4,766
Kaštel Kambelovac	5,076
Kaštel Lukšić	5,254
Kaštel Stari	6,968
Kaštel Novi	6,537
Kaštel Štafilić	2,837

Source: First results of the 2021 census

The table shows that the most populous settlement is Kaštel Stari, while the least populous one is Kaštel Štafilić. In the area of the Kaštel Kambelovac pilot location there are 5,076 inhabitants, which is 13.4% of the total population from the area of the Town of Kaštela.

The age distribution of the population is divided into three categories: young (0-19 years of age), mature (20-59 years of age), and elderly (> 60 years of age). According to statistics from 2011, the young population accounts for 24.58% (9,506), mature 56.46% (21,831), and elderly 18.86% (7,330) of the total population of the Town of Kaštela. The table below shows the distribution of the population by sex and age at the Kaštel Kambelovac pilot location and the entire area of Kaštela. It is evident that, according to gender, there is slightly more female than male population in total, while within the age groups – young and mature – the male population is predominant.

Table 2 Population by age and sex

Settlement	Sex	Population	Age group		
			Young (0-19)	Mature (20-59)	Elderly (> 60)
Kaštel Kambelovac	Total	5,027	1,252	2,798	977
	M	2,487	641	1,402	444
	F	2,540	611	1,396	533
Town of Kaštela	Total	38,667	9,506	21,831	7,330
	M	19,073	4,823	10,985	3,265
	F	19,594	4,683	10,846	4,065

Source: Development Strategy of the Town of Kaštela 2016 – 2020

3.1.3 Transport connectivity

The area of the Town of Kaštela is part of the functional traffic region of northern and central Dalmatia through which the international Adriatic-Ionian Road corridor passes. Between Trieste and Kalamata, the

corridor connects seven countries. Along the Adriatic coast, it connects the main seaports (Trieste, Koper, Rijeka, Zadar, Šibenik, Split, Ploče, Dubrovnik, Bar, Durrës, Igoumenitsa, Patras, Kalamata) and numerous pan-European corridors (V, Vb, Vc, and VIII). Below is a description of road, rail, air, maritime, and the public transport system according to the *Development Strategy of the Town of Kaštela 2016 – 2020*, and the transport infrastructure of the Town of Kaštela is divided into road, rail, air, maritime, and the public transport system.

3.1.3.1 Road infrastructure

The Adriatic Highway, i.e. the state road D8, is the most important road passing through the Town of Kaštela. It is extremely important considering the fact that it is the main traffic corridor in the entire coastal part of the Republic of Croatia, and especially in the area of the Split agglomeration. The Adriatic Highway connects all important coastal city centers from Rijeka, Zadar, Šibenik, Split, Makarska to Ploče and Dubrovnik. In the area from Trogir to Omiš, it forms the Split bypass, which is one of the busiest road sections in Croatia. On the road between Kaštel Stari and Solin, the average annual daily traffic amounts to 16,000 vehicles. During the summer season, the average daily traffic amounts to 24,000 vehicles. The second transversal transport route that passes through the Town of Kaštela and forms the secondary transport axis is the so-called Old Kaštela Road Ž6137 (Dr. Franjo Tuđman road) which stretches along the D8, but is closer to the coast and passes through the centers of the Kaštela settlements, resulting in a significant reduction of the share of transit traffic on said road. The only significant road that does not follow the east-west coast direction, but rather the north-south is the Kaštel Stari – Kladnice road over the Malačka pass, but which in terms of traffic intensity lags considerably behind the two above-mentioned roads. All coastal settlements are connected to the main longitudinal roads by local roads (L67058, L67059, to Kaštel Štafilić, L67060 to Kaštel Lukšić, L6762 to Kaštel Kambelovac, L67063 to Kaštel Gomilica, L67064 to Kaštel Sućurac). In addition to the considerable traffic load, there are also issues concerning the road network that have arisen as a result of the uncontrolled expansion of settlements due to the absence of integrated spatial planning. Insufficient space left for the road means that two vehicles cannot pass one another, or that access for public service vehicles has been obstructed, which results in human lives being endangered. The legal status of public roads and unclassified roads, and the

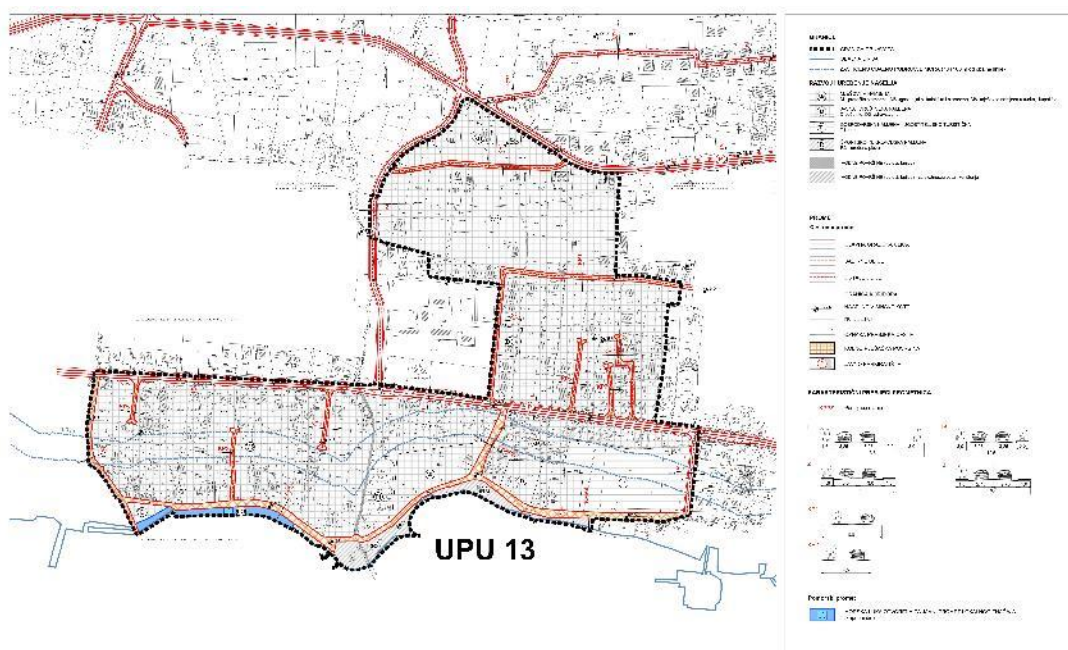
manner of their use and planning of construction and maintenance, as well as concessions, financing and supervision are regulated by the Roads Act (OG 84/11, 22/13, 54/13, 148/13, 92/14, 110/19, 144/21).

Table 3 Length of roads in the area of the Town of Kaštela

Length of highways (km)	Length of state roads (km)	Length of county roads (km)	Length of local roads (km)	Total length of classified public roads (km)
2.55	17.61	21.17	9.23	50.56

Source: Development Strategy of the Town of Kaštela 2016 – 2020

The figure below shows the existing road infrastructure of the Kaštel Kambelovac pilot location, which is defined by the *Urban Development Plan of the Town of Kaštela, Center 2*.



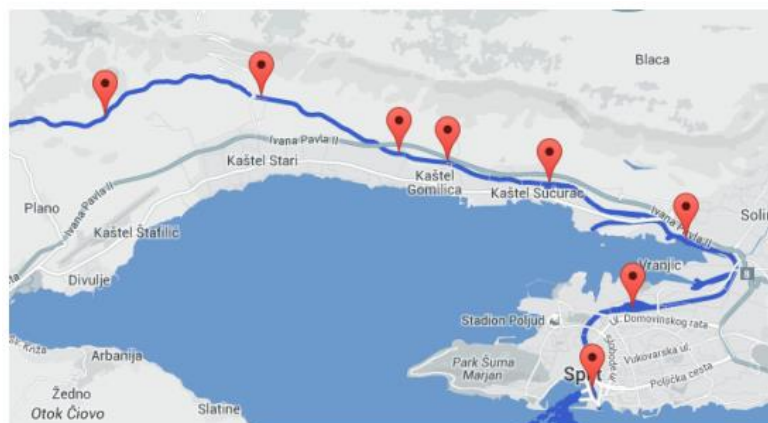
Source: www.kastela.hr

Figure 5 Road infrastructure of Kaštel Kambelovac

3.1.3.2. Railway infrastructure

The railway M604 goes through the Town of Kaštela from Split towards Knin or Zagreb (the so-called Lika railway). The railway is single-track, non-electrified, low-capacity, with a maximum permitted speed of 60 to 100 km/h with a limit of 35 to 60 km/h over switches in railway stations, and up to 60 to 70 km/h in arches. The management of railway infrastructure is regulated by the Railway Act (OG 32/19, 20/21), and

is the responsibility of the Ministry of Maritime Affairs, Transport and Infrastructure. Moreover, the railway is not part of international and pan-European corridors. According to the *Transport Development Strategy of the Republic of Croatia 2014 – 2030*, in the functional region of central Dalmatia, railway transport is less significant since its accessibility levels are not competitive in relation to the road system, therefore the main priority is to improve the links between railway stations in cities with public transport systems. In terms of improving accessibility to freight transport, the priority is to improve accessibility to ports in order to limit and possibly reduce the number of freight trucks in central and tourist areas. Therefore, the priority of the development of railway traffic in the Town of Kaštela is greater integration of the railway into the public transport system and its use in freight transport in order to reduce road traffic congestions, improve cost efficiency and reduce pollution. The figure below shows the railway route in the area of the Town of Kaštela.

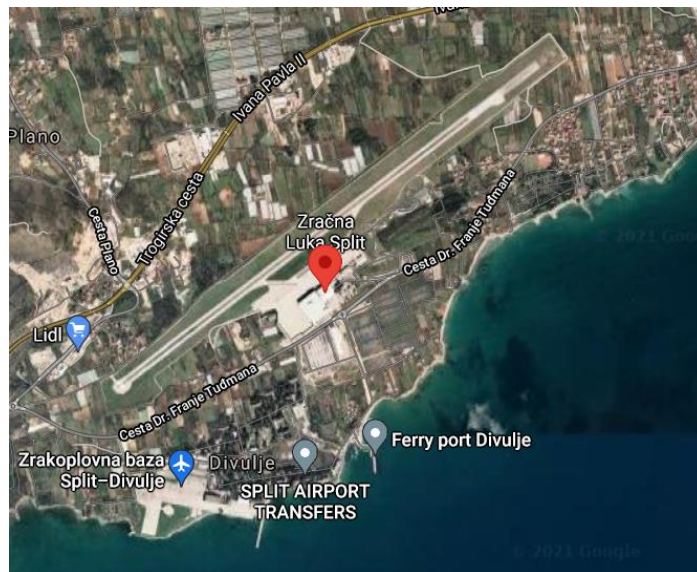


Source: *Development Strategy of the Town of Kaštela 2016 – 2020*

Figure 6 Railway stations within the suburban railway

3.1.3.3. Air traffic

The Split Airport (Resnik) is located in the area of the Town of Kaštela and Trogir, and it covers an area of 95 ha, of which 75 ha is in the area of Kaštela, and 20 ha in the area of Trogir. In 2019, a new terminal was opened, and it covers an area of 3.6 ha. The Split Airport is the second largest and busiest airport in the Republic of Croatia; over three million passengers passed through it in 2019, which is an increase of 5.7% compared to 2018 and an increase of 88.4% compared to 2014. The largest number of passengers is recorded during the summer months, especially in July and August.



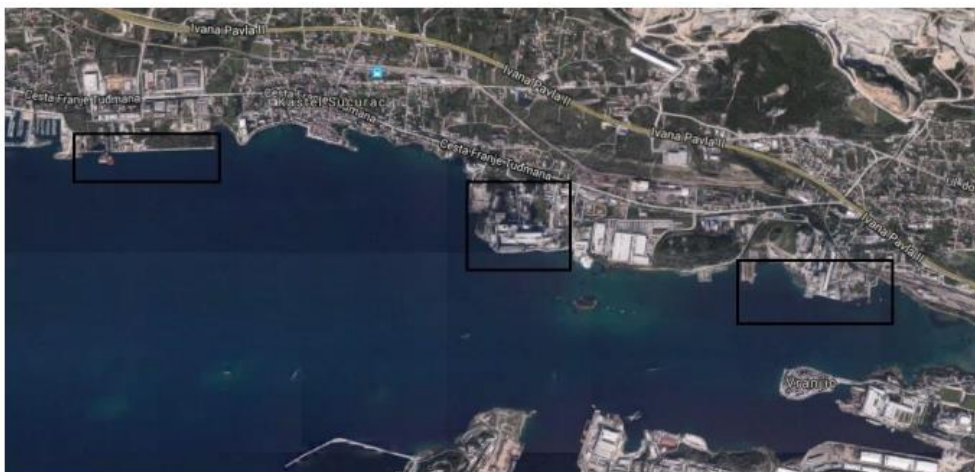
Source: www.google.com/maps, processed by the creator

Figure 7 Satellite view of the Split Airport

3.1.3.4. Maritime traffic

In the area of the Town of Kaštela, there are five ports open to public traffic, which are classified as Category III ports when it comes to their local importance. The ports are located in Kaštel Gomilica, Kaštel Kambelovac, Kaštel Lukšić, Kaštel Stari, and Kaštel Štafilić and are under the jurisdiction of the Port Authority of the Split-Dalmatia County, whose management is primarily regulated by the Maritime Domain and Seaports Act (OG 158/03, 100/04, 141/06, 38/09, 123/11, 56/16, 98/19). When it comes to freight traffic, the Kaštela Bay is divided into three port areas that are also under the integration of the Split Port Authority: Basin A (complex ex *Jugovinil*), Basin B (coast of the St. George I and II Cement Plant) and Basin C (coast of the St. Kajo Cement Plant, Brižine coast, INA tanker terminal, Mala obala Solin). The spatial plan of the Split-Dalmatia County and of the Town of Kaštela envisages the construction of a fishing port in the area of Brižine in Kaštel Sućurac, two nautical tourism ports in the area of Giričić in Kaštel Gomilica and Adriavinil (ex *Jugovinil*) in Kaštel Sućurac, as well as a public transport port. Transfer of passengers from the airport in Resnik is part of the Basin D, which belongs to the Port of Split. It is important to emphasize the significance of nautical tourism in the Kaštela Bay where *Marina Kaštela* is located in Kaštel Gomilica, which has 420 berths and 200 mainland places. It is the largest nautical tourism port in the Split-Dalmatia County which significantly contributes to traffic density in the area of the Kaštela

Bay during the summer months. In addition to the increasing traffic density, the probability of marine pollution is also increasing. The Kaštela Bay is under pressure from pollution from municipal, torrent, and industrial wastewater, atmospheric sediments, as well as wastewater and pollution due to marine traffic. The pollution occurs in various locations along the coast, and sea currents spread it further throughout the Kaštela Bay towards the Trogir Bay and the Split Channel. Furthermore, great pressure from pollution comes from sea currents from the area of Split, i.e. from the Brač Channel and partly from the direction of Trogir. Maritime traffic is often associated with illegal discharges of polluted bilge water, oily water, and black water. Most pollution is often associated with large ships, but the impact of a large number of small recreational boats is not negligible. Even though the Maritime Domain and Seaports Act (OG 158/03, 100/04, 141/06, 38/09, 123/11, 56/16, 98/19), the Ordinance on the Terms and Methods of Maintaining Order in Ports and Other Parts of Internal Waters and the Territorial Sea of the Republic of Croatia (OG 72/21), and the Ordinance on Ships, Boats and Yachts (OG 13/20) define preconditions and methods for disposal and reception of wastewater from vessels, it is often the case that a large number of recreational boaters do not adhere to them, and often, due to the lack of infrastructure for the reception of wastewater, they end up in the sea by illegal discharge.

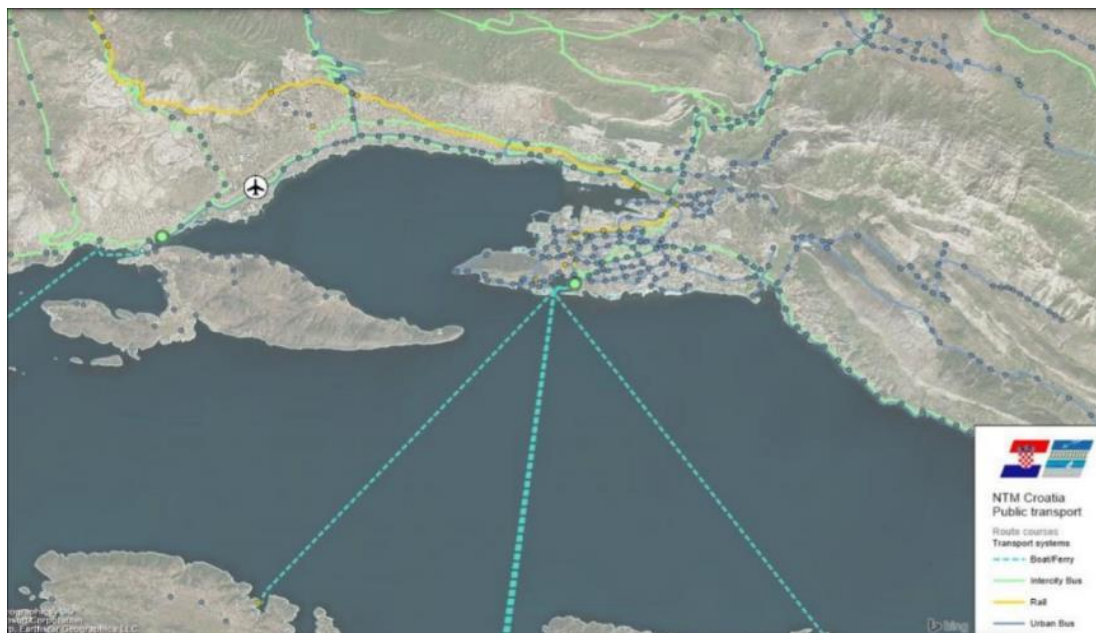


Source: *Development Strategy of the Town of Kaštela 2016 – 2020*

Figure 8 Area of Basin A, B and C (from left to right)

3.1.3.5. Public transport organization

The Town of Kaštela belongs to the area of public suburban transport of the City of Split, which has the most developed local public transport in the region with 44 local (city) lines and 25 suburban bus lines. The largest portion of public transport is carried out by buses of *Promet d.o.o. Split* which provides services in the area of five cities and 11 municipalities. The total daily transport to and from Split amounts to over 34 thousand passengers transported by Promet d.o.o. Split, and another 1,500 passengers a day who use other carriers in both directions. This includes passengers from the area of Kaštel Kambelovac. In the Split agglomeration, the most intensive suburban traffic is on the Split-Solin route, followed by Split-Trogir, where almost 7,000 passengers are transported daily to the most remote Kaštela settlement, and around 8,000 passengers are on the Solin-Kaštel Sućurac route. The conditions and manner of performing the activity of public transport of passengers and freight transport in the internal road traffic, and the activity of providing station services at bus and freight stations are determined by the Road Transport Act (OG 41/18, 98/19, 30/21, 89/21). The figure below shows the public transport system in the area of Kaštela and Split.



Source: *Transport Development Strategy of the Republic of Croatia (2017 – 2030)*

Figure 9 Map of the public transport system in the area of Kaštela and Split (legend: ferries – blue dashed line, interurban buses – green line, railway – yellow line, city buses – blue line).

In the function of public city transport or suburban transport, railway transport is used to a certain extent. On the route between the center of Split to Kaštel Stari, the suburban train travels 24 minutes, and there are five stops between these two destinations (Split-Predgrađe, Solin, Kaštel Sućurac, Kaštel Gomilica, Kaštel Kambelovac).

3.2 Social indicators

Kaštel Kambelovac covers an area of 45,000 square meters and has more than 400 buildings. It consists of a historic center (more in Chapter *Cultural heritage*) with stone masonry buildings built between the 15th and 16th centuries and parts outside the historic center dating from the early 20th century to the present day. The buildings in Kaštel Kambelovac were built in various periods under different technical regulations. The oldest buildings were built prior to 1948, then certain blocks were erected in the periods from 1949 to 1964, from 1964 to 1982, and from 1982 to 2005. The most modern buildings have been built since 2005.

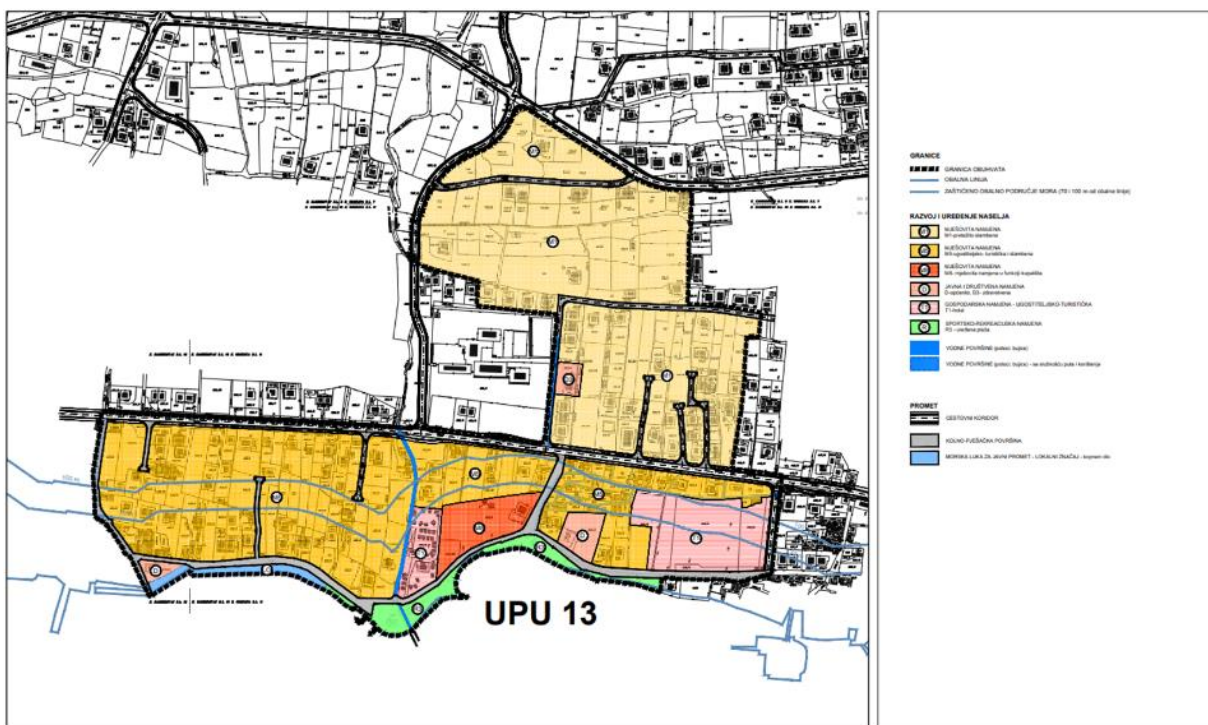
3.2.1 Buildings for public and social purposes

In the area of the Town, there are 11 branches of the Kaštela Kindergarten established on the basis of the Decision of the Municipality of Kaštela, five elementary schools and one high school whose founder is the Split-Dalmatia County. The only Kaštela settlement without an elementary school is Kaštel Kambelovac, but the Prince Trpimir Elementary School in Kaštel Gomilica, which is the largest elementary school in the Town with 35 classes and over 950 students, includes the enrollment area of Kaštel Kambelovac and Kaštel Gomilica. Other buildings for public and social purposes are the Museum of the Town of Kaštela (in two locations – the Vitturi Castle in Kaštel Lukšić and the Archbishop's Palace in Kaštel Sućurac) and the Library of the Town of Kaštela. However, it is worth noting that there is no theater building or concert hall in the Town area.

Of the public health institutions in the Town area, there are four Health Center offices of the Split-Dalmatia County, the branch office of the Institute of Emergency Medicine of the Split-Dalmatia County in Kaštel Stari, and the branch office of the Public Health Institute of the Split-Dalmatia County in Kaštel Sućurac. Within the Pharmacy of the Split-Dalmatia County in the area of Kaštela, there are three pharmacies located in Kaštel Gomilica, Kaštel Sućurac, and Kaštel Stari. However, there are four other

private pharmacies, one of which is located in Kaštel Kambelovac. In the field of social welfare, there is the Social Welfare Center Split – Kaštela Branch, Children’s Home *Maestral – Miljenko i Dobrila* Branch, the Homeless Shelter in Kaštel Gomilica, and the soup kitchen. The Red Cross, in cooperation with the Kaštela Town Society, also carries out numerous voluntary blood donations, first aid education and the like. There is not a single state-owned nursing home in the Town area, but there are private nursing homes: two in Kaštel Gomilica, Kaštel Sućurac, and Kaštel Novi. In Kaštel Kambelovac there is a family nursing home with a capacity of up to 20 people.

The figure below shows the position of buildings for public and social purposes with the letter D (light pink), sports and recreational purposes with the letter R (green), as well as residential and commercial buildings, marked with the letters M and T (other colors).



Source: www.kastela.hr

Figure 10 Arrangement of the Kaštel Kambelovac settlement according to UPU 13

3.2.2 Buildings for residential and commercial purposes

In accordance with the *Development Strategy of the Town of Kaštela 2016 – 2020*, on the basis of the *2011 census*, the Town of Kaštela has over 12 thousand housing units and households. Of the total number of apartments intended for permanent residence, 6,442 are temporarily unoccupied, and 193 are abandoned. Also, according to the same census, the total number of household members living in occupied apartments is 38,403, while in the collective apartments, of which there are 13 in the area of Kaštela, there is a total of 256 people, including the homeless registered in the shelter.

The main issue regarding housing and housing stock in the entire Split agglomeration, and even in the wider coastal zone of the Republic of Croatia is the uncontrolled housing construction, the so-called illegal construction. The most common characteristic of illegally constructed buildings is that they are built in groups on the outskirts of the city, without obeying the spatial plans and without proper design and technical documentation, while houses are randomly scattered regardless of plans for the construction of necessary municipal and other crucial infrastructure. Areas for residential and commercial purposes in the area of Kaštel Kambelovac, Center 2, according to UPU 13, are shown in the previous figure.

3.3 Economic indicators

The share of those employed in the Town of Kaštela is the largest in the activities of wholesale and retail such as trade, repair of motor vehicles and motorcycles, and the manufacturing industry, according to the *Risk assessment of major accidents for the Town of Kaštela*. According to the Croatian Employment Service, the number of unemployed people has increased by 6.5% in the period from 2018 to 2020. Also, seasonal unemployment is pronounced in this area, for which there is a growth rate after the summer months and it reaches its highest level in the winter months. Economic indicators also include branches of the economy and critical infrastructure, described in detail below.

3.3.1 Branches of the economy

In the past, the economy in the area of the Town of Kaštela relied on agriculture and fishing. Following the First World War, the first industry developed in Kaštela – the cement factory in Kaštel Sućurac, and a significant growth of industry in Kaštela was recorded after the Second World War, which led to the increase in population and rapid urbanization of the entire area. Kaštela still bases part of its economy on

industry, agriculture, and fishing; however, as is the case in the entire coastal area, the majority of the population focuses on tourism.

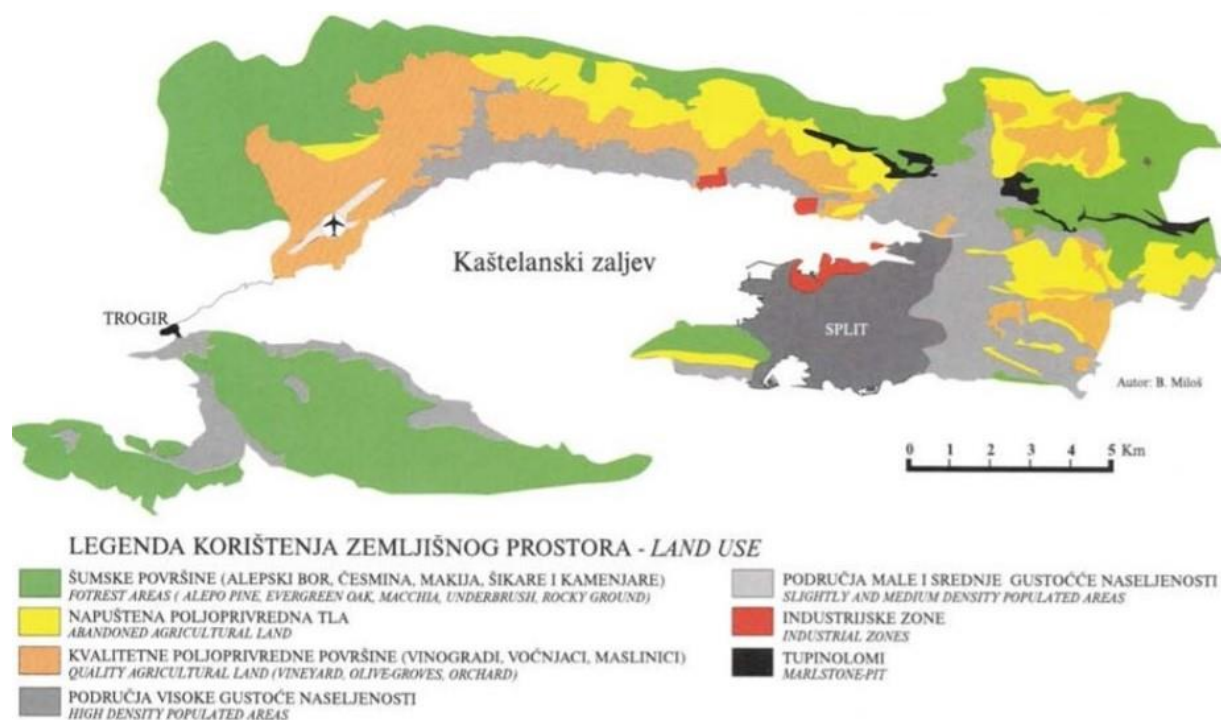
3.3.1.1 Industry

Over the last decades, the area of the Town of Kaštela has undergone significant changes in the economic structure from a former industrial town to a town dominated by trade and service activities, with an emphasis on the development of tourism. There are large companies in the area of the Town, i.e. *Željezara Split d.d.*, *PROPLIN d.o.o.*, and *CEMEX Hrvatska d.d.* The period of significant focus towards industry has left its mark on the Kaštela Bay in the ecological sense, therefore the consequences of pollution caused by industrial processes and waste are still visible today. Exploitation areas for the exploitation of mineral resources for the needs of the cement industry remain within their existing limits. Following the end of exploitation, the users in these fields are obliged to carry out technical and biological remediation of the area in accordance with the adopted remediation program. The area of the said zones is 104 ha, part of which belongs to the construction area for temporary construction of buildings whose function is exploitation.

3.3.1.2 Agriculture

The agricultural land of the Town of Kaštela, the Kaštela Field, is located behind the coastal strip with the settlement zone, and rises in relief towards the Kozjak Mountain. Traditionally, in the area of Split-Dalmatia County, olive-growing and viticulture prevail, along with the continuous development of wine and oil production with the possibility of growing various citrus fruits. For instance, cherry-growing is a tradition in the entire area from Kaštela to Omiš.

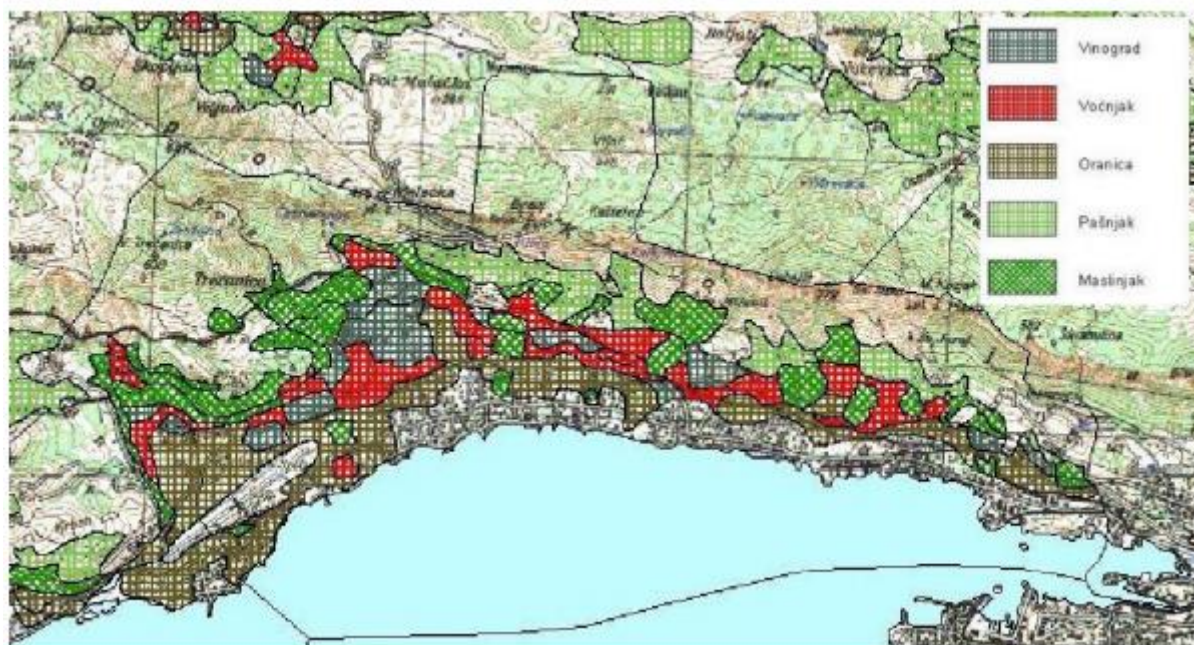
According to the Corine Land Cover Croatia 2018, the total agricultural area in the area of the Town of Kaštela is 1769.29 ha, of which 205.84 ha, or 11.6%, is located in the area of Kaštel Kambelovac. Maintenance and protection of agricultural land, its use, change of purpose, compensation and disposal of agricultural land is regulated by the Agricultural Land Act (OG 20/18, 115/18, 98/19). Olive groves in the area of Kaštela are located on hilly plateaus in the outskirts of the town, and on terrains with a deeper terrain profile and a greater ability to retain soil moisture, there is a tradition of table olive production. From the cultivation of fruit trees, the most common are cherries and figs, almonds and peaches. The figure below shows a map describing the land usage in the area of the Kaštela Bay.



Source: Soils of the Kaštela Bay and issues with regards to their protection, *Agronomy Journal* (4/1998)

Figure 11 Map describing the land usage

According to the data from the Registry of Agriculture from 2015 in the area of the Town of Kaštela, a total of 906 members of agricultural holdings have been registered, while in the overall structure, family farms prevail. There are 134 family farms and two companies located in the area of Kaštel Kambelovac, out of a total of 710 registered agricultural holdings on a total of 502 ha of land. Also, out of the total number of registered entities, as many as 704 have an area of less than 3 ha. The Spatial Plan of the Town of Kaštela defines the purpose of agricultural land, construction in these areas and future protection. The figure below shows the purpose of agricultural land in the area of the Town of Kaštela.



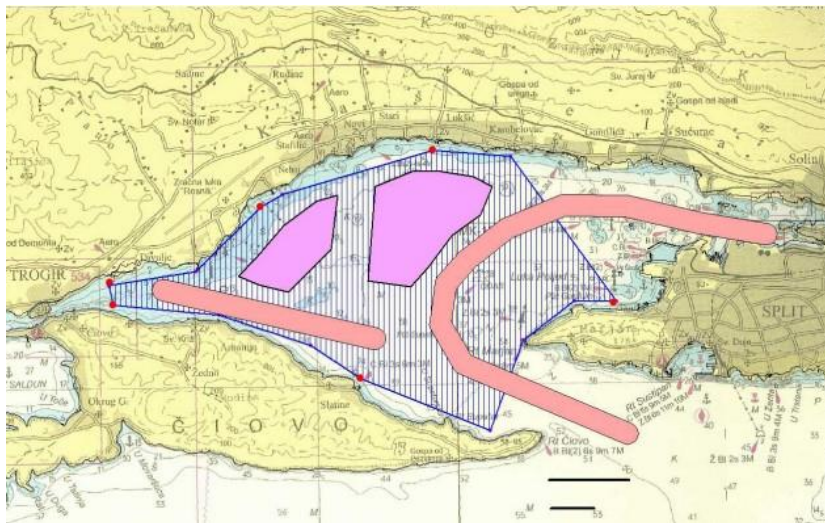
Source: Development Strategy of the Town of Kaštela 2016 – 2020

Figure 12 Purpose of agricultural land in the area of the Town of Kaštela

3.3.1.3 Fishery and mariculture

In the Republic of Croatia, mariculture includes the breeding of white and blue fish, as well as shellfish. The most important fish species in farming are the European bass (*Dicentrarchus labrax*), the gilt-head bream (*Sparus aurata*), and the Atlantic bluefin tuna (*Thunnus thynnus*), and when it comes to shellfish, those are the Mediterranean mussel (*Mytilus galloprovincialis*) and the European flat oyster (*Ostrea edulis*). Fish farming in the coastal waters is characteristic for the area of the Town of Kaštela and the Kaštela Bay. In this case, the coastal waters imply areas of the sea that are protected and partially protected from waves, and can be distinguished into two categories. The first is farming in protected coastal locations, i.e. a bay where the waves during windstorms do not exceed a height of 1 m. Due to generally weak changes of the sea and thus limited reception capacity, such locations are suitable for small fish farming. The advantage of this fish farming method is that the impact on the environment is almost negligible. The second type of farming includes exposed coastal locations (semi-open sea). Exposed coastal locations are areas where at least one side is protected from waves, and waves during windstorms do not exceed a height of 3 m. The following fish farming technologies are used in the coastal waters area:

hatcheries, cultivation of organisms in cages, cultivation in fish farms, and cultivation on the seabed. The figure below shows the view of the Kaštela Bay with the potential zones of shellfish farming. The blue area is marked by the shellfish fishing zone, the red dots represent the locations for sampling and determining the quality of the sea and shellfish meat, the bright red corridors are 500 m wide corridors for seaplane traffic, and the purple zones are the two proposed shellfish farming zones.



Source: Study of the use and protection of the sea and the submarine area in the Split-Dalmatia County

Figure 13 Multi-criteria analysis of the Kaštela Bay for potential shellfish farming

3.3.1.4 Tourism

In the last twenty years, tourism in Croatia has been continually on the rise. Data from the Croatian Bureau of Statistics for the reference year 2019 (last pre-pandemic year) show that for six consecutive years there has been an increase in arrivals and overnight stays of domestic and foreign tourists, therefore in 2019 there were 19.6 million arrivals and 91.2 million tourist overnight stays in Croatia. Compared to the year prior, it was an increase of 4.8% in arrivals and 1.8% in overnight stays. Naturally, the number of arrivals and overnight stays dropped dramatically in 2020 due to the COVID-19 pandemic. However, as early as in 2021 there was an improvement in tourism and a return of figures to an upward trajectory towards pre-pandemic results.

In the Split-Dalmatia County, the development of tourism follows national trends. It is characterized by continuous growth and pronounced seasonality. According to the Croatian Bureau of Statistics, in 2019

the Split-Dalmatia County accounted for 19% in the total number of tourist arrivals, and 20% in overnight stays. Tourist traffic at the level of the Split-Dalmatia County in the Town of Kaštela and neighboring towns for 2019 is shown in the table below.

Table 4 Tourist traffic in 2019

Tourist board	Tourists 2019			Overnight stays 2019			%	2018	2018/2019
	Domestic	Foreign	Total	Domestic	Foreign	Total	Share	Total	Index
Town of Kaštela	10,518	105,610	116,128	40,046	598,667	638,713	3.5	585,679	109
City of Split	75,951	868,514	944,465	166,947	2,590,358	2,757,305	15.2	2,510,171	110
Town of Solin	4,860	36,645	41,505	9,280	93,239	102,519	0.6	88,289	116
Town of Trogir	6,916	141,436	148,352	27,969	570,610	598,579	3.3	583,989	102

Source: Statistical analysis of tourist traffic in 2019, Split-Dalmatia County Tourist Board, processed by the creator

The Town of Kaštela, as well as the Kaštel Kambelovac pilot location and the entire county, except for the pandemic period, have been recording a continuous increase in tourist arrivals and overnight stays. Out of the total number of arrivals and overnight stays at the level of the Split-Dalmatia County, the Town of Kaštela recorded a total of 116,128 arrivals (3.2%) and 638,713 overnight stays (3.5%). Kaštela is important in the context of tourism not only because of its tourist offer, but also because of its location, i.e. its proximity to the Split Airport and Marina Kaštela, points of significant concentration of tourists.

3.3.2 Critical infrastructure

3.3.2.1 Coast and coastal infrastructure

The length of the coastal area is 23.4 km. The coastal area is of lowland type, up to an altitude of 100 m and an average width of 2 km, and is mostly urbanized. During the previous centuries, the development of the Kaštela settlements was marked by systematic embankments and construction of the coast, which also represents one of the main issues today. Moreover, the coastal zone bears the consequences of many years of negative effects in the form of unsystematic sectoral management marked by inadequate construction of industrial plants, non-systematic construction and maintenance of coastal infrastructure in an unsystematic and inadequate manner (non-compliance with the Maritime Domain and Seaports Act (OG 158/03, 100/04, 141/06, 38/09, 123/11, 56/16, 98/19) and the Spatial Planning Act (OG 153/13, 100/04, 141/06, 38/09, 123/11, 56/16, 98/19) responsible for coastal planning and coastal infrastructure),

and in recent years the uncontrolled growth of tourist capacities. Simultaneously, the marine environment is particularly endangered. The coastal area stands out as a high-risk area and special attention should be paid to cumulative impacts in order to identify all of the present pressures and propose measures that would alleviate pressures on the narrow coastline, preserve natural shores and spatial characteristics, preserve the cultural landscape, prevent further pollution of the marine environment, and preserve the coastal resources for sustainable tourism development. Due to these negative impacts, there is a need for a systematic, sustainable and thoughtful model of coastal management of the Town of Kaštela that will minimize the negative effects by implementing innovative methods, taking into account the environmental impact of activities related to coastal engineering. To this effect, the *Coastal Zone Management Plan of the Town of Kaštela* was adopted, which defines concrete measures and activities for the management of the coastal area of the Town of Kaštela.

The plan also covers beach management considering the fact that beaches, as part of the coastal strip, are extremely important in the context of tourism. According to the *Guidelines for Coastal Strip Management of the Town of Kaštela (2014)*, there are 9,620 m or 44% of undeveloped natural coast in the area of Kaštela. These are mostly organized and unorganized beaches and the coast which is not suitable for bathing. The table below shows the list of beaches in the area of the Town of Kaštela, as well as their standard.

Table 5 Beach standards in Kaštela

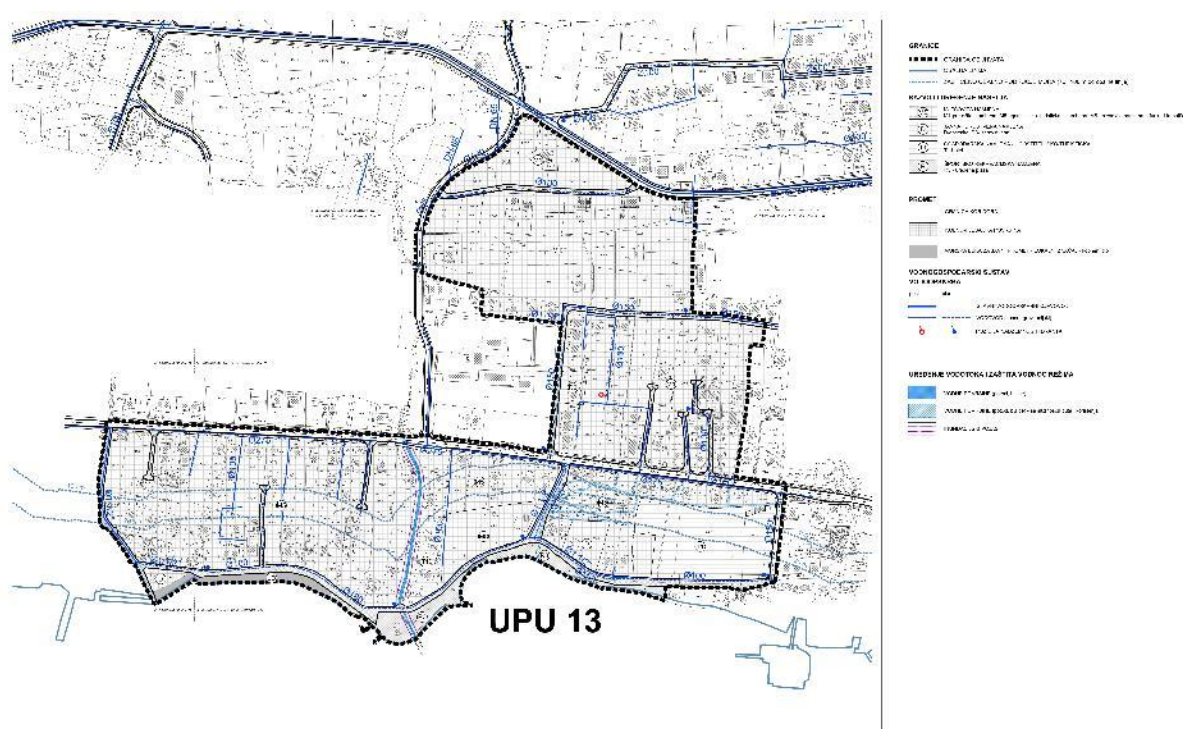
Beaches	Length in m	Surface area in m ²	Beach type	Number of bathers	m ² per bather	Number of bathers per beach linear metre
Gojača	337	6,000	sand, gravel, concrete	200	30.00	0.59
Sokolana	128	1,900	shingle, concrete	60	31.67	0.47
Kamp	167	3,576	shingle, stone	300	11.92	1.80
Torac	212	3,713	sand, concrete	400	9.28	1.89
Bilajka	200	4,739	gravel, concrete	100	47.39	0.50
Baletna škola	464	6,630	gravel, concrete	800	8.29	1.72
Pošta	133	4,460	sand, gravel, concrete	250	17.84	1.88

Glavica	140	3,090	gravel, large stones	200	15.45	1.43
Ilirija	163	2,476	sand, gravel, concrete	100	24.76	0.61
Šulavy	70	1,938	concrete	100	19.38	1.43
Željeznički	100	2,000	gravel, concrete	100	20.00	1.00
Šumica	150	2,670	stone and concrete wall	200	13.35	1.33
Palace	300	4,000	gravel, concrete	300	13.33	1.00
Štalija	300	5,000	gravel, concrete	300	16.67	1.00
Đardin	224	7,670	gravel, stone, concrete	900	8.52	4.02
Gabine	165	2,532	shingle, stone, concrete	450	5.63	2.73
Bile	600	16,500	shingle, stone, concrete	1,000	16.50	1.67
Resnik	450	15,200	shingle, stone, concrete	1,600	9.50	3.56
Divulje	260	8,500	shingle, stone, concrete	1,600	5.31	6.15

Source: Coastal Zone Management Plan of the Town of Kaštela, processed by the creator

3.3.2.2 Public water supply

The area of the Town of Kaštela is supplied with water from the Split-Solin-Kaštela-Trogir water supply system from the source of the Jadro River. Water is brought by gravity from the source to the main pumping stations, then the necessary quantities are further distributed to the main water tanks. The said water supply system encompasses eight large pumping stations, five water tanks with a volume of 15,000 m³, and 20 km of pipelines of various profiles. The connection of residents to the public water supply system is higher than 87%, and is under the jurisdiction of the company *Vodovod i kanalizacija d.o.o.* The key issues faced by the water supply system concern water turbidity and water reduction during the summer months. Due to the high turbidity that occurs up to several times a year, when the turbidity exceeds the permitted level of 4 NTU, the water is disinfected with chlorine gas before distribution, and the population is warned to boil the water prior to its use. Preparations are underway for the construction of a drinking water treatment plant from the source of the Jadro River so that turbidity will no longer be the cause of the interruption of the regular supply. On the other hand, during the summer tourist season, there is a considerable load on the water supply system with existing losses in the system itself that exceed 40%. The current water supply system in the area of the Kaštel Kambelovac pilot location is shown below.

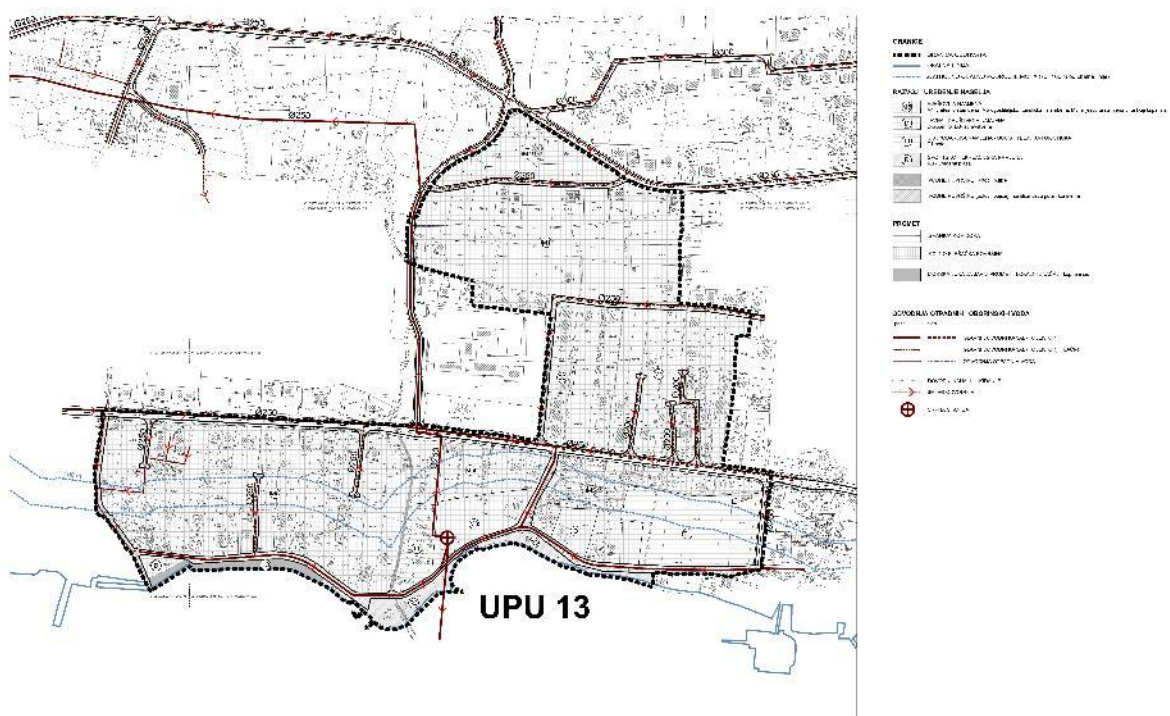


Source: www.kastela.hr

Figure 14 Water supply system of Kaštel Kambelovac according to UPU 13

3.3.2.3 Public sewerage

The Town of Kaštela is not sufficiently covered by the sewerage network and the settlements below the old Dr. Franjo Tuđman road have a mixed drainage system, and due to insufficient capacity, the secondary network was not expanded. Another issue is the large number of illegal connections of roof and yard rainwater to the wastewater drainage system, which endangers its functioning and overloads the operation of the system. Furthermore, the area above the Adriatic Highway is not currently covered by the main or secondary sewerage network, but the drainage of wastewater in that area is carried out by collection pits. The connection to the sewerage system is only 40%, and according to the *Development Strategy of the Town of Kaštela 2016 – 2020*, it should be higher than 80%. The public sewerage system in the pilot location area is shown in the figure below.



Source: www.kastela.hr

Figure 15 Sewerage system of Kaštel Kambelovac according to UPU 13

The investment in the public water supply system within the *Improvement of water and municipal infrastructure of the Kaštela – Trogir agglomeration* project includes the construction of 59.87 km of the new public water supply system, reconstruction of 65.41 km of the existing public water supply system, construction of four pumping stations and two water tanks (2 x 500 m³), and 1,640 arrangements for household connections. On the other hand, investment in the public drainage and wastewater treatment system includes the construction of 215 km of new sewer collectors, reconstruction of 4.04 km of sewer collectors, construction of 6.03 km of pressure pipelines, 640 incident systems, 13 pumping stations and 8,613 arrangements for household connections. The investment also includes the upgrade of the existing Divulje central device for wastewater treatment from the first to the second level of treatment with an increase in capacity from 40,000 ES to 100,000 ES, and the construction of the Čiovo second-level treatment device for wastewater treatment with a capacity of 25,000 ES. Also, the Spatial Plan of the Town of Kaštela envisages the construction of a wastewater drainage system in such a way that rainwater and sanitary wastewater are drained by separate canal systems. Moreover, the recovery of sanitary

wastewater is planned in several phases within the Integral Protection Project of the Kaštela Bay by dividing the sanitary water drainage system into zones that can be connected to the water treatment plant by gravity and zones connected using the pumping station system, and enabling the use of the coastal waters as a recipient exclusively for rainwater provided that the coastal waters meet the Category II sea conditions in a width of at least 300 m.

3.3.2.4 *Energy infrastructure*

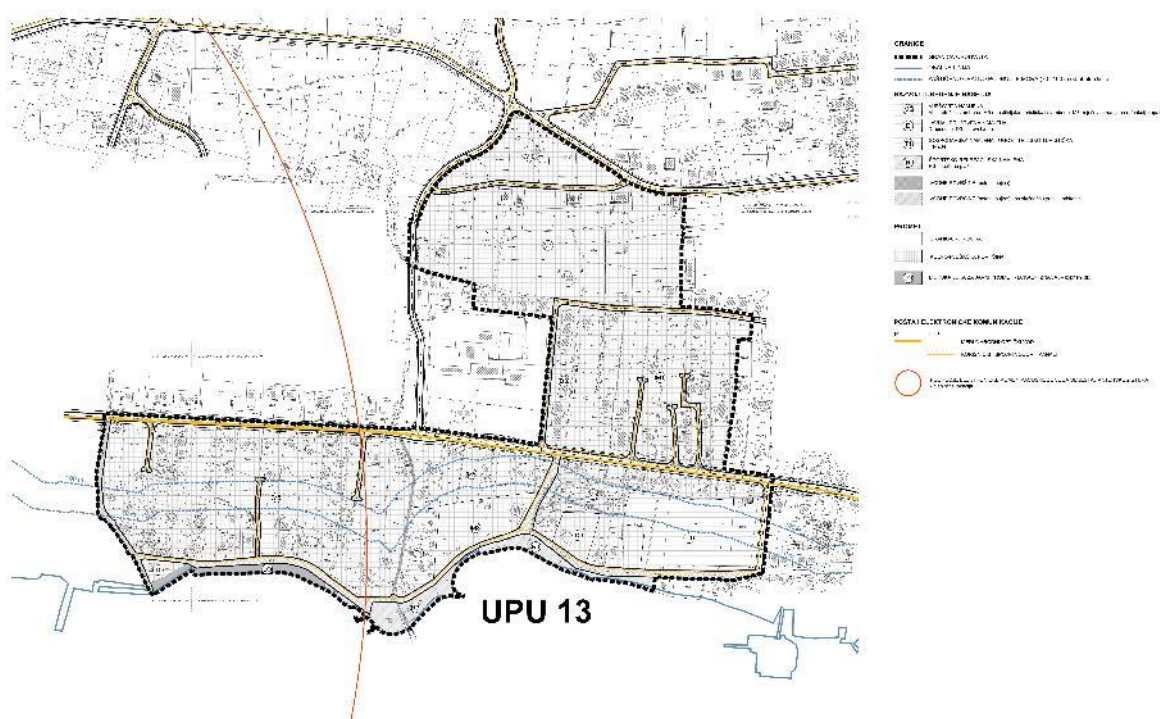
In the area of Kaštela there two solar photovoltaic power plants. One is the Kozjak solar photovoltaic power plant with an installed capacity of over 300 kW, which was commissioned in 2014 and for which photovoltaic cells were placed on the roof of CEMEX's St. George mine in Kaštel Sućurac, while the second solar photovoltaic power plant is located on the roof of the Ostrog Elementary School. The Town of Kaštela has implemented four energy efficiency projects co-financed by the Environmental Protection and Energy Efficiency Fund, two of which are directly related to the preparation of documentation, and the other two are related to the installation of energy-efficient solutions in public lighting and renovation of the city administration building envelope.

As for other energy-related infrastructure, the coastal part of the Town of Kaštela, mostly including areas from the sea to the Adriatic Highway, has an electricity system that supplies all consumers. The basic industrial transformation is located in Kaštel Sućurac from the level of 110/35 kV, which is connected to the electricity system by the following power lines:

- 2*110 kV Kaštela substation 1 – Trogir substation (route length 16.6 km, conductor Al/Č240/40mm²) built in 1983 and enables power transmission of 204 MVA.
- 2*110 kV Kaštela substation 1 – Konjsko substation (total route length 12.5 km, conductor Al/Č240/40mm²) built in 1989 and enables power transmission of 204 MVA.

Also, there are the 220 kV power line HPP Zakučac – Bilice substation, 110(35) kV Kaštela substation 1 – KK Željezara, cable 110 kV Dobri substation – Kaštela substation 1, and the 110/35 kV Kaštela substation 1, which was built in 1981 with two transformers of 2x8 MVA. The installed transformation power and the power line transmission power with maximum load in recent years indicates that the current situation meets today's needs and that there are reserves for the foreseeable future. In 1954, the Briža substation

12,530 households (99.89%), i.e. 38,411 inhabitants (99.34%)). Units of the postal network (post offices and communication hubs in the fixed network) and local headquarters are located in Kaštel Sućurac, Gomilica, Kambelovac, Lukšić, Novi, Štafilić, Rudine and Smokvica. In the figure below, in the area of Kaštel Kambelovac, user lines, interconnectors, channels, and an international fiber optic guide are marked in accordance with UPU 13.



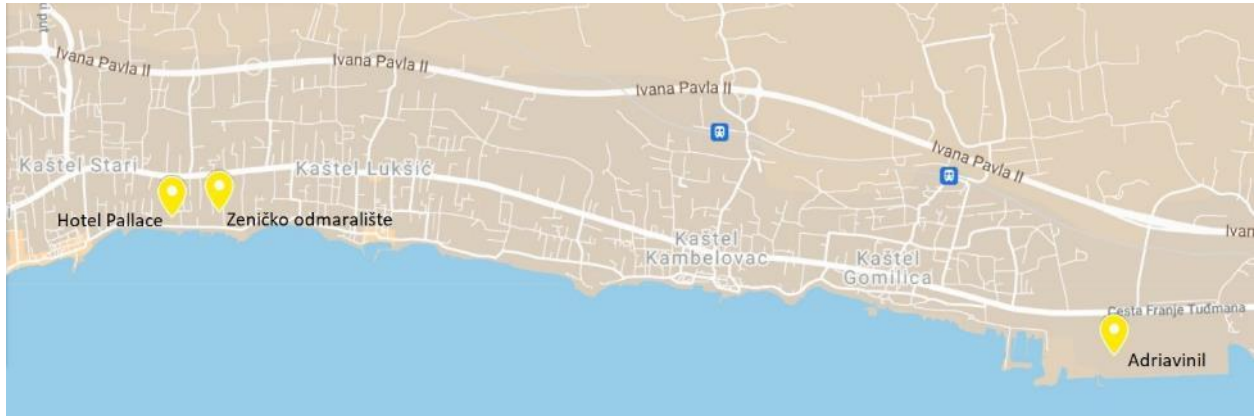
Source: www.kastela.hr

Figure 17 Post and telecommunications infrastructure of Kaštel Kambelovac according to UPU 13

3.3.2.6 Brownfield areas

Brownfield areas are abandoned, polluted and unused industrial, commercial and military facilities and complexes that are available for conversion and reuse. Due to their close proximity to the sea, their underutilization and dysfunction, they pose a problem for urban development and are a potential threat to the environment. Kaštela has three such areas, and one of them may be classified as an industrial *brownfield* area, the former *Adriavinil* plant in Kaštel Sućurac, which covers an area of 230,000 m² and is located on a maritime domain under the management of the Port of Split. The other two locations fall into the

category of separate *brownfield* areas, which are: *Hotel Palace* and *Zeničko odmaralište*. All locations are shown in the figure below and are privately owned.



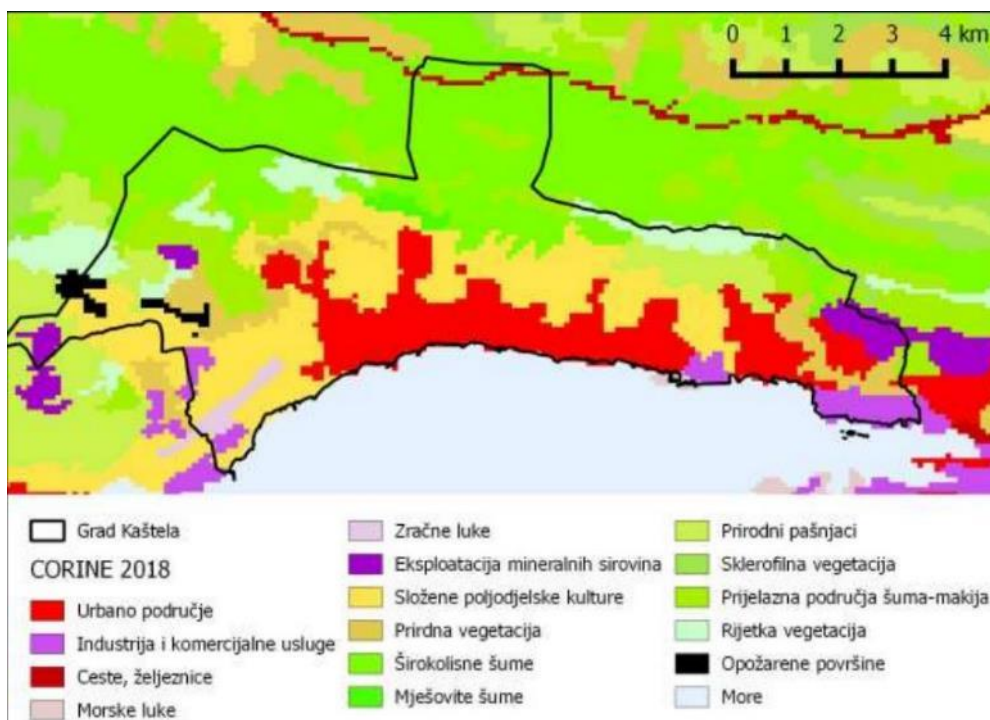
Source: www.google.com/maps

Figure 18 Brownfield locations in the area of the Town of Kaštela

3.4 Natural and cultural indicators

3.4.1 Green areas and protected natural areas

As previously mentioned, the area of the Town of Kaštela, especially along the coast, is highly urbanized. Out of a total of 5,785.86 ha belonging to the administrative area of the town, only 35% are covered by forests and shrub and herbaceous vegetation. According to the vegetation classification of Croatia, the area of the Town of Kaštela belongs to the Mediterranean vegetation region with two separate areas: Mediterranean coastal belt and Mediterranean mountain belt. A total of 23 types of terrestrial habitats are present in the area of the Town of Kaštela, and the area is dominated by coastal thermophile forests, downy oak shrubs, rocky pastures and dry grasslands of the eumediterranean and stenomediterranean. The figure below shows the land cover in the area of the Town of Kaštela.



Source: Coastal Zone Management Plan of the Town of Kaštela

Figure 19 Map of land cover according to the CORINE classification for the area of the Town of Kaštela

Pursuant to the Nature Protection Act (OG 80/13, 15/18, 14/19, 127/19), there are five protected areas in the area of the Town of Kaštela, of which three are monuments of park architecture and two are natural monuments, Figure 20. Monuments of park architecture are:

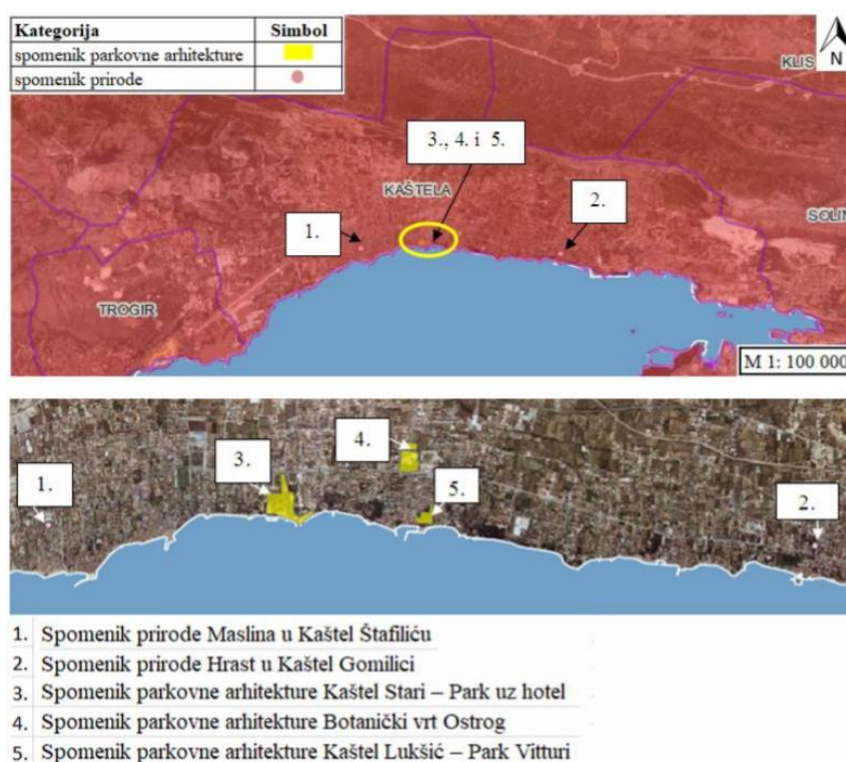
- the school botanical garden of the *Vjeko Butir* Elementary School
- the *Vitturi* Park in Kaštel Lukšić
- the *Park* in Kaštel Stari.

Natural monuments are:

- an old olive tree in the yard of the *Braće Perišić* Kindergarten in Kaštel Štafilčić
- an oak tree in Kaštel Gomilica.

The above-mentioned protected areas are urban in nature and can certainly contribute to the quality of life in the town, as well as the tourist offer. As these are artificially created parks located in the town center, the active involvement of managers is required in order to maintain and organize them. Individual protected trees are more sensitive to pressures than they would be if they were in their natural forest

habitat. Therefore, it is important to monitor their condition for their preservation, and in case of diseases, pests and similar phenomena, it is crucial to implement active protection measures in a timely manner. The *Sea and Karst* Public Institution is in charge of managing protected parts of nature in the Split-Dalmatia County in accordance with the Nature Protection Act.

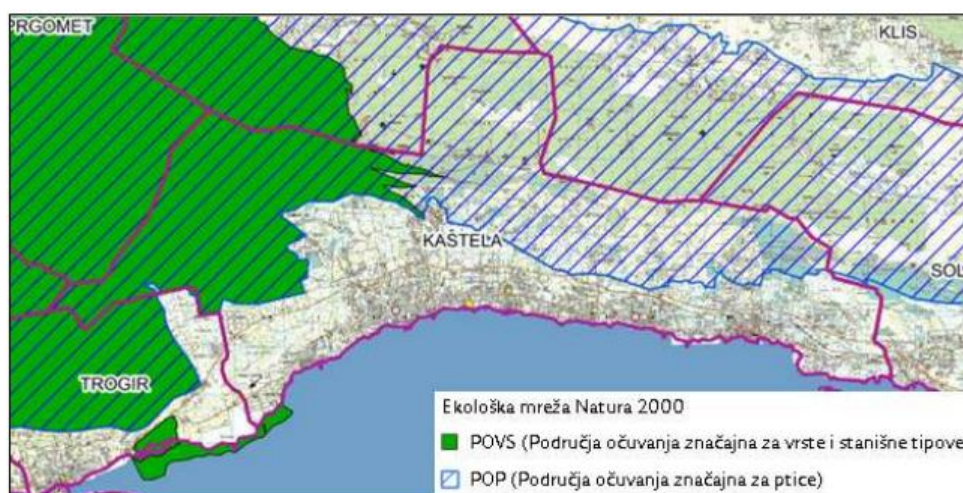


Source: Waste Management Plan of the Town of Kaštela for the period from 2018 to 2023

Figure 20. Map of protected areas

The *Ecological Network* of the Republic of Croatia represents the areas that Croatia, in accordance with the EU Birds Directive and the Habitats Directive, has singled out as areas of particular significance for the target species and habitats listed in the same directives. At the EU level, these areas are called Natura 2000 sites. The Natura 2000 network supports the principle of sustainable development and its goal is not to stop overall development activities, but to set the standards according to which they will be able to take place, while preserving biodiversity. As such, Natura 2000 can provide new opportunities through eco-tourism, recreation or natural agriculture and forestry. Within and in the immediate vicinity of the administrative boundaries of the Town of Kaštela, there are several areas of the ecological network. These

are conservation areas important for birds (Mosor, Kozjak and the Trogir hinterland), and conservation areas important for species and habitats (the Trogir hinterland, Pantan-Divulje and Pantan) shown in the figure below. The pilot location in Kaštel Kambelovac is located within the ecological network and does not include conservation areas important for species and habitat types, but partially includes conservation areas important for birds.



Source: Development Strategy of the Town of Kaštela 2016 – 2020

Figure 21 Areas of the Natura 2000 Ecological Network

3.4.2 Biodiversity

3.4.2.1 Flora

The Mediterranean coastal belt is characterized by the vegetation of evergreen oak forests and Aleppo pine and Dalmatian black pine forests. The coastal belt of the Town of Kaštela is marked by the vegetation of the eumediterranean zone, which has almost completely vanished due to the construction of settlements, arable land, and littoralization. Oriental hornbeam and downy oak forests belonging to the sub-Mediterranean zone can also be found in the coastal area. The hilly vegetation belt that is predominant in the Kozjak area is characterized by colder climate, and its representatives are the European hop-hornbeam, oriental hornbeam, downy oak, and Dalmatian black pine.

No Posidonia beds have been recorded in the area of the Kaštela Bay. Seagrass such as little Neptune grass (*Cymodocea nodosa*) and dwarf eelgrass (*Zostera noltii*) have been recorded. Dwarf eelgrass stocks are spread along the northern shores of the Kaštela Bay and in the area of the mouth of the river Jadro,

while the *little Neptune grass* has been recorded only in the northern part. More systematic and precise habitat mapping will be done in the future, as well as monitoring of the state of marine habitats and future developments with regards to the current state of the environment.

Due to its closed nature, but also due to the large number of industrial plants and increased pressures caused by rapid urbanization, the area of the Kaštela Bay has become an area that is ecologically disturbed. Therefore, the state of the marine environment is being intensively monitored and efforts are being made to return it to the state it was in prior to ecological pollution. Great efforts are put into the restoration of the habitats of neptune grass (*Posidonia oceanica*) and protected species of noble pen shell (*Pinna nobilis*). The state of planktonic communities is also monitored as an indicator of eutrophication processes that are closely related to marine pollution.

3.4.2.2. Fauna

The most represented fauna in the area of the Town of Kaštela is the fauna of small mammals such as hedgehogs, shrews, rabbits, and several species of rodents. The presence of wolves has been recorded in the areas of Kozjak. In 2009, a partial fauna inventory was conducted, i.e. listing of species such as wolves, rabbits, squirrels, garden dormice, European fat dormice, and several species of bats. Since the area is in the Mediterranean region, a large number of reptiles were recorded such as the eastern Montpellier snake, the Dahl's whip snake, the European ratsnake, the European cat snake, the four-lined snake, the Pallas' glass lizard, land and pond tortoises, and several species of lizards such as the European green lizard, the Mediterranean house gecko and the common wall gecko, and the Dalmatian wall lizard, the Italian wall lizard, and the Mosor rock lizard. There are several species of birds on the slopes of Kozjak, such as the olive-tree warbler, the hen harrier, the short-toed snake eagle, and the peregrine falcon. The Kozjak area is part of the *Conservation Area Important for Birds* POP HR1000027; Mosor, Kozjak, and Trogir hinterland, which stands out as an area of great importance for the nesting of vultures. Among the game in the hunting area of the hunting association *Kaštilac* from Kaštel Lukšić, which covers 4,078 ha, species such as the European hare, the pheasant, the rock partridge, the woodcock, the marten, the fox, and the wood pigeon have been recorded.

3.4.3 Cultural heritage

The area of the Town of Kaštela was inhabited by many: the Illyrian tribe Delmats, Greek colonists, Romans, and Croats arrived in the 7th century. Traces of high civilization of the area are shown by the remains of tools from the Stone Age, sites of ancient rustic villas, stone finds of early Christian and pre-Romanesque sacral buildings and others in the hinterland (Kaštela Field, the slopes of Kozjak), while the area of today's Town started to develop in the 15th century. In the period from the 15th to the 17th century, 17 fortifications and 12 fortified settlements were built, and to this day, 12 fortifications and 10 fortified settlements have been preserved: Historic buildings are divided into two groups: civil (castles-fortifications, residential buildings, public buildings etc.) and sacral buildings (churches, cemeteries etc.).

Table 6 Cultural heritage of the Town of Kaštela

Settlement	Type of cultural property – immovable cultural goods		
	Individually	Cultural and historic elements	Museum material
Kaštel Gomilica	Church of Saints Jerome, Church of St. Jerome with the parochial house, Church of Saints Cosmas and Damian with the cemetery, public laundry-washing site in Torac, Kaštel Kaštilac, convent in Kaštilac	Urban complex of the Kaštel Gomilica settlement	/
Kaštel Kambelovac	Church of Saints Michael and Martin, Church of St. Michael of Lažani and the tower on Krug, the Cambi tower and country villa, the Cambi family oil mill, the building of the former ballet school, Mala and Velika Piškera, Kaštel Lippeo	Urban complex of the Kaštel Kambelovac settlement	/
Kaštel Lukšić	Church of Saints John the Baptist on Brinje, Church of St. Lawrence, Old Church of the Assumption of the Blessed Virgin Mary, Rosani country villa with a small church, Parish Church of the Assumption of the Blessed Virgin Mary	Cemetery on Stupi, Vitturi Park, Urban complex of the Kaštel Lukšić settlement	Kaštela Town Museum
Kaštel Novi	Church of Saints George of Žestinja, Church of St. Mary of Špiljan (Stomorija), Church of St. Peter, the Brotherhood Lodge of St. Peter and the clock tower (Brce Square)	Urban complex of the Kaštel Novi settlement	/

Settlement	Type of cultural property – immovable cultural goods		
	Individually	Cultural and historic elements	Museum material
Kaštel Stari	Archaeological site Mirje, Church of Our Lady of the Rosary, Church of St. John the Baptist, Church of St. Joseph, Church of St. Nicholas, Palace Hotel with a garden, Cippico Castle (Brce Square), underwater archaeological site – remains of the Andreis Castle, Renaissance waterworks, residential complex with the Cega Tower, Villa Nika, winery in Kaštel Stari	Urban complex of the Kaštel Stari settlement	/
Kaštel Sućurac	Archaeological site Gornja Krtina (villa rustica), archdiocesan palace, underwater archaeological site	Urban complex of the Kaštel Sućurac settlement	/
Kaštel Štafilić	Archaeological site Knežine (villa rustica), archaeological site Resnik, Church of St. Vital (St. Clare) on Cape Tarce in Divulje, Kaštel Nehaj (Lodi), Kaštel Stafileo – Rotondo	Urban complex of Kaštel Nehaj, urban complex of the Kaštel Štafilić settlement	/

Source: Risk assessment of major accidents for the Town of Kaštela

The cultural heritage of the Kaštel Kambelovac pilot location includes the historic center (Figure 22.), a fortified settlement next to the round Cambi Tower, Mala and Velika Piškera, a fortified settlement of the Lippeo Castle, and the *Ballet School* Villa. The historic center (urban complex of the settlement) consists of several connected fortifications. The oldest are the Kumbat Towers, which were abandoned after the construction of fortified settlements within which the inhabitants of the medieval villages of Lažani and Kruševik settled. The fortified settlement next to the round Cambi Tower was built in the 15th century and had three gates: the southern *sea* gates, the western ones towards the Brce Square, and the northern ones which have been preserved to this day. Furthermore, the next fortified settlements include Mala and Velika Piškera and the settlement of the Lippeo Castle. Mala and Velika Piškera were built in the 15th century by the inhabitants of the village of Kruševik, while the Lippeo Castle was built in the 16th century on sea cliffs. The fortified settlement of the castle is irregularly shaped and was mostly created on land, and partially on the embankment in the sea, and it had only one gate which was preserved to this day along with one part of the eastern wall. Ballet School Villa was founded in the 20th century in the Art Nouveau style for the needs of the resort. Today it is used as a Music School from which the park extends to the west, and the beach to the east.



Source: *Development Strategy of the Town of Kaštela 2016 – 2020*

Figure 22. Historic center of Kaštel Kambelovac

Cultural heritage, as a living environment, exposed to permanent impact and pressures (pollution, urbanization, natural hazards etc.), due to its physical structure, is particularly sensitive and prone to decay. In the specific case of the Town of Kaštela, the cultural heritage is integrated into the landscape as a whole and is affected by all of the pressures that are present in the town itself, while the current level of protection is not at a satisfactory level. Therefore, historic settlements and their parts, buildings and their environment, natural and cultivated landscapes, archaeological sites and others must be included in a professionally acceptable manner in the future development of the municipality and the county. This primarily implies taking all protection measures according to the Act on the Protection and Preservation of Cultural Goods of the Republic of Croatia (OG 69/99) and others in accordance with the Urban Development Plan of the Town of Kaštela and the measures for protection against natural disasters.

3.5 Indicators of operational capability

According to the Civil Protection System Act (OG 82/15, 118/18, 31/20, 20/21), local self-government units and operational forces of the civil protection system are obliged to maintain and update a database on members, capabilities and resources of their operational forces, and submit the said data to the Line Ministry once a year, by March of the following year at the latest. The list of operational forces is particularly important in cases of accidents due to various causes, natural disasters and the like. The main tasks of the protection and rescue system are the assessment of possible threats and consequences, planning and preparedness for response, response with regards to protection and rescue in case of

disasters, as well as implementing the necessary activities and measures in order to eliminate the consequences so that the day-to-day life could resume as quickly as possible.

Measures and activities in the civil protection system are carried out by the following operational forces: civil protection headquarters, fire brigade operational forces, Croatian Red Cross operational forces, Croatian Mountain Rescue Service operational forces, civil society organizations, units and civil protection commissioners, on-site coordinators and legal entities in the civil protection system. Lists of measures and activities in the civil protection system may be found in the Civil Protection Plan. It is a document that organizes all stakeholders in the civil protection management system, and those include:

- Town of Kaštela Civil Protection Command (CZ Command)
- General Civil Protection Units (PON CZ)
- Specialist Civil Protection Units (PSN CZ)
- Civil Protection Commissioner and Deputy (CZ Commissioners)

The description of individual operational forces in the area of the Town of Kaštela, and thus the pilot location, is provided below.

3.5.1 Civil Protection Headquarters

The Civil Protection Headquarters of the Town of Kaštela consists of 12 members and represents a professional, operational and coordinating body that provides professional assistance and prepares protection and rescue actions. It is established in order to manage and coordinate the activities of operational forces and overall human and material resources of the community in cases of imminent threat, disasters and major accidents with the aim of preventing, mitigating and eliminating the consequences of disasters and major accidents in the area of the Town of Kaštela. The Headquarters is managed by the Chief of the Civil Protection Headquarters, and in case of major accidents, the role is taken over by the mayor. Also, in the area of the Town of Kaštela, the Headquarters collects and processes early-warning information on the possibilities of major accidents and disasters and develops the civil protection system, manages the response of the civil protection system, informs the public and proposes the adoption of decisions regarding the termination of measures and activities in the civil protection system.

3.5.2 Operational forces of the fire brigade

There is no Public Fire Brigade in the area of the Town of Kaštela as a legal entity; it was established in 2019, but it is still not operational. However, there are three Voluntary Fire Brigades (VFD): Mladost VFD, Kaštel Gomilica VFD, and Kaštela VFD. Voluntary societies are defined as central fire brigades with zones of responsibility in the area of the Town.

Table 7 Operational forces of the fire brigade

Fire department	Location	Number of operational firefighters	Number of professional firefighters	Number of vehicles
Mladost VFD	Kaštel Sućurac	59	16	12
Kaštel Gomilica VFD	Kaštel Gomilica	50	3	14
Kaštela VFD	Kaštel Stari	62	2	9

Source: Risk assessment of major accidents for the Town of Kaštela

In accordance with the *Program of activities in the implementation of special fire protection measures of interest to the Republic of Croatia* of the Government of the Republic of Croatia, there are seasonal firefighters additionally employed in all of the above-mentioned VFDs. Also, 24-hour shifts are carried out throughout the year, and in the period from June 1st to October 1st there are fire patrols and surveillance activities.

3.5.3 Operational forces of the Croatian Red Cross

In the area of the Town of Kaštela, there is the Kaštela Red Cross Urban Society which implements numerous programs, such as voluntary blood donation, assistance to socially most deprived persons, first aid education and the like, as well as the assistance program in case of (natural) disasters. The Society has eight employees and 10 volunteers. Eight people were trained to provide first aid. It also owns four vehicles and two tents.

3.5.4 Operational forces of the Croatian Mountain Rescue Service

The Croatian Mountain Rescue Service (HGSS) is the main operational force of the civil protection system which, in the event of major accidents and disasters, performs duties in the civil protection system in accordance with specific regulations which govern the area of the HGSS' activities. In the area of the Town of Kaštela, the Checkpoint of the Croatian Mountain Rescue Service was established in 2011. The HGSS Kaštela branch has three teams consisting of 30 members. The teams are trained to work autonomously

in the field, provide first aid and perform search and rescue activities with two vehicles, various types of stretchers and technical equipment.

3.5.5 Civil society organizations

Civilian society organizations that are important for the civil protection system in the Town of Kaštela are three Croatian mountaineering associations (*Ante Bedalov* in Kaštel Kambelovac, *Kozjak* in Kaštel Sućurac and *Malačka* in Kaštel Stari), and three hunting associations (*Donja Kaštela* in Kaštel Stari, *Kaštilac* in Kaštel Lukšić and *Putalj* in Kaštel Sućurac).

3.5.6 Civil protection units and commissioners

Given the data and the *2011 census*, the Town of Kaštela was obliged to make a Decision on the Appointment of Civil Protection Commissioners and Deputies for the area of the Town according to the following table.

Table 8 Required number of civil protection commissioners and deputies of the Town of Kaštela according to the 2011 census

Settlement	Population	Number of commissioners	Number of deputies
Kaštel Gomilica	4,881	16	16
Kaštel Kambelovac	5,027	17	17
Kaštel Lukšić	5,425	18	18
Kaštel Novi	6,411	21	21
Kaštel Stari	7,052	24	24
Kaštel Sućurac	6,829	23	23
Kaštel Štafilić	3,042	10	10
Total	38,667	129	129

Source: Risk assessment of major accidents for the Town of Kaštela

According to the Civil Protection System Act (OG 82/15, 118/18, 31/20, 20/21), the Government of the Republic of Croatia has adopted a regulation on the composition and structure of civil protection units. Accordingly, in the area of the Town of Kaštela it was necessary to establish a General-purpose civil protection unit and a Specialist civil protection unit for search and rescue in ruins – light category, and a Specialist civil protection unit for technical and tactical support.

3.5.7 On-site coordinators

The Chief of the Civil Protection Headquarters from the ranks of operational forces appoints an on-site coordinator in accordance with the specifics of the extraordinary event. The on-site coordinator assesses the situation and its consequences in the field and, in cooperation with the competent civil protection headquarters, coordinates the activities of the operational forces.

3.5.8 Legal entities in the civil protection system

Legal entities of interest in the civil protection system in the area of the Town of Kaštela are legal entities that are the most important operators in the area of the Town with their production, service, material, human and other resources. In accordance with the Civil Protection System Act (OG 82/15, 118/18, 31/20, 20/21), the Town of Kaštela should have made a Decision on the designation of legal entities in the civil protection system which have the required equipment that would meet the assessed needs of the Town depending on the risks. The table below shows the minimum amount of required equipment and number of people for the civil protection system of the Town of Kaštela.

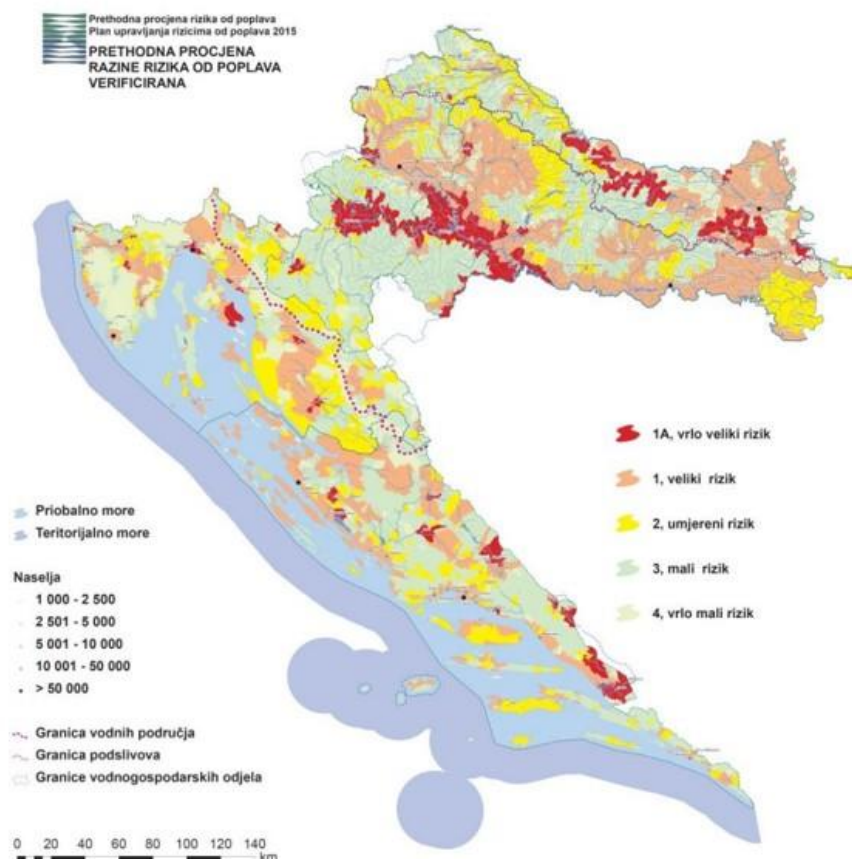
Table 9 Minimum amount of required equipment and number of people

Resources	Required equipment	Minimum amount of equipment	Minimum number of people	
Material and technical equipment	Trucks	37	for servicing the construction machinery	74
	Loaders	37		
	Concrete breaker machines	37		
Transport	Means of transport (buses)	104	for servicing means of transport	104
Accommodation and food	Accommodation capacities	/	which need to be taken care of and ensured nutrition	5,177
	Ensuring nutrition	/		5,177

Source: Risk assessment of major accidents for the Town of Kaštela

4 Analysis of the Exposure of the Pilot Location to the Risks of Coastal Floods Caused by Rising Sea Levels Due to Climate Change

A flood is defined as a temporary occurrence of an unusually large amount of water in a particular area due to the action of natural forces or other causes. Floods cause significant damage to the economy, infrastructure, and can lead to catastrophic consequences for human lives. Taking into account the scenarios that predict the growth of the average sea level, it is clear that the risk of floods is increasing, and consequently it poses a threat to the population and infrastructure. Below is a flood risk assessment map that has been created for the area of Croatia. It shows that the area of Kaštela is a high-risk area.



Source: River Basin Management Plan 2016 – 2021

Figure 23 Flood risk assessment map in Croatia with risk levels

Coastal and tidal floods are caused by high tides, and can be increased by strong winds that go towards the coast. The pilot location in Kaštel Kambelovac, as well as the entire area of the Town of Kaštela, is in constant danger of coastal flooding due to low coastal levels compared to sea level, as well as due to the fact that most of the historic center was built by the sea. Other facilities built along the coast are also at high risk of coastal floods caused by rising sea levels due to climate change. Therefore, an exposure analysis that is used to determine the potential impacts of coastal floods is extremely important for future planning and selection of defense measures. This analysis is based on previously designed project deliveries, and the figure below shows a planning view of the pilot location where the green line represents the Kaštel Kambelovac boundaries, the purple line represents the boundaries of the historic center, and the red line represents the natural coastline.

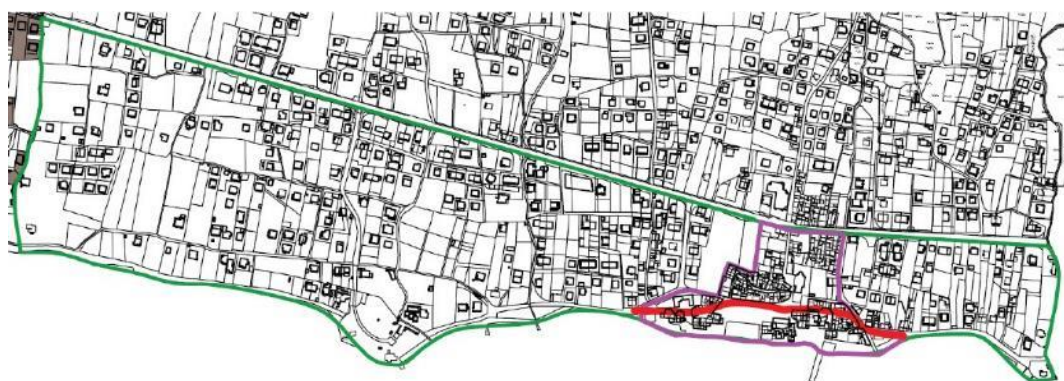


Figure 24 Planning view of the pilot location in Kaštel Kambelovac

Given that the sea level is extremely important for monitoring exposure to floods, it is necessary to monitor its oscillations. Due to the ongoing climate change, the frequency of coastal floods caused by rising sea levels is becoming more frequent, and oscillations are increasing. In the coastal area of the pilot location, the phenomenon of coastal floods caused by rising sea levels usually occurs due to long-term oscillations caused by changes in tides, but also due to short-term oscillations which are a result of disruptions in air pressure. Sea level oscillations are constantly monitored at the Institute of Oceanography and Fisheries in Split. Data obtained in the period between 25. 1. 2010 and 27. 6. 2011

were drawn from the available series of results since they represent the longest continuous series with 12,444 samples. The figure below shows the range of sea levels in which it is evident that the difference between the minimum and maximum is almost one meter.

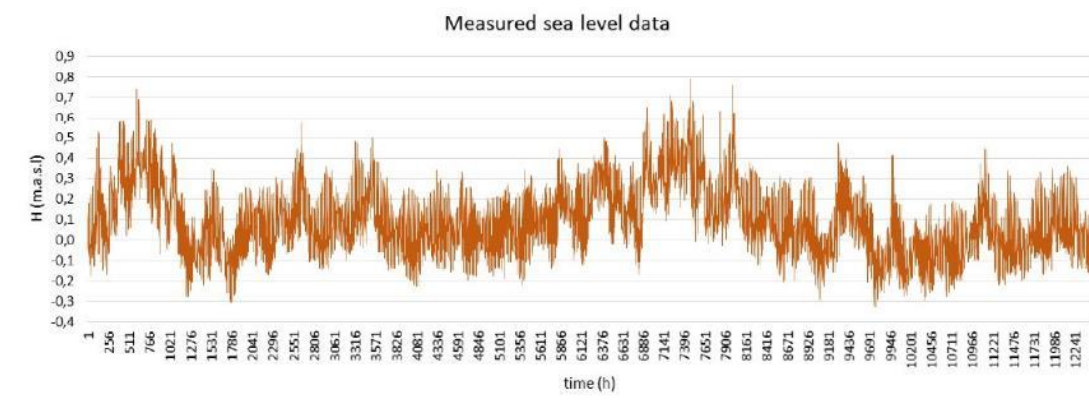


Figure 25 Sea levels oscillations in the period from 25.1.2010 to 27.6.2011

The figure below shows the area of the pilot location in Kaštel Kambelovac and the spatial distribution of critical zones that are most exposed to coastal floods caused by rising sea levels due to climate change.

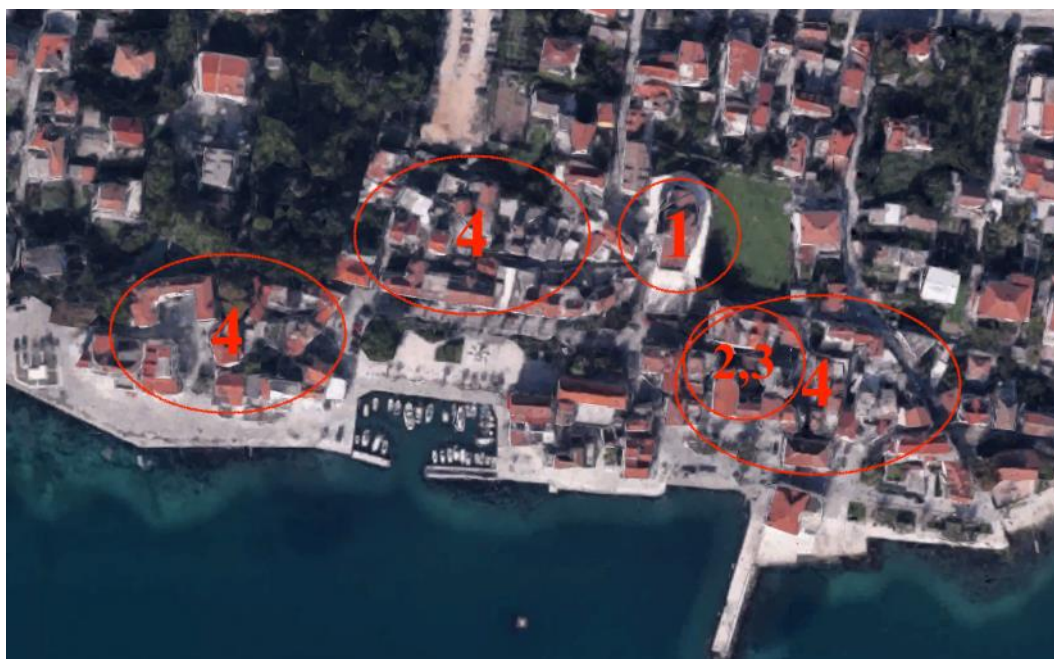


Figure 26 Spatial analysis of exposure of buildings to floods caused by rising sea levels due to climate change

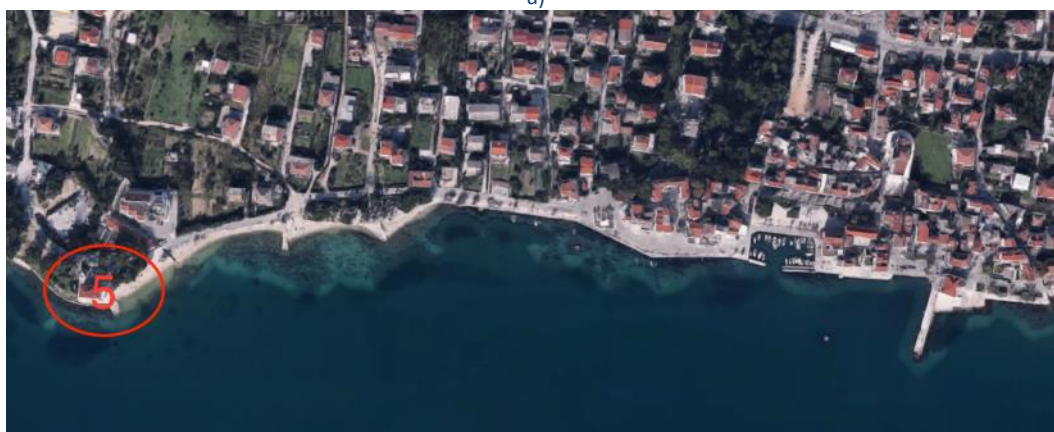
It can be seen that the most critical areas are along the coast, especially the area of the historic center in which critical points that are exposed to flood risks caused by rising sea levels have been identified. These include:

1. Church of Saints Michael and Martin
2. Cambi Tower and Palace
3. Cambi historic mill
4. Historic urban area of Kaštel Kambelovac
5. Old Ballet School (present day Music School).

The figures below present the said critical points.



a)



b)

Figure 27 Representation of identified historic and protected a) critical points from 1 to 4, and b) critical point 5 at the pilot location

In addition to the historic and protected buildings, public and other types of buildings located mainly near the coastline are also compromised. The figure below shows the following buildings for such purposes:

1. City library
2. Bowling club
3. Kindergarten *Kaštela*
4. Kindergarten *Smokvica*

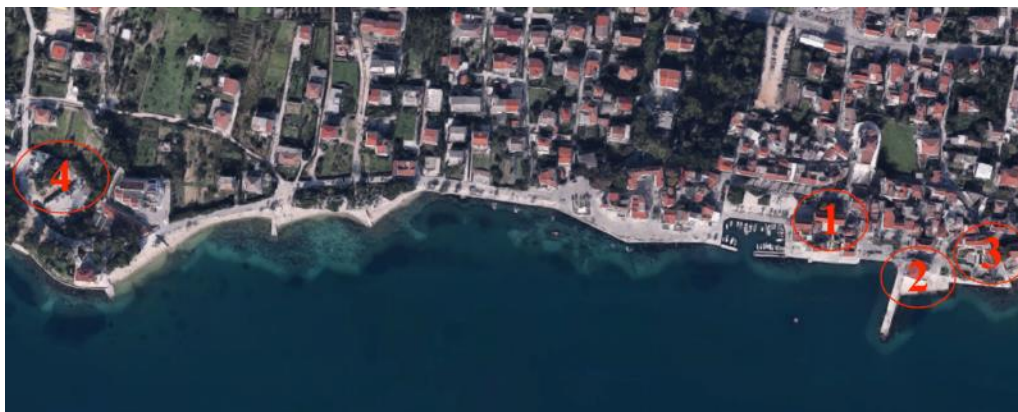


Figure 28 Representation of identified critical points for public and other types of buildings

Using the GIS analysis of the pilot location, the level of flood risk exposure for the entire area was obtained (Figure 29). The vulnerability index ranges from 0.14 to 0.82, with the highest risk areas having the higher index.



Figure 29. Exposure of coastal infrastructure to floods in the area of the historic center

It is evident that, on the vulnerability scale, most buildings in the area of the historic center have a vulnerability index over 0.3, and one building has an index over 0.8.

In order to conduct a flood risk assessment, the analysis of potential future scenarios on the basis of which future construction plans and flood protection measures can be made is also important. Taking into consideration the probability of occurrence, there are three levels of future scenarios that concern the risk of coastal floods caused by rising sea levels due to climate change, and these include:

- floods with a low probability of occurrence, i.e. extreme scenarios;
- floods with a medium probability of occurrence (return period ≥ 100 years);
- floods with a high probability of occurrence.

Analyses of possible flood scenarios are based on the predictions of the *Intergovernmental Panel on Climate Change* (IPCC) and the results of their modeling. Scenario RCP4.5 from the IPCC AR5 report predicts an increase in sea level in Croatia between 19 and 33 cm in the period between 2046 and 2065 with an additional projection for the year 2100. The figures below show the scenarios with the corresponding probability of occurrence.



Figure 30 Overview of potential floods caused by rising sea levels with occurrence probability levels for 2046

The first scenario, which refers to 2046, predicts an increase in sea level by 19 cm compared to the current situation (+0.09 m). Taking into consideration the exposure of the historic center, it is evident that only buildings located along the coast were flooded, even those with a low probability of occurrence.

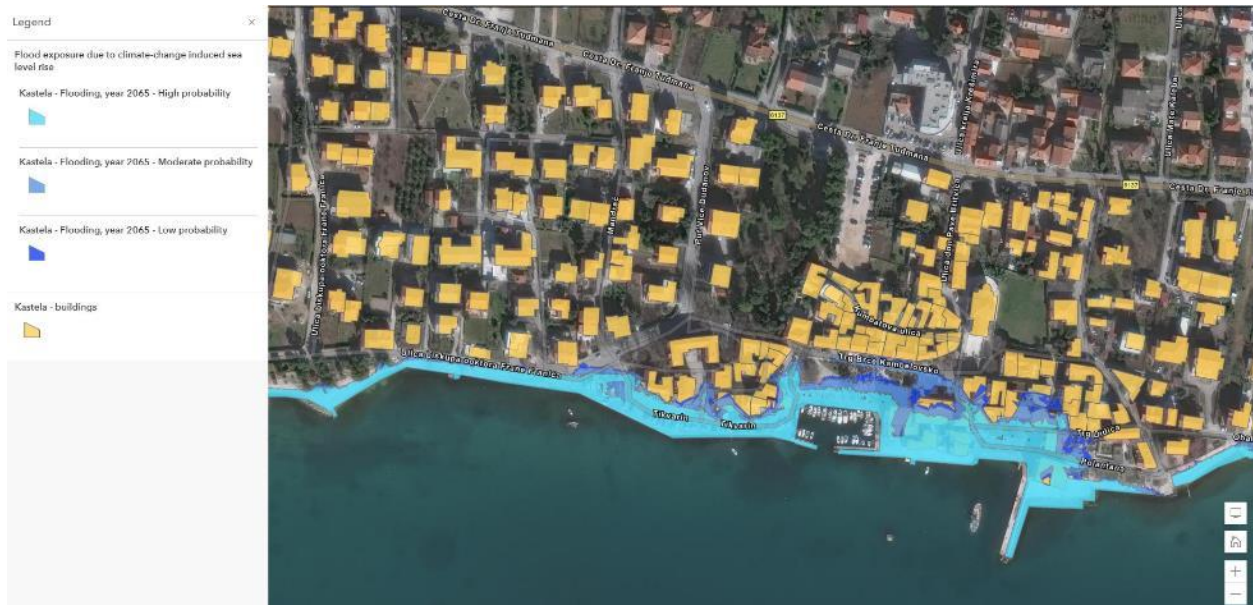


Figure 31 Overview of potential floods caused by rising sea levels with occurrence probability levels for 2065

The second scenario, which refers to 2065, predicts an increase in sea level by 33 cm compared to the current situation. If the situation presented in this scenario is compared with the situation projected for 2046, it is evident that the area is not only flooded along the coast, but the wider historic center is flooded as well.



Figure 32 Overview of potential floods caused by rising sea levels with occurrence probability levels for 2100

The third scenario, which refers to 2100, predicts an increase in sea level by 65 cm compared to the current average sea level. If we compare the level of flooding in the area with the one from the scenario for 2065, the flooding of buildings in the historic center is evident, as well as flooding of other buildings in the wider historic center.

4.1. Analysis of Possible Consequences of Coastal Floods Caused by Rising Sea Levels Due to Climate Change

The previous analysis included an assessment of flood risk exposure from the aspect of coastal floods caused by rising sea levels due to climate change, flood vulnerability, and flood risk for the three periods. Accordingly, the historic center of the settlement has been identified as the most sensitive area in the event of floods. On the other hand, when observing the exposure of the pilot location to flood risk from the aspect of various spatial indicators, different consequences that floods have on the population, infrastructure, environment, and society as a whole can be defined.

4.1.1. Coastal infrastructure and infrastructure cultural heritage

In the last thirty years, the number of buildings in Kaštela has drastically increased, which has not been accompanied by the balanced development of the water supply network and the wastewater and

rainwater drainage system. If we add exposure to sea flooding to that, then it is clear that there is a tremendous issue that needs to be solved. The rise in sea levels is already recorded in the area of Kaštela and amounts to approx. 30 cm per 100 years, which results in more frequent floods and greater exposure of the coastal area and infrastructure to the influence of the sea. Due to the increase in rainwater intensity and the risk of torrential spills during the construction, it is crucial to ensure appropriate capacities for the reception and drainage of rainwater in order to ensure proper water run-off with minimal impact on the coast and coastal infrastructure. The impact of climate change on the coast and coastal infrastructure is visible in the entire area of Kaštela and the Kaštela Bay, and it is expected to be more pronounced in the future. The reason for this lies primarily in the fact that sea levels will be on the rise due to climate change, but there are additional factors such as splashing of the waves that can be several meters high, and can thus cause coastal erosion, which can then lead to coastal damage or collapse. Likewise, we should expect similar effects on other infrastructure along the coast that have not been built in accordance with said risks, and this primarily refers to the infrastructure cultural heritage such as: Kaštilac in Kaštel Gomilica, Vitturi Castle and Rušinac Castle in Kaštel Lukšić, Cipicco Castle and Rotondo Castle in Kaštel Štafilić, which are located on the coast itself. Due to the above, it is crucial to take into account climate change and the risks of floods that occur as a consequence and that can affect future development, upgrading, and construction works, and to apply all the rules of the profession in order to preserve the coast and coastal infrastructure.

4.1.2. Transport infrastructure

The Town of Kaštela is part of the functional traffic region of northern and central Dalmatia through which the international Adriatic-Ionian Road corridor passes. Considering that almost the entire transport infrastructure in Kaštela is located near the sea, it is clear that it is susceptible to its influence. The transport infrastructure of the Town of Kaštela is divided into road, rail, air, and maritime transport. Roads that go through the Town of Kaštela, such as the so-called Old Kaštela Road Ž6137 (Dr. Franjo Tuđman road), the state road D8 (Adriatic Highway) which is the main traffic corridor in the entire coastal part of Croatia, as well as the railway and the Split Airport, are located near the sea and near the flood zones. Rising sea levels pose a threat for the maintenance of roads and other transport infrastructure, their functionality and, ultimately, their existence. It is not uncommon for coastal flooding to cause damage to

the transport infrastructure, which is susceptible to the influence of soil erosion. Transport infrastructure is also important due to crisis management during floods, which is significantly more impeded if roads and other transport infrastructure are not functional or in use.

4.1.3. Water and municipal infrastructure

Rising sea levels will block not only transport, but also the entire water and municipal infrastructure, which is already badly deteriorated and does not have sufficient capacities. There are several factors that led to this situation, and these include: excessive construction that has led to congestion, unplanned and illegal construction and system obsolescence, whose renewal began only in 2020 with the project *Improvement of water and municipal infrastructure of the Kaštela – Trogir agglomeration*. On the other hand, the sewerage network is developed only south of the Dr. Franjo Tuđman road, where a combined drainage system is in use. The area above the Adriatic Highway does not have a wastewater drainage system at all, but the waters are collected in collection pits. For this reason, the risk of coastal floods caused by rising sea levels is significantly higher. Furthermore, the increased volume of rainwater that cannot be properly drained, along with rising sea levels, will also cause wastewater spills that can have negative consequences on the health of the population.

4.1.4. Energy and telecommunications infrastructure

The energy infrastructure in Kaštela, which could be damaged during coastal floods caused by rising sea levels due to climate change, includes transmission lines and transformer stations which are located in the area of Kaštel Kambelovac near the sea. Also, the current electric energy supply and telecommunications infrastructure of the Town of Kaštela, such as connecting and user channels and cables on buildings above the ground, may be endangered by coastal flooding since they are located near the coast and at low altitudes.

4.1.5. Buildings for private and public purposes

Given the extremely high degree of urbanization of the coastal zone in the Kaštela Bay, it comes as no surprise that a large number of buildings, both for private (residential houses, buildings, and agricultural facilities) and public purposes (schools, kindergartens, public institutions) and other business buildings and facilities are built in relative vicinity to the sea. With rising sea levels due to climate change, all these buildings and facilities are in danger. Parts of the buildings located by the sea are already being damaged

by splashing of the waves, which can lead to their collapse. The problem does not end there since, due to the excessive construction of the coastal zone and unplanned construction, drainage is also not well organized and the entire infrastructure is affected. Therefore, it is important that drainage systems are provided with sufficient capacities in future reconstructions and planning of construction of residential and commercial buildings, as well as to implement solutions against coastal floods caused by rising sea levels due to climate change.

4.1.6. Economic infrastructure

Fishing ports, harbors, Marina Kaštela, fish farms, as well as factories from various industrial domains are located in the coastal strip, which will be endangered by rising sea levels and floods that such an event will cause. A particular problem concerns numerous boats, sailboats and the like, which can end up in the coastal area due to rising sea levels and may consequently destroy the facilities on the coast. Coastal floods caused by rising sea levels may also cause great damage to the boats and lead to pollution of the coast and sea. The coastal economy related to agricultural land is also endangered since there is a possibility of soil deformation and its flooding due to the fact that most of the land is relatively close to the sea. Floods may cause permanent soil contamination and its unserviceability. Additionally, agricultural facilities such as greenhouses, tunnels, and agricultural equipment warehouses are in danger. Flooding of the coast is extremely dangerous for factory plants as well since wastewater generated by industrial processes in factories can be spilled and end up in the sea, which would cause significant pollution. Also, relocating factories and plant facilities is an extremely expensive and time-consuming process that is difficult to implement. Rising sea levels could leave a mark not only on the environment, but also on the economy, given that the destruction of industrial and commercial plants and facilities could cause significant damage to business people who would find them difficult to compensate.

4.1.7. Terrestrial and marine ecosystems and biodiversity

In the area of the Town of Kaštela there are five protected areas, of which three are monuments of park architecture and two are natural monuments, and in the immediate vicinity there are several areas of the Natura 2000 Ecological Network (conservation areas important for birds and conservation areas important for species and habitats). Rising sea levels caused by climate change will cause changes in the

plant and animal ecosystem, as well as flooding of the part of the ecological network located along the coast, while the protected areas in the Kaštela area will be in danger of flooding and destruction.

4.1.8. Waste management and *brownfield* areas

Considering that the waste from the area of the Town of Kaštela is taken to the Karepovac landfill, in that sense there is no direct threat from the risk of coastal floods caused by rising sea levels. However, the area of the Town of Kaštela and Marina Kaštela, as the largest nautical port of the Kaštela Bay, recorded a large number of tourists during the summer months, which significantly increases the amount of waste generated and requires more time in order to remove it. The risk of coastal floods may cause environmental pollution if waste that has not been taken to landfill ends up in the sea. Also, there is a danger of environmental pollution caused by the risk of coastal floods in *brownfield* areas which are abandoned and not restored in such a way that all substances potentially dangerous for the environment are removed. For example, the area of the former *Jugovinil* where plastics and chemical products were produced, which is classified as a *brownfield* area, may also have a negative impact on the environment if the realization of the risk causes release of residual substances and substances dangerous for the environment into the sea or soil.

4.1.9. Population and visitors

Due to the said issues with unplanned construction, insufficiently developed infrastructure that is not suitable for quality flood risk protection, as well as insufficiently developed communication network between operational services that are active during disasters, the population and visitors of the Town of Kaštela are extremely endangered by flood risks. Also, during disasters caused by floods, it is important to provide sufficient quantities of basic groceries and hygiene items. In addition, shelters for residents and visitors are important during and after disasters, which will ensure normal temporary living conditions. Shelters must be located in areas that are sufficiently protected from rising sea levels and that have alternative energy sources and drinking water and a sufficient number of sanitary facilities in order to avoid potential infections and threats to the health of the population and visitors.

5. Key identified issues

The analysis of the situation in the area of coastal floods caused by rising sea levels due to climate change determined the current situation with the main characteristics of the area, social, economic, and natural and cultural indicators, as well as indicators of operational capabilities of the Town of Kaštela, i.e. the Kaštel Kambelovac pilot location, where available. With the analysis of the exposure of the pilot location, possible flood scenarios were observed, as well as the dangers that coastal floods caused by rising sea levels may bring to various features of the area. Thereby, rise in sea levels and floods have been identified as the consequences of future climate change, mostly caused by human activity. As part of both analyses, key issues in managing the risk of coastal floods caused by rising sea levels due to climate change have been identified and summarized below:

- coastal embankments and systematic construction of the coast during development
- unplanned and illegal construction of housing developments
- lack of distance from the coast
- pollution and devastation as a consequence of industrialization
- high density of buildings and population in a narrow coastal strip
- concentration of economic infrastructure in the coastal strip
- inadequate traffic road flow and inability of public service vehicles to access all buildings
- coastal erosion, damage to coastal infrastructure and beaches caused by ocean waves
- *brownfield* areas located by the coast
- unsatisfactory construction of water and municipal infrastructure with high system losses and insufficient level of connection of the population to the public sewerage system
- low level of reception and drainage of rainwater
- unsatisfactory state of railway infrastructure
- underdeveloped maritime transport and inadequate infrastructure
- negative impacts of urbanization on environmental and natural heritage degradation
- potential reduction of biodiversity regarding terrestrial and marine ecosystems and crops caused by floods due to climate change
- insufficient level of protection of cultural heritage sites from flooding.

In the area of the pilot location in Kaštel Kambelovac, as well as in the entire area of the Town of Kaštela, analyses have shown that this is a high-risk area and that there is a pronounced sensitivity to climate change and natural disasters such as coastal floods caused by rising sea levels. The fact that the Town of Kaštela is located on a narrow coastal strip and that the entire area is marked by illegal and non-systematic construction and unplanned expansion without adequate infrastructure, as well as embankment of the coast, poses dangers to natural habitats, cultural heritage, and biodiversity. Precisely for these reasons, it is necessary to develop a systematic and sustainable management model of the area of the Town of Kaštela with special emphasis on exposure to natural disasters caused by rising sea levels due to climate change.

6. Management vision and goals

The vision of the desired future condition of the Kaštel Kambelovac pilot location by 2030 and the management goals derive from the analyses of the situation and the identification of key challenges. They are based on an integrated approach to managing the risk of coastal floods caused by rising sea levels due to climate change through aspects of infrastructure management and operational capabilities. Therefore, the vision is as follows:

Kaštel Kambelovac is an area of enhanced resistance to the risks of coastal floods caused by rising sea levels due to climate change, where measures of infrastructure management, spatial planning, information and protection of the population and management of operational forces are continuously implemented, along with the involvement of the local community in decision-making processes.

The management goals include:

1. Effective infrastructure management and spatial planning

The area of Kaštel Kambelovac is a low-altitude area, located on a narrow coastal strip, and is highly urbanized with geomorphological and hydrological features, which makes it sensitive to various natural hazards. Previous analyses have established that it belongs to the area of high flood risk, in which there is a large number of buildings of varying ages. In particular, there is a large number of cultural heritage buildings that highlight the age of construction. Also, the settlement is characterized by unplanned construction, where the buildings are densely built or are leaned against each other, and the road which passes in between them is narrow. In the event of rising sea levels and the occurrence of floods, great damages occur, which poses a threat to human lives, and the narrow transport infrastructure prevents access to emergency services. In addition to the above, floods may also cause damage to transport, electricity, telecommunications and water and municipal infrastructure, which causes difficulties for health institutions, prevents communication between rescue services, drinking water and food supply etc. Also, coastal floods caused by rising sea levels may lead to the mixing of drinking water with wastewater, which can endanger the health of the entire population. Therefore, the first identified management goal implies the effective infrastructure management and spatial planning.

2. Improvement of risk management systems

The area of Kaštel Kambelovac is a high-risk area extremely sensitive to natural hazards. Even though the *Action Plan in the field of natural disasters for 2021 of the Town of Kaštela* establishes a system of civil protection measures, the information and communication system is flawed or non-existent. It follows from the above that there is the need to strengthen the capacity of decision-makers to act in a timely manner, i.e. to solve said issues, which ultimately leads to the identification of another management goal through the improvement of risk management systems.

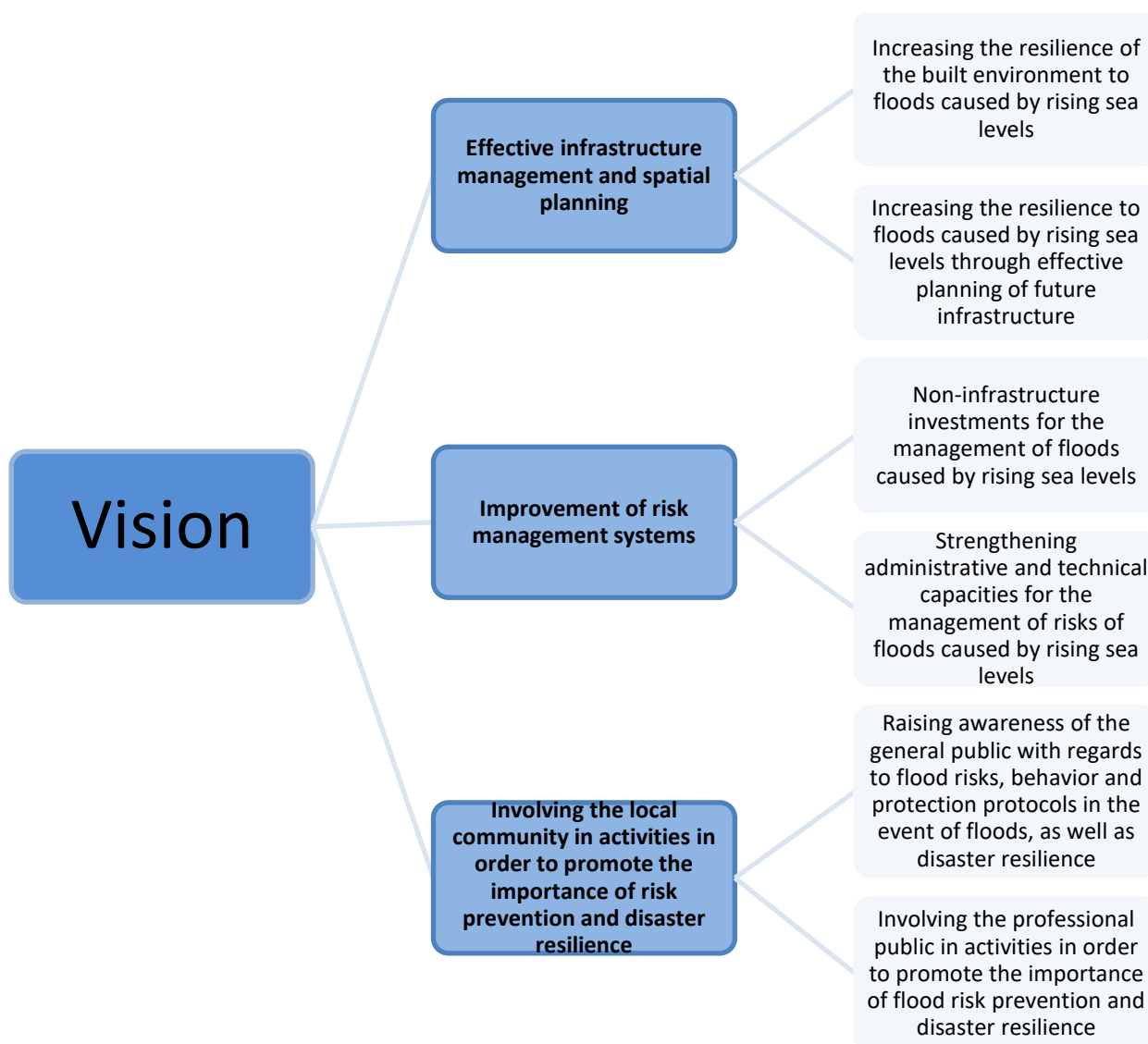
3. Involving the local community in activities in order to promote the importance of risk prevention and disaster resilience

Coastal floods caused by rising sea levels due to climate change are quite predictable and there are already extremely precise projections for future flood scenarios. Therefore, preparedness for the

potential consequences of floods must be at a high level, and measures for defense and increase in resilience of the population and infrastructure must be effective. Therefore, it is important to continuously work on the development of various programs, projects, policies, and measures in order to prevent risks and promote resilience to natural hazards, especially in the field of prevention and response in such cases. It is extremely important to involve the society as a whole in this process, from the authorities, SMEs, academic community to the professional and general public in order to work together to increase the level of protection from natural disasters. That results in the third goal, which encourages the involvement of the local community of a particular area, in this case the Kaštel Kambelovac area, in activities which serve to promote the importance of risk prevention and disaster resilience.

7. Management measures

Management measures are quantified activities that contribute to the achievement of land management goals of the pilot location. In doing so, one or more management measures may contribute to one goal. The diagram below summarizes the goals and measures, followed by the tables showcasing the measures individually and their relevance in relation to the set goals, time frame, project developers, stakeholders involved and activities.



Goal 1:	Effective infrastructure management and spatial planning
Measure 1.1:	Increasing the resilience of the built environment to coastal floods caused by rising sea levels due to climate change
Description:	<p>Kaštel Kambelovac is an area that extends through a narrow coastal belt and is highly urbanized. Due to its low altitude, the area is classified as an area of high risk of disasters and thus of floods. The buildings are mostly older and there are many buildings of cultural importance whose construction dates back to the 15th century. Such buildings are particularly at risk and are prone to various natural disasters. Also, in some places, other infrastructure is outdated, such as transport, energy or water and municipal infrastructure whose damage and/or collapse caused by the action of strong torrential waves that occur along with floods may cause interruptions in the supply of drinking water and food, communication and the like. Large amounts of water cause coastal and land erosion and thus lead to the collapse of infrastructure facilities and roads. In order to reduce the potential impact of flood risk and contribute to the effective management of all types of infrastructure, it is crucial to invest in existing infrastructure with regards to vulnerability categories of floods caused by rising sea levels. The dynamics and priorities of the implementation of individual activities should take into account the flood vulnerability categories with an emphasis on buildings with a high vulnerability index.</p>
Time frame:	2030
Area:	Kaštel Kambelovac
Project developers:	Town of Kaštela
Stakeholders involved:	Split-Dalmatia County
Activities:	<ul style="list-style-type: none"> 1.1.1. Investments in adaptation and increase of resilience of critical infrastructure (insulation of energy infrastructure, reconstruction of the old water supply network, remediation of run-down transport infrastructure) 1.1.2. Construction of water regulation systems such as canals, drainage and retention systems 1.1.3. Redistribution of existing urban facilities and prevention of construction of new facilities in areas exposed to flood risks 1.1.4. Investments in adapting and increasing the resilience of public and social purpose buildings to floods and mitigating their effects, with special emphasis on cultural heritage buildings 1.1.5. Infrastructure operations on buildings aimed at reducing the risk of floods (strengthening of the structure, remediation of jeopardized buildings) and construction of new and reconstruction of old protective structures such as protective walls, breakwaters, groins, and wave breakers

Goal 1:	Effective infrastructure management and spatial planning
Measure 1.2:	Increasing the flood resistance through effective planning of future infrastructure
Description:	<p>Kaštel Kambelovac is an area where buildings (residential, public and commercial buildings) are concentrated in a narrow coastal strip. Due to the visible unplanned and illegal construction during development, the buildings are dense and sometimes lean against one another, and the road between them is often narrow. This type of spatial distribution makes the area extremely vulnerable to flood risks, primarily due to the fact that access to public services that are active during natural disasters is difficult. In the case of floods caused by rising sea levels, due to the narrow construction of roads and blocked access to all facilities, access to rescue services may be difficult, which may result in a significant number of casualties. Also, the spatial distribution of buildings of this type entails the same characteristics of the positioning of other infrastructure (transmission lines, water supply and drainage etc.). With the aim of effective management of future infrastructure, quality spatial planning of future facilities and other infrastructure is needed with regards to the categories of vulnerability of flood caused by rising sea levels due to climate change. The dynamics and priorities of the implementation of individual activities should take into account the flood vulnerability categories with an emphasis on buildings with a high vulnerability index.</p>
Time frame:	2030
Area:	Kaštel Kambelovac
Project developers:	Town of Kaštela
Stakeholders involved:	Split-Dalmatia County, Vodovod i kanalizacija d.o.o., Hrvatska elektroprivreda d.d., Hrvatski Telekom d.d.
Activities:	<p>1.2.1. Investments in adapting and increasing the resilience of water and municipal, energy, telecommunications and transport infrastructure</p> <p>1.2.2. Consideration of alternative traffic routes</p>

Goal 2:	Improvement of risk management systems
Measure 2.1:	Non-infrastructure investments for the management of the risk of coastal floods caused by rising sea levels due to climate change
Description:	<p>Kaštel Kambelovac is an area of high risk of natural disasters. Due to its specific location, hydrological characteristics, density of buildings and their type and age, it is particularly at risk of floods caused by rising sea levels, or the consequences they entail. Based on the <i>Action Plan in the field of natural disasters for 2020 of the Town of Kaštela</i>, protection measures for various threats have been defined. However, the development and modernization of the civil protection and public alert information and communication system is needed in order to implement protection measures in a timely and effective manner and in order to alert the public, i.e. to improve the management system of the said risk.</p>
Time frame:	2030
Area:	Kaštel Kambelovac
Project developers:	Town of Kaštela
Stakeholders involved:	Split-Dalmatia County
Activities:	<p>2.1.1. Development and modernization of the civil protection information and communication system</p> <p>2.1.2. Development and modernization of the public alert information and communication system</p> <p>2.1.3. Development of a system for the supply of groceries and basic hygiene items during disasters</p>

Goal 2:	Improvement of risk management systems
Measure 2.2:	Strengthening administrative and technical capacities for flood risk management
Description:	In the area of the Town of Kaštela, various measures of civil protection have been defined due to various threats in the document <i>Action Plan in the field of natural disasters for 2021 of the Town of Kaštela</i> . The document identified the competent authorities and institutions for certain dangers caused by flood risks and torrential floods, as well as the creation of backwaters. However, the existing spatial planning documentation does not encompass measures of infrastructure adaptation to the risks of floods caused by rising sea levels due to climate change. Therefore, it is imperative to strengthen the capacity of decision-makers with regards to the hazards caused by natural disasters in the form of various educations and to encourage the integration of adaptation measures into the necessary documentation. Additionally, it is important to ensure the technical preparedness of operational forces in order for them to respond in a timely manner, as well as the appropriate level of human resources.
Time frame:	2030
Area:	Kaštel Kambelovac
Project developers:	Town of Kaštela
Stakeholders involved:	Split-Dalmatia County, operational forces in the civil protection system, Ministry of the Interior
Activities:	<p>2.2.1. Integration of flood risk adaptation measures into the spatial planning documentation (remediation and/or reconstruction of critical infrastructure, planning according to flood vulnerability zones etc.)</p> <p>2.2.2. Organization of trainings to strengthen the capacity of decision-makers with regards to the dangers of floods caused by rising sea levels due to climate change and ways to mitigate their consequences</p> <p>2.2.3. Development of rescue and evacuation plans with regards to flood vulnerability zones</p> <p>2.2.4. Improvement of the training system for operational forces and frequent emergency rescue drills</p> <p>2.2.5. Performance of regular checks on the correctness of technical equipment of operational forces</p>

Goal 3:	Involving the local community in activities in order to promote the importance of risk prevention and disaster resilience
Measure 3.1:	Raising awareness of the general public with regards to flood risks, behavior and protection protocols in the event of floods, as well as disaster resilience
Description:	Floods caused by rising sea levels due to climate change are quite predictable and there are already extremely precise projections for future flood scenarios. Therefore, preparedness for the potential consequences of floods must be at a high level, and measures for defense and increase in resilience of the population and infrastructure must be effective. Involving the local community in activities to promote risk prevention and disaster resilience by raising awareness of the general public with regards to flood risks, behavior and protection protocols in the event of floods plays an extremely important role in strengthening the resilience of the population. Meeting these preconditions creates the opportunity for efficient spending of resources and a sustainable society that will have clearly structured and effective disaster defense systems.
Time frame:	2030
Area:	Kaštel Kambelovac
Project developers:	Town of Kaštela, University of Split
Stakeholders involved:	General public
Activities:	<p>3.1.1. Organizing public campaigns in order to raise awareness of the general public in cooperation with the academic community and experts in the field of flood risk management and disaster resilience and their consequences for people, society, infrastructure, and the environment</p> <p>3.1.2. Organizing public campaigns in order to raise awareness of the general public on the protocol of behavior of the population in case of floods and other natural disasters</p>

Goal 3:	Involving the local community in activities in order to promote the importance of risk prevention and disaster resilience
Measure 3.2:	Involving the professional public in activities in order to promote the importance of flood risk prevention and disaster resilience
Description:	For years, the United Nations, the European Union and the World Meteorological Organization have been developing programs and projects in order to promote the prevention of climate risks, as well as their consequences for society and the economy. As a member, Croatia is involved in the implementation of various policies and measures to this effect. In order to achieve satisfactory disaster resilience and efficiently manage various risks, especially floods caused by rising sea levels due to climate change, it is necessary to involve and encourage the professional public to act. Namely, the active involvement of experts from various fields is a basic condition for increasing the level of protection of a particular area and society as a whole.
Time frame:	2030
Area:	Kaštel Kambelovac
Project developers:	Town of Kaštela, University of Split
Stakeholders involved:	Vodovod i kanalizacija d.o.o., Čistoća d.o.o., Sea and Karst Public Institution, other companies in the area of Kaštela engaged in municipal activities, Split-Dalmatia County, Split Port Authority, economic entities, business support organizations
Activities:	<ul style="list-style-type: none"> 3.2.1. Organization of scientific conferences in cooperation with the academic community 3.2.2. Implementation of activities in order to improve the systems of prediction of floods caused by rising sea levels in cooperation with sectoral experts 3.2.3. Implementation of applied research activities in cooperation with public administration and scientific organizations 3.2.4. Strengthening the capacity of SMEs and business support organizations, with emphasis on activities in the field of construction, spatial planning, water supply, energy and environmental protection