

Proposal of combined risk management plans in the HR test site

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Combined Risk Management Plan

Kaštel Kambelovac pilot location

1. Introduction

The causes of major accidents and catastrophes usually imply a combination of various factors, i.e. they are the result of the influence of natural phenomena and technical and technological processes caused by 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 natural 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, with innovation in disaster risk management systems as one of its goals.

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, 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 and planning the development of 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. The project is implemented in Croatia at a pilot location in Kaštel Kambelovac, which serves as a *test bed* for the entire area of the Town of Kaštela. Management plans have been developed for the entire area for events of individual risks, i.e. earthquakes and floods caused by climate change and extremely high ocean waves. However, the simultaneous occurrence of multiple risks is not to be excluded, and the events of combined

risks multiply their consequences on the population, environment, and infrastructure. Due to this, it is important to work on prevention and protection against combined risks in order to minimize them. 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.

This document presents a combined risk management plan for the pilot location in Croatia, and it encompasses a description of the spatial coverage of the pilot location, an analysis of the current situation, and an analysis of the exposure to combined risks. The document also defines 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 Lećevice 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 figure below shows the spatial coverage of the Town of Kaštela and the breakdown by settlements.



Source: www.google.com/maps

Figure 1 Spatial coverage of the Town of Kaštela and the settlements it encompasses

The Kaštel Kambelovac pilot location 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 2 Orthophoto map of the spatial coverage of the Kaštel Kambelovac pilot location

3. Analysis of the situation in the field of combined risk management at the Kaštela Kambelovac pilot location

Analysis of the situation from the point of view of combined risks encompasses the main characteristics of the area, social indicators, economic, natural and cultural indicators, and operational capability indicators. Each of the said indicators is divided into characteristic elements specific to the observed area.

3.1 Main characteristics of the area

Kaštela belongs to the *coastal area of central and southern Dalmatia* landscape unit. The main features of said unit are the coastal mountain range, a number of large islands and their woodedness. The Town of Kaštela is located in the Kaštela Bay. The Jadro River and the Pantan Stream flow into the Bay, and there are several islands in that area such as Školjić, Galera, Barbarinac and the Šilo cliffs. The area is characterized by a narrow coastal strip with a populated zone along the coast itself, which is connected to the Kaštela field and an elevated relief towards the Kozjak mountain. Such features of the area have a significant impact on natural and socio-economic processes and on the solutions concerning the strengthening of resilience to climate change by which the area will be affected.

3.1.1 Lithosphere

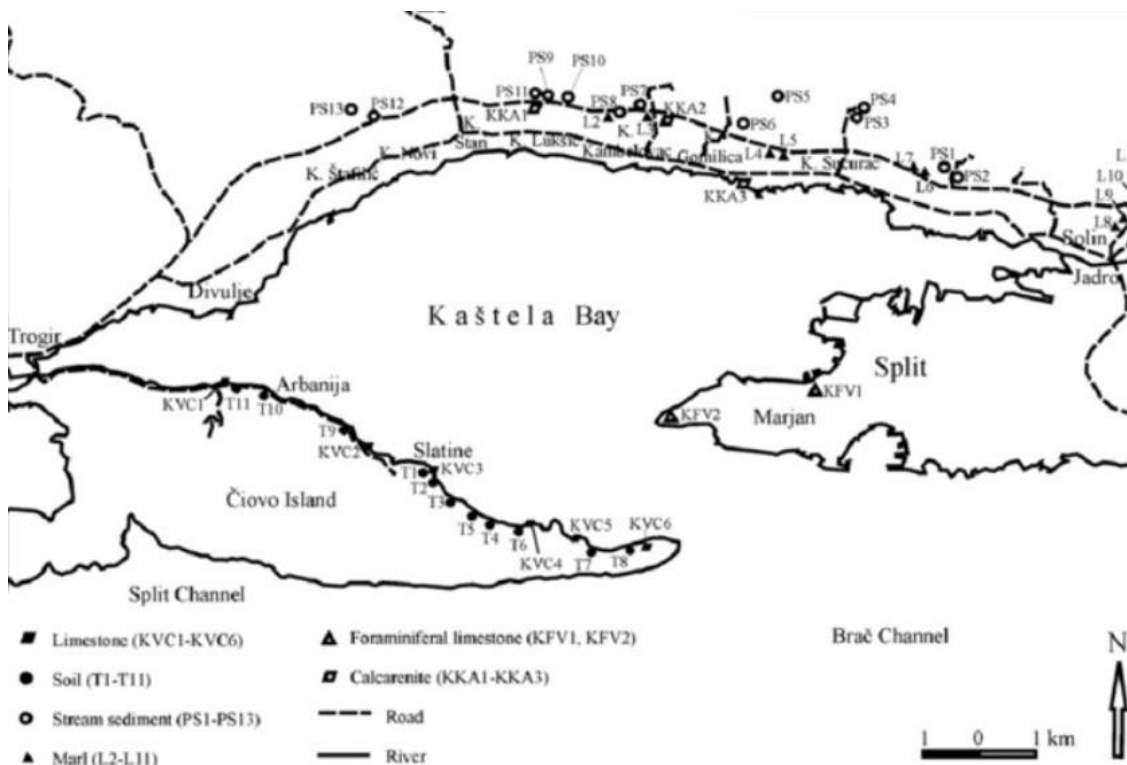
The tectonics of contacts of various types of rocks and complex geological structure largely determine the geomorphological characteristics of the Town of Kaštela. The characteristic geological and geomorphological determinant for the Kaštela area is the contact between older carbonate and less old flysch formations. The morphological characteristics of the Kaštela Bay on the northern, landward side, are represented by limestone massifs in the Dinaric direction (NW-SE). There is the Krban elevation (310 m) in the west, located near Trogir, while the northern relief part of the hinterland from west to east consists of Trnošćak (473 m), Labinštica (701 m), Opor (647 m), and Kozjak (779 m). When we take into consideration the fact that flat and slightly sloping terrains are predominant in the area of the Town of Kaštela, most of its inhabitants live along the sea shore. The following figure shows the relief configuration of the terrain in the area of the Town of Kaštela.



Source: www.kastela.org

Figure 3 Relief map of the Town of Kaštela

The coastal strip of Kaštela consists mainly of flysch sediments that are in tectonic contact with the surrounding carbonate rocks. The northern part of the area consists of older, Mesozoic carbonate sediments. The flysch is mostly covered with eluvial soil. The area is for the most part characterized by limestones from the Mesozoic and Cenozoic era, of high purity and with few insoluble elements. During the past, the deposits have been subjected to strong compression which has caused intense wrinkling, faults, and the formation of numerous cracks and fragmented zones. Geological development was extremely important for its morphology, however, today the main influence is human activity, which is why the coastal area is predominantly flat. The central part is locally hilly with gentle slopes, while the northern part of the area is located under the steep slopes of Kozjak, which consists mainly of layers of clastic rocks, calcite marls and limestones. Soil types are highly dependent on the topography of the area. The soils are mostly automorphic and arable in parts where there is a gentle slope. The soil was formed by the weathering of carbonate rocks and flysch deposits, and the area is overgrown with macchia and sparsely wooded areas. The figure below shows the area of the Kaštela Bay with sediment sampling stations.



Source: Distribution and origin of major, minor, and trace elements in sediments and sedimentary rocks of the Kaštela Bay (Croatia) coastal area (Lovrenčić Mikelić, Oreščanin, Barišić, 2013)

Figure 4 The Kaštela Bay and sediment and sedimentary rock sampling stations in the coastal area

3.1.2 Hydrosphere

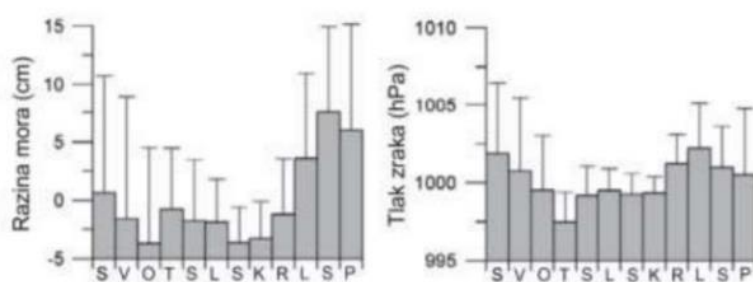
The entire area is located on impermeable flysch deposits and is thus known for the large amounts of torrential waters that occur during heavy rains. The figure below shows the entire area of Kaštela on a map of flood hazards with a high probability of occurrence.



Source: www.preglednik.voda.hr/

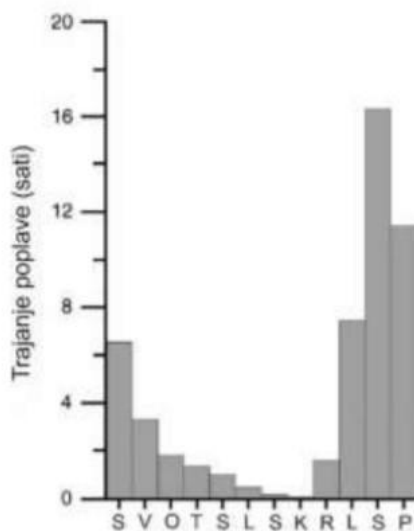
Figure 5 Flood hazard map with high probability of occurrence

Sea levels are highly variable throughout the year, with the highest values recorded during late autumn and early winter. This is also the time of year when there is the highest probability of occurrence of extreme floods in the coastal area, which, with the extremely strong south wind, can cause major floods and endanger people and infrastructure. The figures below show the following: the annual course of the mean sea level and air pressure, and the annual course of the flood duration.



Source: Coastal Zone Management Plan of the Town of Kaštela

Figure 6 Annual course of mean sea level and air pressure with the corresponding standard deviation



Source: Coastal Zone Management Plan of the Town of Kaštela

Figure 7 Annual course of the flood duration (in hours)

The Adriatic-type Mediterranean climate zone characteristic for the Town of Kaštela, and thus for the Kaštel Kambelovac pilot location, is determined mostly by its geographical position and openness to the

sea. The climate is characterized by hot and dry summers and mild and humid winters with many sunshine hours and pronounced windiness. The annual temperature range (mean temperature difference between the warmest and coldest months) is 17.5 °C, while the average annual air temperature in this area is 15.9 °C. The area of the Kaštela Bay is quite windy and analyses in the area of Split have shown that winds stronger than 3 bf¹ occur in more than 75% of cases per year. Also, the wind is extremely volatile during the winter period, while the summer periods are characterized by light winds. During the winter, the winds *bura* and *jugo* are the most common as a result of frequent changes in synoptic disturbances over several days, while summer is mostly characterized by winds from the northeast or southwest that alternate within a 24-hour period as a result of the alternation of day and night.

3.1.3 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. The distribution of the population by settlements is shown in the table below.

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

¹ Beaufort scale for the evaluation of the wind strength by its effects

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*

3.1.4 Transport connectivity

The Town of Kaštela and its area are 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*.

3.1.4.1 Road infrastructure

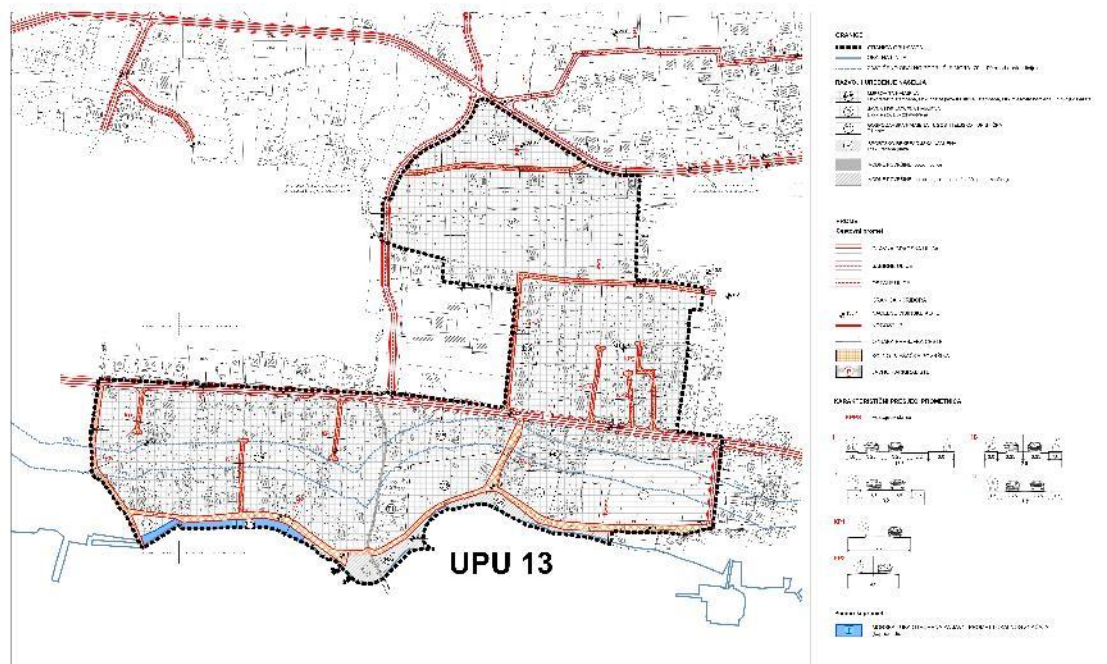
The main road that passes through the Town of Kaštela is the state road D8, better known as the *Adriatic Highway*, and is the main transport corridor for the entire coastal part of the Republic of Croatia, especially in the Split agglomeration area. The Adriatic Highway connects all important coastal 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 (Cesta dr. Franje Tuđmana) 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*.



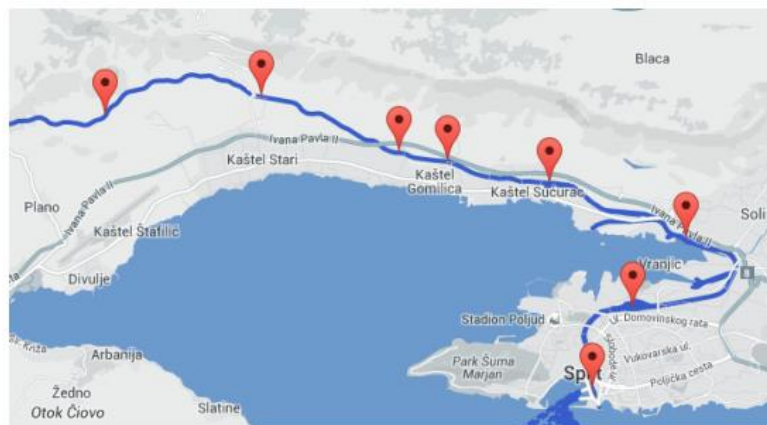
Source: www.kastela.hr

Figure 8 Road infrastructure of Kaštel Kambelovac

3.1.4.2 Railway traffic

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 an integral 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 following figure shows the railway route in the area of the Town of Kaštela.



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

Figure 9 Railway stations within the suburban railway

3.1.4.3 Air traffic

The Split Airport (Resnik) is also located in the area of the Town of Kaštela and the Town of 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, which 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.



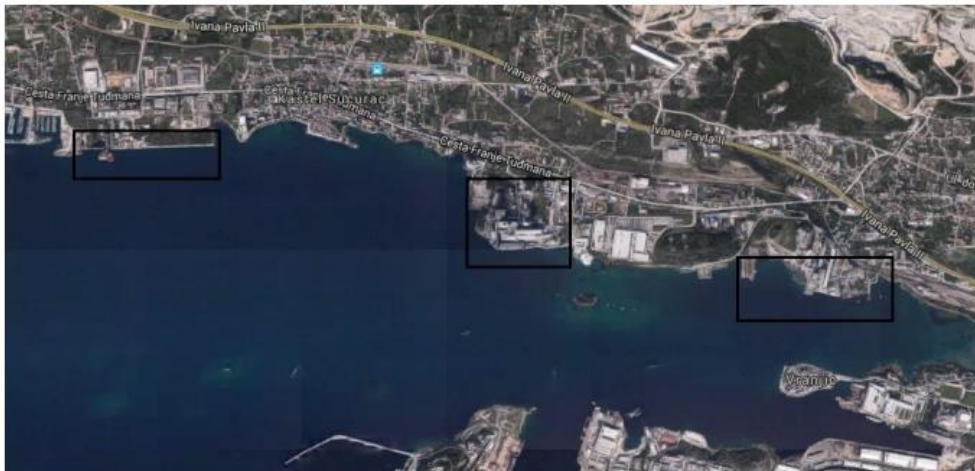
Source: www.googlemaps.com, processed by the creator

Figure 10 Satellite view of the Split Airport

3.1.4.4 Maritime traffic

Five ports open to public traffic in the area of the Town of Kaštela 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 (SDŽ), 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 Adriavinil), 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 Kaštela envisages the construction of a fishing port in the area of Brižine in Kaštel Sućurac, and 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.

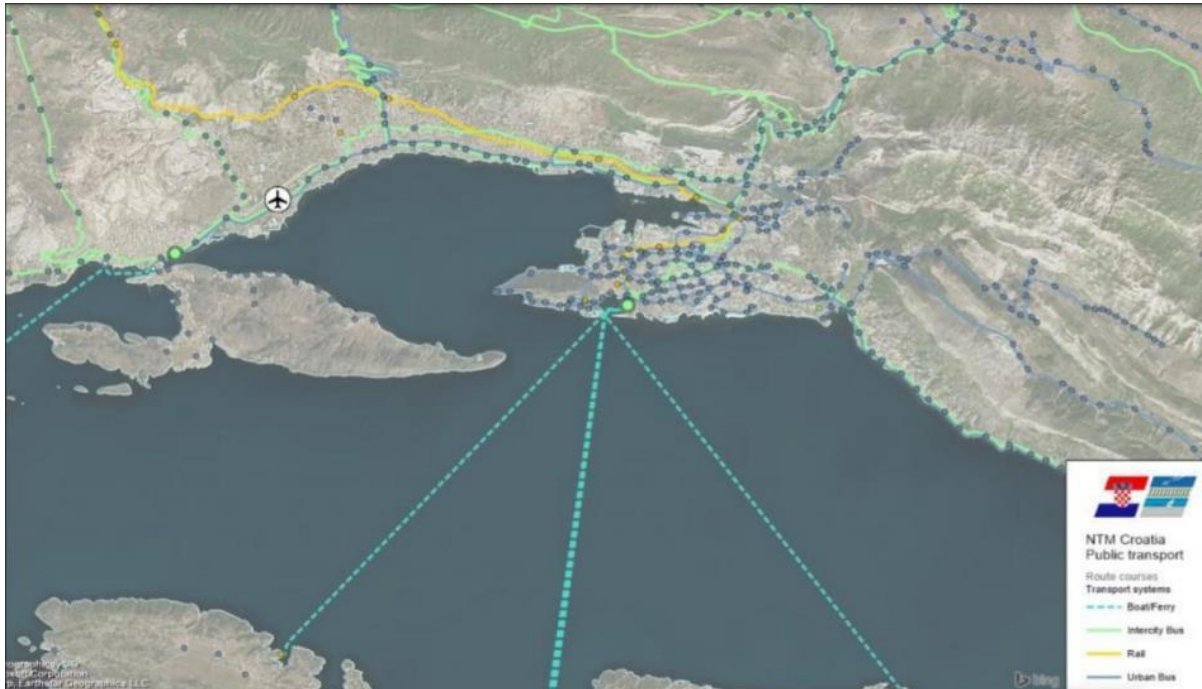


Source: Development Strategy of the Town of Kaštela 2016 – 2020

Figure 11 Area of Basin A, B and C (from left to right)

3.1.4.5 Public transport system

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 12 Map of the public transport system in the area of Kaštela and Split (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).

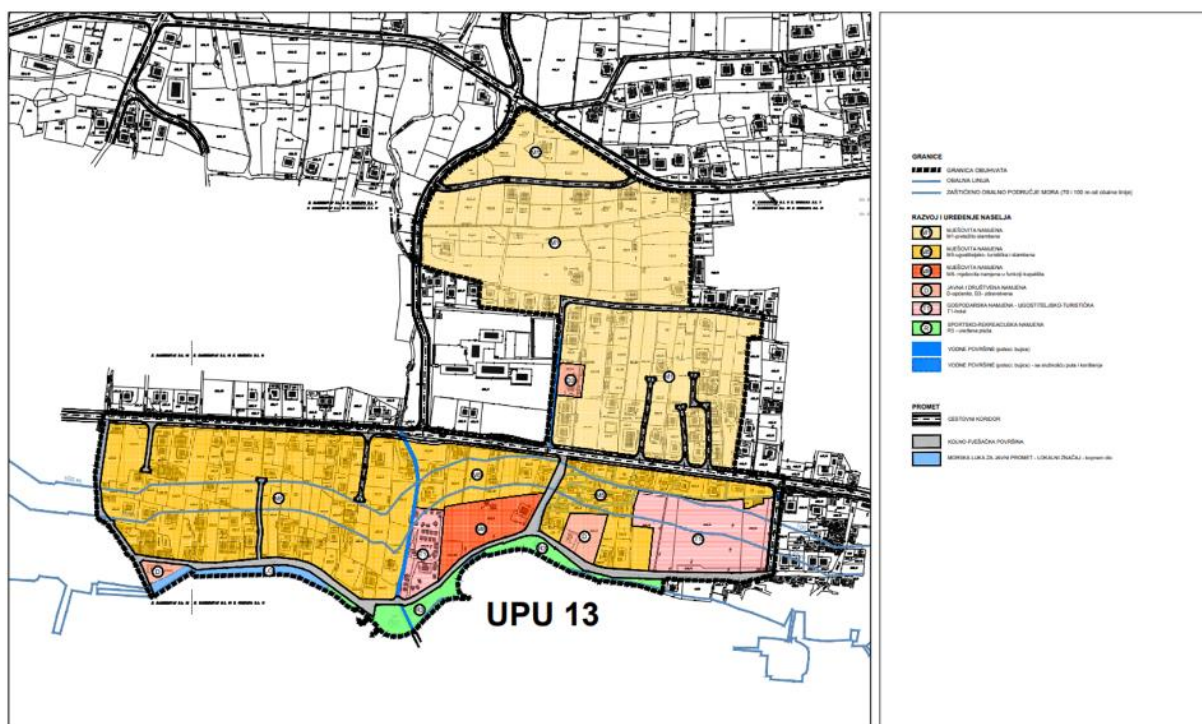
3.2 Social indicators

Kaštel Kambelovac covers an area of 45,000 square meters and has more than 400 buildings. It consists of a historic center 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 located in the Vitturi Castle in Kaštel Lukšić, divided into two locations (Vitturi Castle and the Archbishop's Palace in Kaštel Sućurac) and the Library of the Town of Kaštela. However, 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 in the area of Kaštel Kambelovac marked with the letter D (light pink), as well as residential and commercial buildings, letters M (orange and yellow) and T (pink).



Source: www.kastela.hr

Figure 13 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*, created 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 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.

3.3.1 Branches of the economy

The economy of Kaštela relied on fishing and agriculture in the past. Only in the period following the First World War the first industry developed in the area, and Kaštela, as an industrial town, gathered its momentum in the period following the Second World War. At that time, a number of industrial plants developed in the area of Kaštela, and in parallel with this process, the processes of sudden urbanization of the entire area took place. Even today, there are some industrial plants in Kaštela even though the majority of the population focused on tourism.

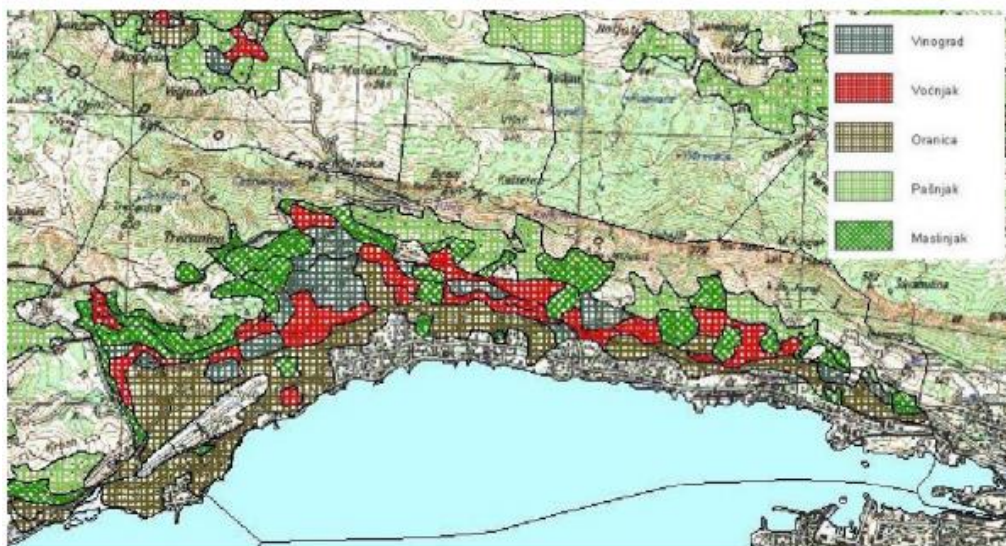
3.3.1.1 Industry

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 economic entities 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. The following figure shows the purpose of agricultural land in the area of the Town of Kaštela.

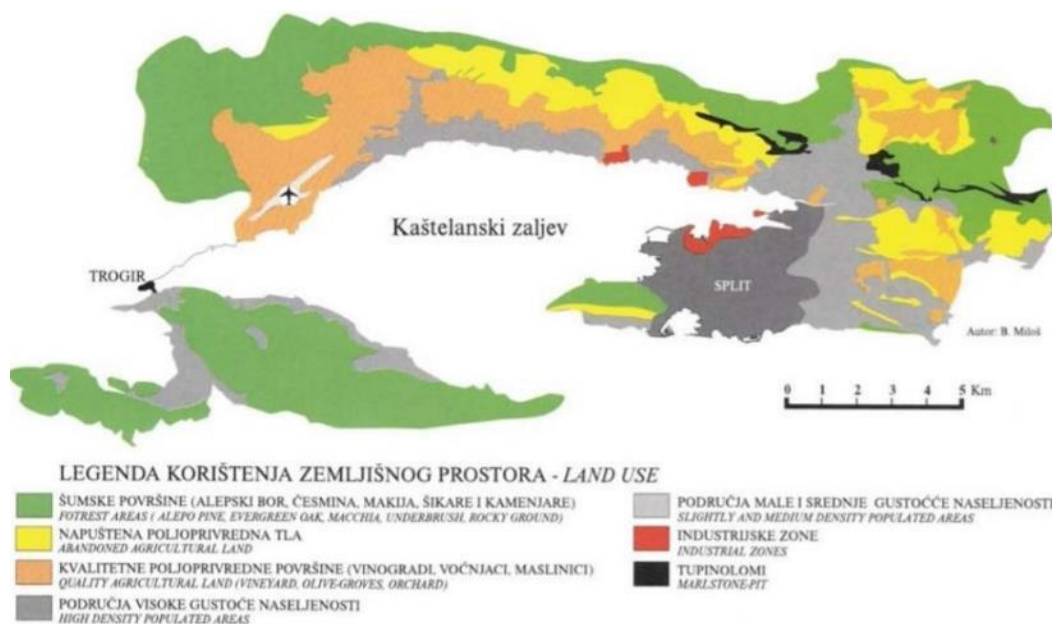


Source: Development Strategy of the Town of Kaštela 2016 – 2020

Figure 14 Purpose of agricultural land in the area of the Town of Kaštela

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 the above-mentioned cherries and figs, almonds and peaches. The figure below shows the utilization of agricultural land in the area of the Town of Kaštela.



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

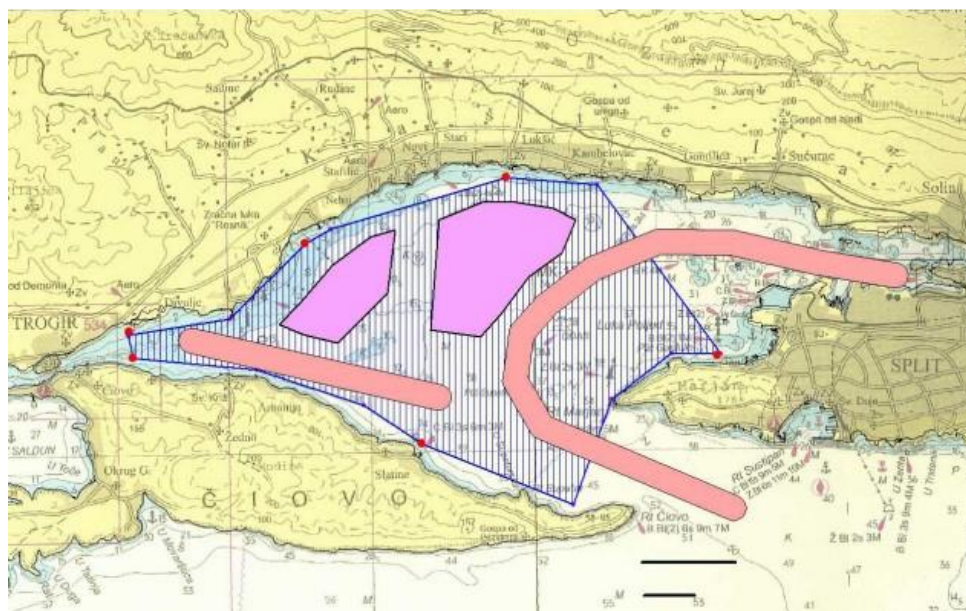
Figure 15 Utilization of agricultural land in the area of Kaštela

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.

3.3.1.3. Fishery and mariculture

In the Republic of Croatia, mariculture primarily refers to the breeding of white and blue fish, as well as shellfish. Fish farming mostly involves species such as 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*). Due to its closed nature and favorable trophic levels², the area of the Kaštela Bay is extremely suitable for shellfish farming. Unfortunately, due to the high level of pollution and the burden the sea suffers due to numerous facilities, this is only possible in certain smaller parts of the bay. 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 16 Multi-criteria analysis of the Kaštela Bay for potential shellfish farming

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. The advantage of this fish farming method is that the impact on the environment is almost negligible. The second type of farming

² Trophic is the process of primary productivity of nutrients in a water body. There are three trophic levels: bad – eutrophic, medium – mesotrophic, and good – oligotrophic.

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.

3.3.1.4. Tourism

Tourism is one of the most important branches of the economy in Croatia and, with the exception of two pandemic years, it has been recording continuous growth from 2013 to 2019. 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. The table below shows the tourist traffic for 2019 for the Town of Kaštela, and the surrounding tourist boards in the Split-Dalmatia County.

Table 4 Tourist traffic in certain tourist boards of the Split-Dalmatia County 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

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. 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

town also manages the organization of beaches and the accompanying facilities. The table below shows data on the utilization of the coastal area in the area of the Town of Kaštela.

Table 5 Utilization of the coastal area in Kaštela

Type of coastal area	Type of buildings and structures	Length in meters	%
Coastal area built for public purposes	Traditional settlements, coastal promenade, waterfront, old mooring, public transport ports	5,430	28
Coastal area built for commercial and other purposes	Commercial and industrial ports and operational coastal area, marinas, coastal area for military purposes	4,480	23
Undeveloped (natural) coast	Organized and unorganized beaches, coast not suitable for bathing	9,620	44
Settlement	Coastal area built for public purposes (m)	Coastal area built for commercial purposes (m)	Undeveloped coast (m)
Kaštel Sućurac	1,280	4,480	950
Kaštel Gomilica	900	0	1,300
Kaštel Kambelovac	700	0	1,440
Kaštel Lukšić	770	0	730
Kaštel Stari	500	0	900
Kaštel Novi	780	0	0
Kaštel Štafilić	500	0	4,300

Source: Coastal Zone Management Plan of the Town of Kaštela

The previous table shows that almost 44% of the coast length refers to organized and unorganized beaches and the coast not suitable for bathing. At the Kaštel Kambelovac pilot location, there are 700 meters of coastal area built for public purposes, while there are 1,440 meters of undeveloped coast. The table below shows the list of beaches in the area of the Town of Kaštela, as well as their standard.

Table 6 Beach standards in Kaštela

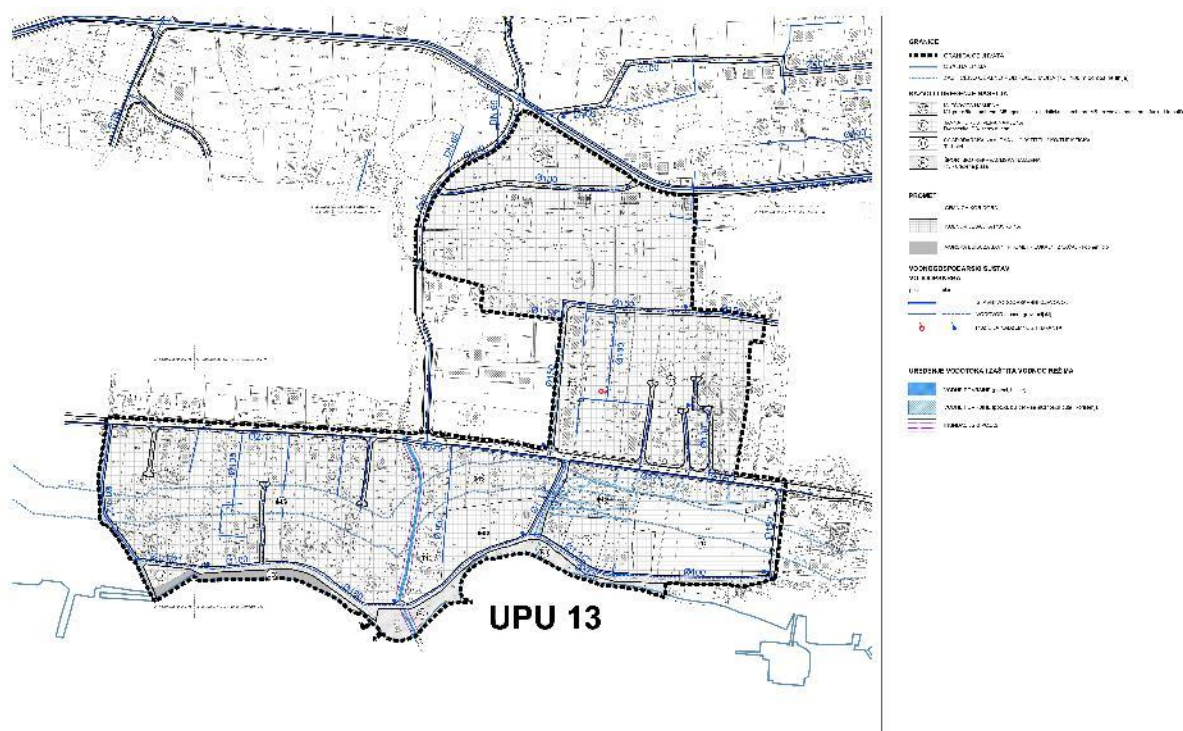
Beaches	Length in m	Surface area in m ²	Beach type	Number of bathers	m ² per bather	Number of bathers per beach linear metre
Gojača	337	6,000	sand, gravel, concrete	200	30.00	0.59
Sokolana	128	1,900	shingle, concrete	60	31.67	0.47
Kamp	167	3,576	shingle, stone	300	11.92	1.80
Torac	212	3,713	sand, concrete	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

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.



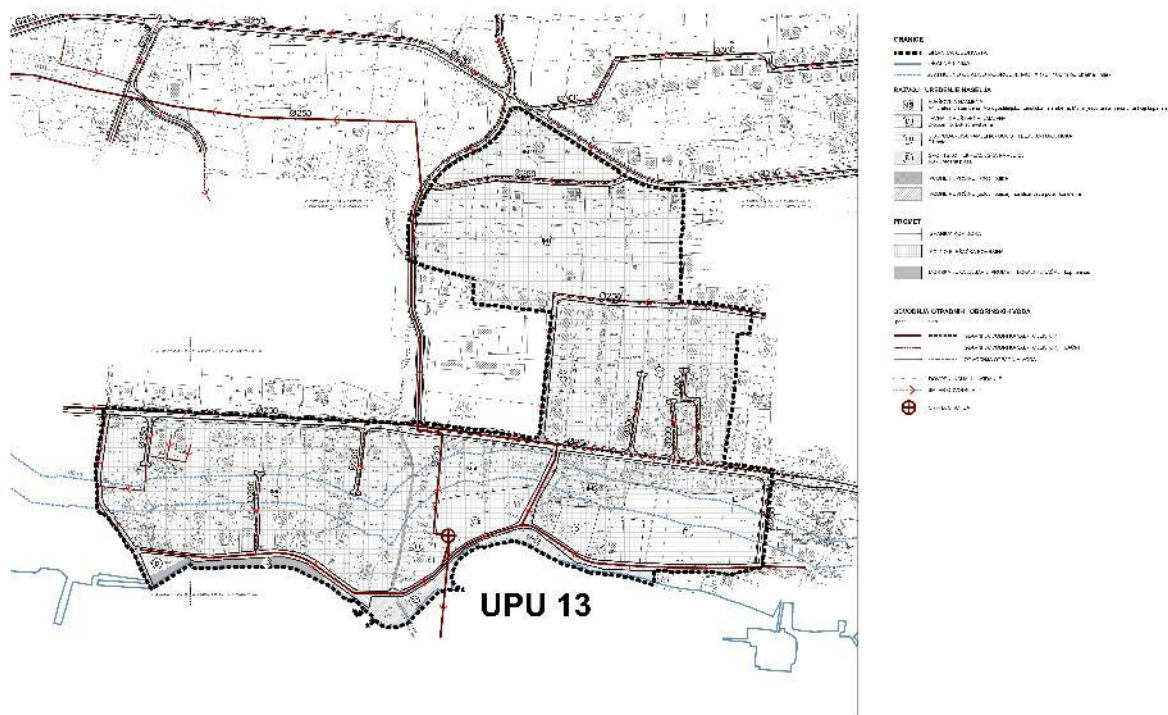
Source: www.kastela.hr

Figure 17 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 18 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

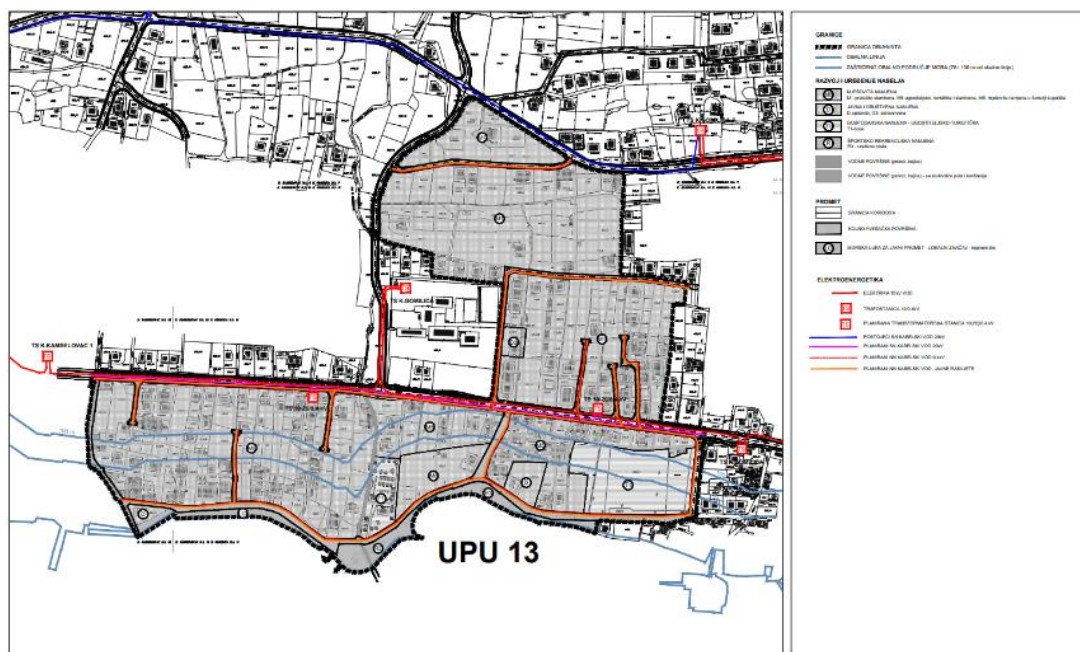
In the area of Kaštela there are two solar photovoltaic power plants. One is the Kozjak solar photovoltaic power plant with an installed capacity of over 300 kW, which was commissioned in 2014 and for which photovoltaic cells were placed on the roof of CEMEX's St. George mine in Kaštel Sućurac, while 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 with an installed capacity of 2x4 MVA was built, which is not satisfactory in terms of security of the consumer supply due to the deterioration of equipment, therefore there is a need for reconstruction. The electric 10 kV network of the coastal area is burdened with unplanned and extensive construction, which causes a lack of necessary substations (10/0.4 kV) and the corresponding electrical network. In the area between the sea and the Adriatic Highway, the network is mostly cable, and in the northern area it is mostly air. The highest energy consumption by settlements was recorded in Kaštel Sućurac, where there is a concentration of industry, while in Kaštel Stari, which is the largest settlement in terms of population, the consumption is 50% lower. At the Kaštel Kambelovac pilot location, energy consumption in 2014 amounted to over 10 million kWh, which is a share of 9.34% of total energy consumption in the Town of Kaštela in that same year. The following figure shows the state of energy infrastructure in the area of the Kaštel Kambelovac pilot location according to UPU 13.

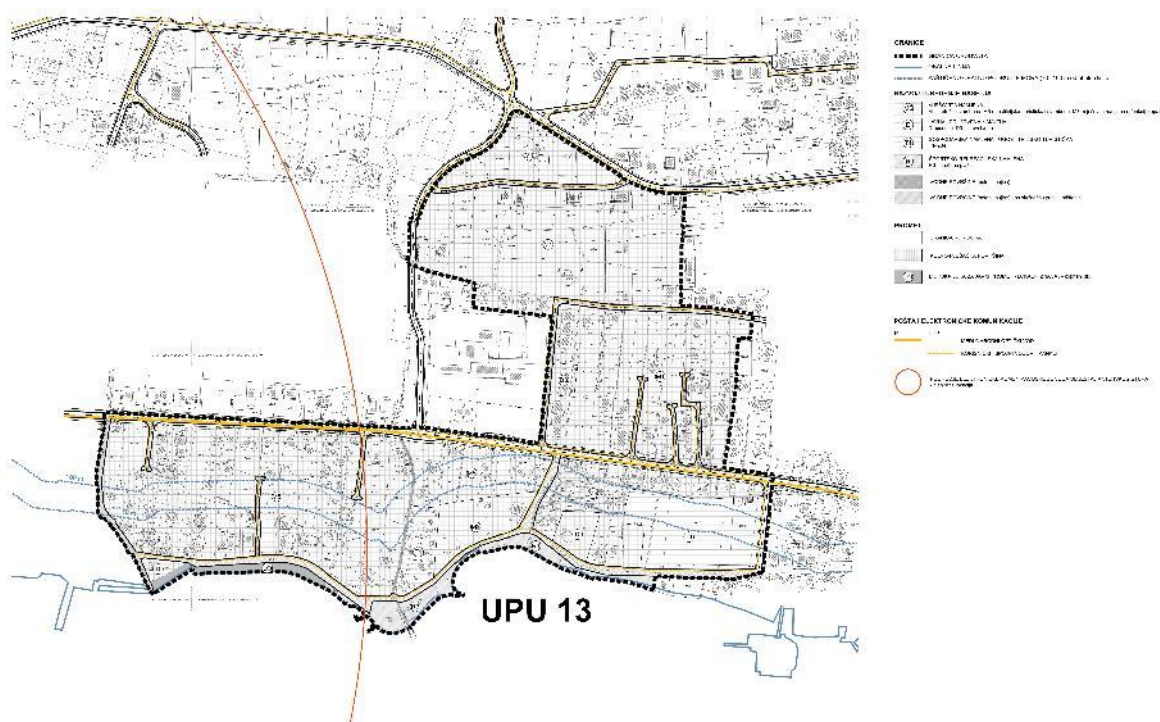


Source: www.kastela.hr

Figure 19 Energy infrastructure of the Kaštel Kambelovac pilot location according to UPU 13

3.3.2.5 Telecommunications infrastructure

The area of the Town of Kaštela, especially the narrow town area, is mostly covered by broadband infrastructure, meaning that the population has or can have Internet access (network coverage includes 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.



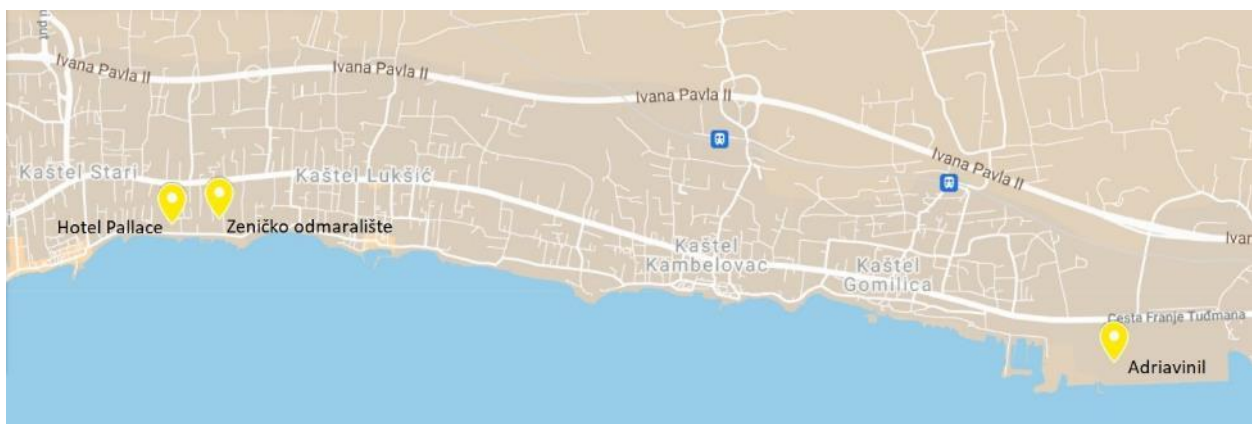
Source: www.kastela.hr

Figure 20 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 under-

utilization 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 21 Brownfield locations in the area of the Town of Kaštela

3.3.2.7 Waste collection system

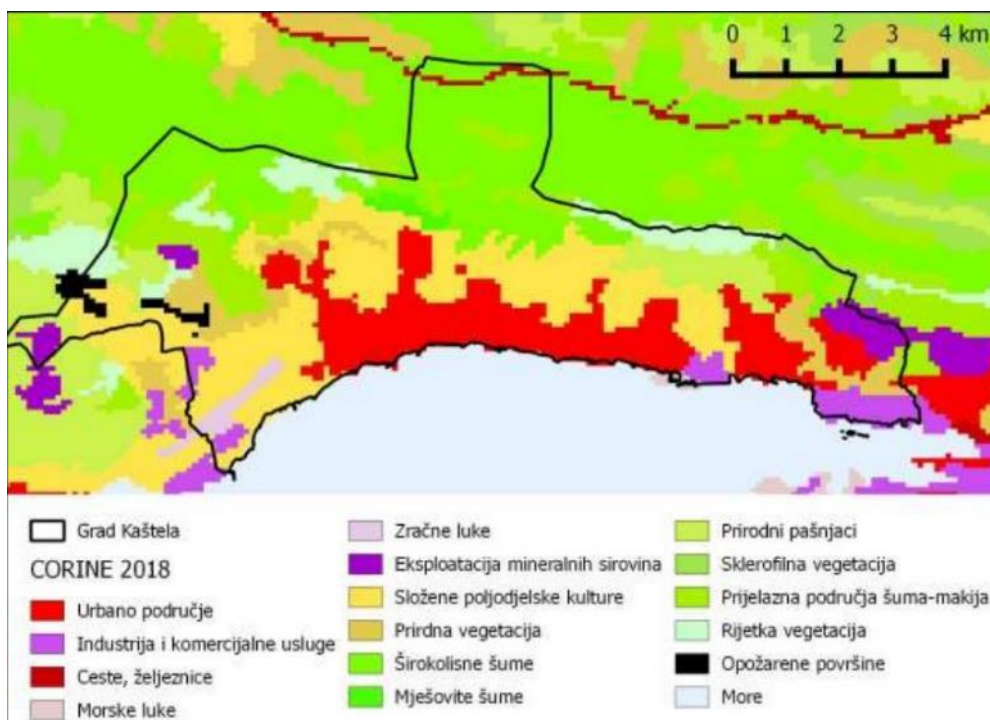
The waste management system in the area of Kaštela is related to the activities of the public utility company *Čistoća d.o.o. Split*, which performs the collection of mixed municipal waste. Municipal waste is taken to the Karepovac landfill. The Town of Kaštela is characterized by a great diversity of facilities and activities ranging from industrial, maritime, tourist to agricultural, therefore, in addition to municipal waste, the types of produced waste range from construction, problematic, hazardous and industrial. The company *Mali Luka* installs paper storage boxes in town and public institutions, private companies and households, the company *Unija papir* collects paper in containers placed in public areas and within green islands, and the company *Jolly-JBS d.o.o.* collects plastic packaging. Recently, there have been significant increases in the collection and production of municipal waste as a result of the increase in tourism activities. Waste generated from the tourism activities is similar in its properties and structure to household waste. Sources of waste are hotel complexes, campsites, apartment complexes, marinas and private tourist accommodations, and it is generated by guests and seasonal catering staff. Considering the

fact that *Marina Kaštela* in Kaštel Gomilica is one of the largest nautical tourism ports, to which tourists from the entire Split-Dalmatia County gravitate, it is clear that it carries the greatest burden when it comes to waste from vessels. In this context, *Marina Kaštela* has developed a Plan for the reception and handling of waste from ships. The plan encompasses the types of waste collection devices, their locations, the list of contractors for waste collection, as well as the methods of waste disposal and its locations. In the area of Kaštel Kambelovac, 59 containers for municipal waste collection and three containers for waste textile treatment have been installed. According to the Waste Management Plan of the Town of Kaštela for the period from 2018 to 2023, developed on the basis of the Waste Management Plan of the Republic of Croatia for the period of 2017 – 2022, there is a plan to procure 13,000 containers for each type of waste and install 17 green islands.

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 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 22 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), 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 23).

Monuments of park architecture are:

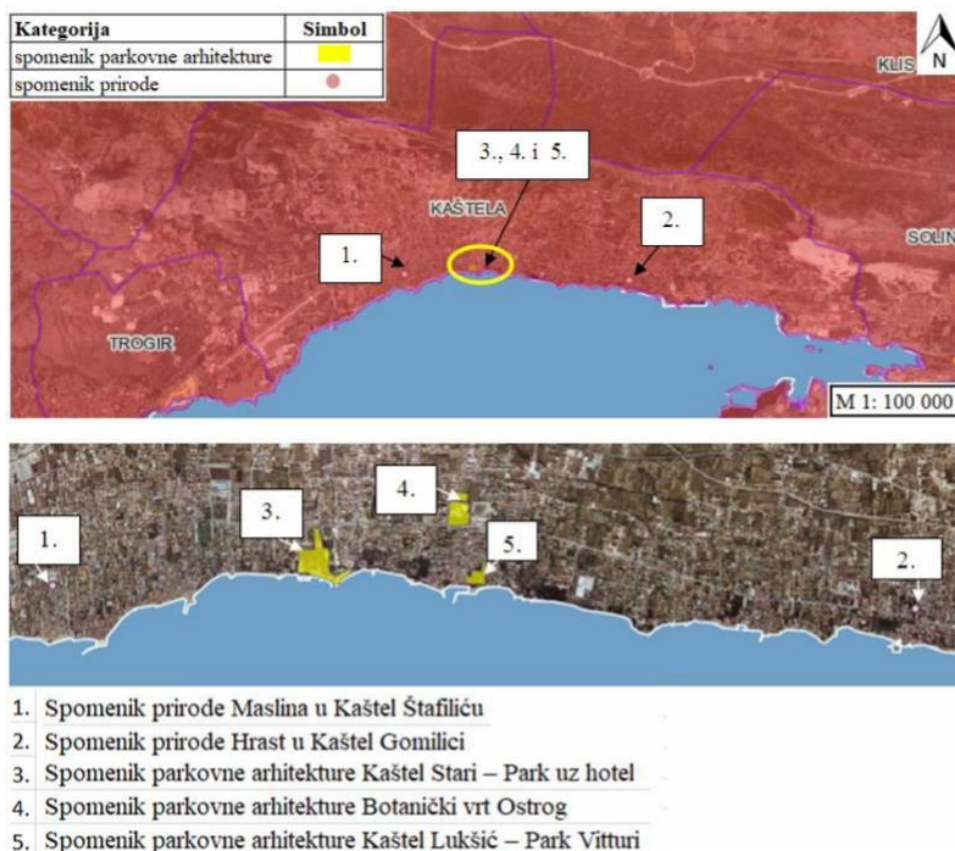
- the school botanical garden of the *Vjeko Butir* Elementary School
- the Vitturi Park in Kaštel Lukšić
- the *Park* in Kaštel Stari.

Natural monuments are:

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

Said protected areas are urban in nature, and as these are artificially created parks located in the town center, 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. “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 23. 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 24 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 strip 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. 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 buildings (castles-fortifications, residential buildings, villas, public buildings, schools etc.) and sacral buildings (churches, cemeteries etc.). The cultural heritage of the Town of Kaštela is shown in the table below.

Table 7 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,	Urban complex of the Kaštel	/

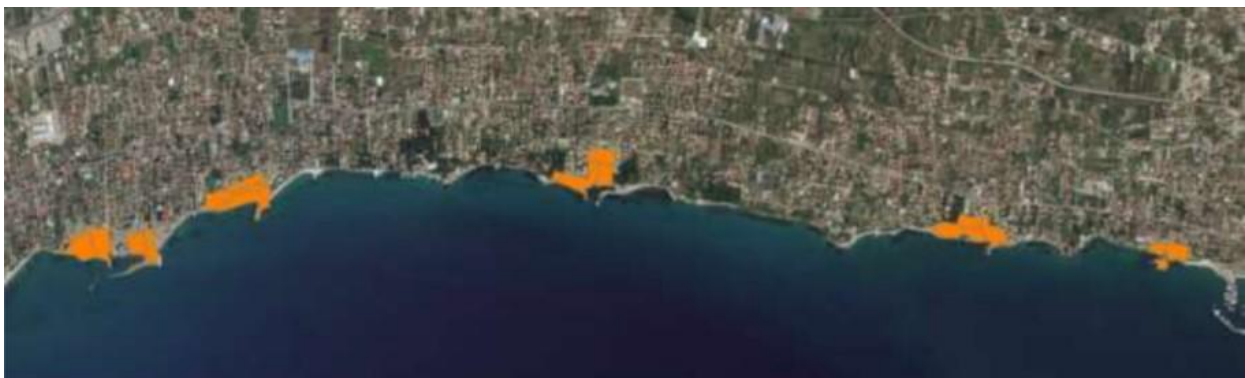
Settlement	Type of cultural property – immovable cultural goods		
	Individually	Cultural and historic elements	Museum material
	the Cambi family oil mill, the building of the former ballet school, Mala and Velika Piškera, Kaštel Lippeo	Kambelovac settlement	
Kaštel Lukšić	Church of Saints John the Baptist 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 Žestinje, 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	/
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 26 Historic center of Kaštel Kambelovac

), 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. Cultural and historic elements in Croatia are protected via zone protection, ranging from complete (zone A) to partial and environmental protection (zones B and C). The figure below shows the Zone A of protected historic and construction units.



Source: Coastal Zone Management Plan of the Town of Kaštela

Figure 25 Zone A – protected historic and construction units

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, 151/03, 157/03, 100/04, 87/09, 88/10, 61/11, 25/12, 136/12, 157/13, 152/14, 98/15, 44/17, 90/18, 32/20, 62/20, 117/21) and others in accordance with the *Urban Development Plan of the Town of Kaštela*, as well as measures for protection against natural disasters. The purpose of the buildings in zones A of the protected historic and construction units located on the ground floor is shown in the table below.

Table 8 Purpose of buildings in Zone A – protected historic and construction units – ground floor

Purpose – ground floor	Unknown	Auxiliary	Business	Residential	Total
Kaštel Štafilić	16	8	19	70	113
Kaštel Gomilica	4	1	7	46	58
Kaštel Kambelovac	12	17	16	87	132
Kaštel Lukšić	7	10	12	110	139
Kaštel Novi	23	2	12	53	90
Kaštel Stari	17	19	23	72	131
Kaštel Sućurac	26	3	8	79	116
Total	105	60	97	517	779
Percentage	13.48%	7.70%	12.45%	66.37%	100.00%

Source: Coastal Zone Management Plan of the Town of Kaštela

The table shows that the largest number of protected historic and construction units of the residential type (517 in total) is located in Kaštel Lukšić (110 in total), while the Kaštel Kambelovac pilot location is in second place in terms of the number of protected residential historic and construction units (87 in total).



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

Figure 26 Historic center of Kaštel Kambelovac

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 competent 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 9 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 10 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. According to the *Risk assessment of major*

accidents for the Town of Kaštela, reorganization of the existing General-purpose civil protection unit is proposed, which would consist of one management group with two members and seven operational groups, and each would have its own manager. In total, this Unit would consist of 70 members. There is also a proposal which includes a reorganization of the Specialist civil protection unit for search and rescue in ruins – light category, which would consist of one management group, one operational group and one logistics group, and would consist of a total of 20 members and two search dogs. The same composition is proposed for the Specialist civil protection unit for technical and tactical support which would consist of 12 members.

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. According to the *Risk assessment of major accidents for the Town of Kaštela*, the table below proposes the amount of required equipment and the number of people.

Table 11 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 exposure of the pilot location to combined risks

Due to its specific geographical location and geomorphological and hydrological features, the Kaštel Kambelovac pilot location is exposed to floods that can occur due to rising sea levels, floods caused by extremely high ocean waves, as well as strong winds and earthquakes. It is extremely likely that the combination of these natural disturbances will cause disasters if certain measures are not taken in a timely manner in order to increase safety and resilience. The PMO-GATE project is based on several research issues concerning combined risks, exposure analysis, risk analysis based on a multilevel GIS approach, as well as risk assessments and risk management plans. This analysis is based on data from previously designed project deliveries, and it encompasses risk scenarios for individual parameters such as various types of infrastructure, and flora and fauna. The figure below shows the analysis of exposure to combined risks with the analyzed risk scenarios.

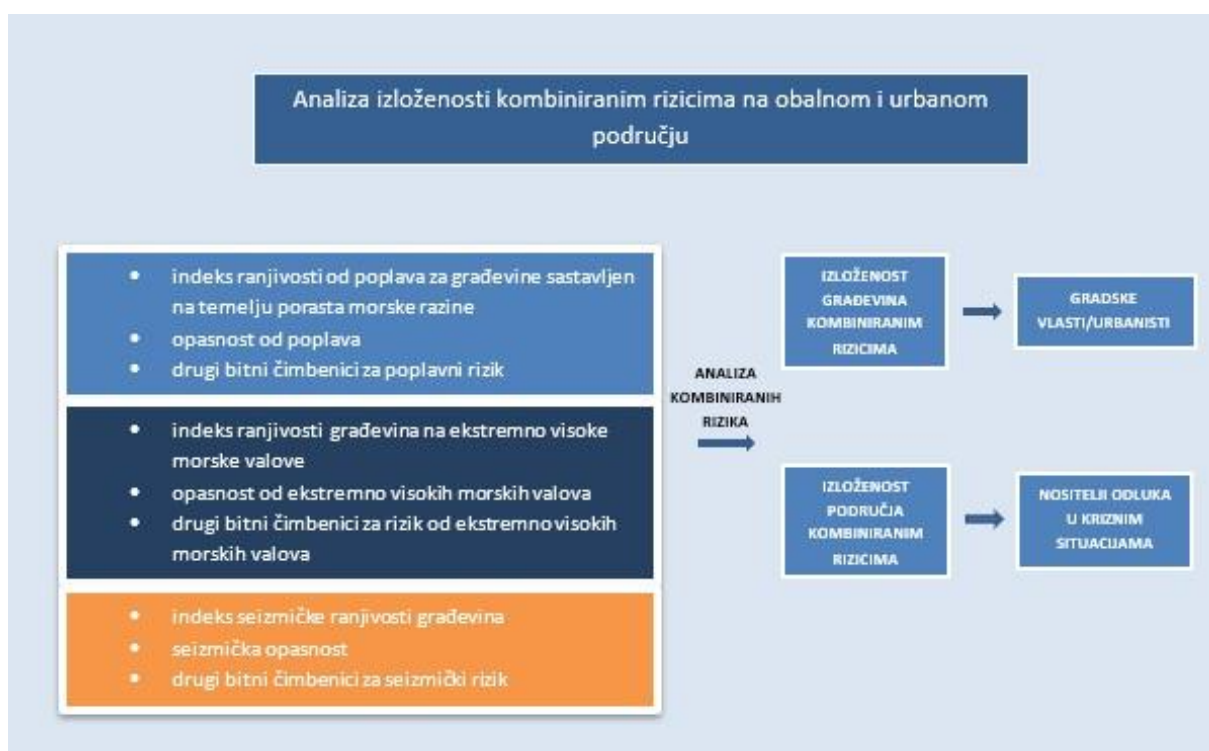


Figure 27 Analysis of exposure to combined risks

The analysis of exposure to combined risks for the pilot location includes a risk assessment for the two most likely scenarios:

1. Risk assessment for the event concerning a combination of floods and earthquakes with relevant parameters:
 - Flood vulnerability index for buildings
 - Flood hazard
 - Earthquake vulnerability index for buildings
 - Seismic hazard
2. Risk assessment for the event concerning a combination of floods, earthquakes, and extremely high ocean waves with relevant parameters:
 - Flood vulnerability index for buildings
 - Flood hazard
 - Vulnerability index for buildings in case of extremely high ocean waves
 - Hazard regarding extremely high ocean waves
 - Seismic vulnerability index for buildings
 - Seismic hazard.

These parameters can be used in order to obtain a measure assessment index for combined risks (multihazard – mh), which depends on previously obtained data for the analysis. Additional quantifiable parameters are also important for the analysis, and they refer to the following:

- distance between buildings
- historic and cultural infrastructure
- population density
- road infrastructure
- water and municipal infrastructure
- factor of importance of a building (public building, school, hospital etc.).

The figure below shows the exposure of the pilot location to combined risks with the corresponding level of risk, where it is evident that the entire coastal area is at risk, and the zones of the historic center (areas 12 and 13) are considered the most critical.

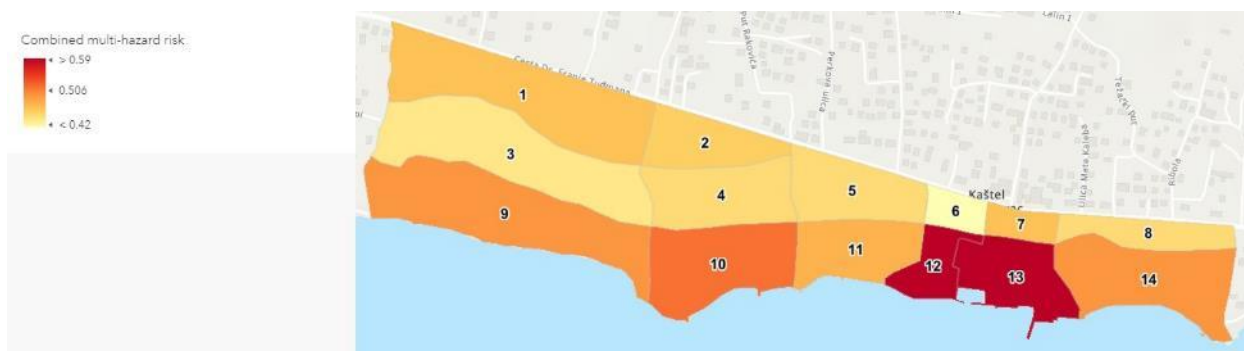


Figure 28 Exposure of the Kaštel Kambelovac pilot location to combined risks

The most popular method for risk assessment is the PROMETHEE method (*Preference Ranking Organisation METHod for Enrichment Evaluations*). This method is known to be the most effective, robust, and easiest in the field of combined risk assessment. Given the fact that it is comprehensive and has the ability to present results through simple ranking methods, it has been approved by decision-makers. The PROMETHEE method is also used to obtain an assessment index for combined risks in a particular area. It is important to emphasize that according to the *European Commission's Risk Assessment and Mapping Guidelines for Disaster Management* (EC 2010), combined risks cannot be defined only as a consequence of two factors (disaster effects and likelihood), but their functional link must be found. Therefore, the assessment of combined risks and vulnerabilities is given using a technical analysis of the criteria for the assessment of combined risks. The figures below show the results of the combined risk analysis expressed as the net risk value using the PROMETHEE method (green – low net value, yellow – medium, orange – high, red – very high), and as values on the risk rating scale given in the figure (the color green represents a low level of risk 40 – 49, yellow represents a medium level 50 – 69, and red represents a high level 70 – 89)

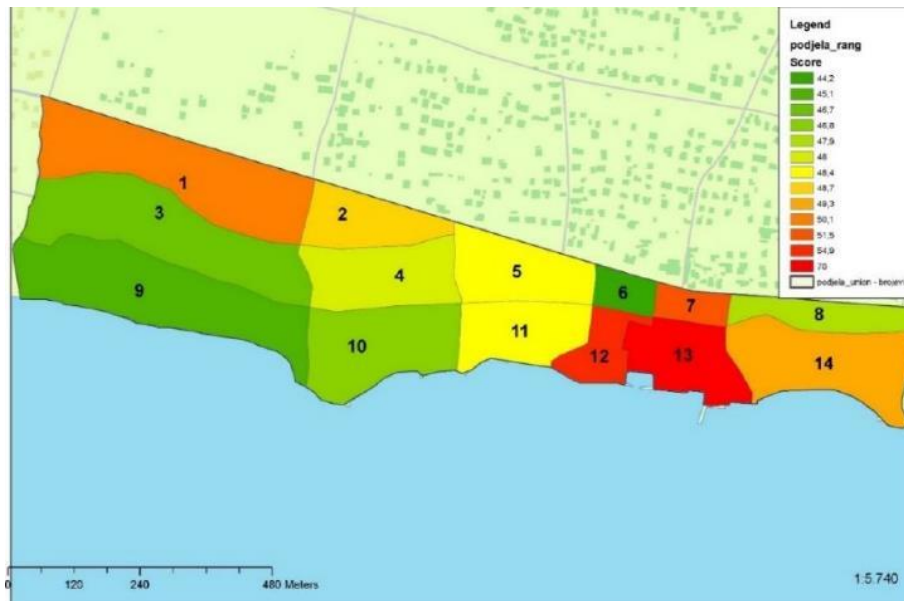


Figure 29 Combined risk assessment map for the pilot location expressed in net values

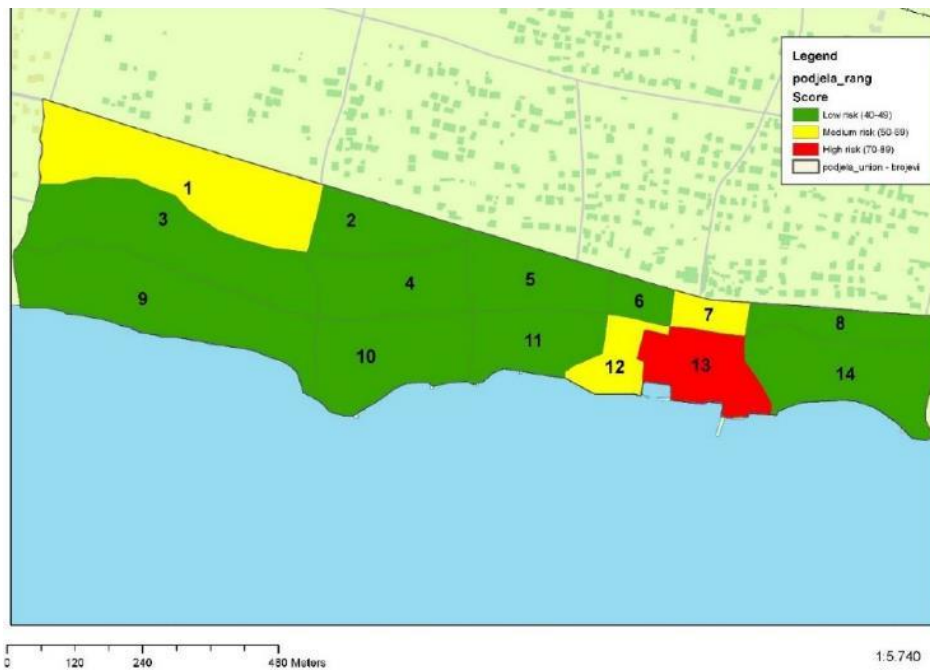


Figure 30 Combined risk assessment map for the pilot location on the value scale

4.1. Analysis of possible consequences of combined risks

4.1.1. Coastal infrastructure and infrastructure cultural heritage

Due to the high density of buildings on the narrow coastal strip along which the associated water supply network and wastewater and rainwater network has not develop simultaneously, and due to the proximity of the sea, it is evident that there is a high risk of floods in the Town of Kaštela. The rise in sea levels, the exposure to extremely high ocean waves, and a seismically active area are the main causes of concern and risk factors for disasters. The risk is even greater if we take into account the possibility that some of the natural disasters occur as a result of the interaction between natural disasters, i.e. if an earthquake causes floods. Due to the impact of climate change on the coast and coastal infrastructure visible in the entire area of Kaštela and the Kaštela Bay, and it is expected to be even more pronounced in the future, it is important to ensure the necessary protection for coastal infrastructure and cultural heritage, which are already significantly exposed to risks. Particular attention should be paid to the fact that in the central part of the Kaštel Kambelovac pilot location, as well as in other cores in the area of the Town of Kaštela, there are mostly old buildings that were not built in accordance with the risks. This primarily refers to cultural heritage sites 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 combined risks 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

Kaštela is located on one of the main traffic routes in Dalmatia, which is also one of the busiest routes, and this is especially pronounced in the summer months during the tourist season. 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 (the 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, due to their locations, at risk of disasters caused by combined risks. The combination of earthquake and flood risks, due to the proximity of the sea and seismic activity, could lead to significant consequences for the population, as well as for the infrastructure.

Also, combined risks pose a threat since they can cause the collapse of roads and transport infrastructure. Parts of broken and collapsed infrastructure can be carried away by floodwaters and thus significantly endanger the population. Therefore, it is necessary to develop strategies for the reconstruction and protection of transport infrastructure according to modern standards of protection against combined risks. The figure below shows the state of the traffic road flow at the pilot location. Roads that are narrower than 3 m or longer than 100 m are marked in red, and the vehicles cannot be rotated while on those roads. Those that are suitable for use in crisis situations are marked in green, while those in blue are wider than 6 m and allow two-way passage of vehicles.



Figure 31 Map of the traffic road flow of the pilot location in Kaštel Kambelovac

4.1.3. Water and municipal infrastructure

Excessive construction and congestion of the system, unplanned and illegal construction and many years of lack of investments in infrastructure reconstruction have led to the current situation due to which the entire water and municipal infrastructure is in very poor condition, and is, as such, exposed to combined risks. Even though the rehabilitation of infrastructure commenced with the *Improvement of water and*

municipal infrastructure of the Kaštela – Trogir agglomeration project, which started in 2020, it will take a long time before it is brought to a state of reduced exposure to combined risks. The combination of floods and earthquakes will not only endanger the drinking water supply system, but there is also a risk of damage and wastewater spills. Also, considering the fact that the sewerage network is developed only south of the Dr. Franjo Tuđman road, where a combined drainage system is in use, there is a danger above the Adriatic Highway where the wastewater drainage system is not well organized, and in the event of a disaster caused by combined risks, wastewater can be spilled and carried away by torrential floods throughout the area, which endangers the health of the population.

4.1.4. Energy and telecommunications infrastructure

Combined risks endanger the energy and telecommunications infrastructure primarily due to the fact that most of the infrastructure is below ground level, and in the event of earthquakes and floods there is a high probability of pipe bursts, short circuits, and shutdowns of the entire network. The current electric energy supply and telecommunications infrastructure of the Town of Kaštela, which is located above the ground, may be endangered by coastal flooding and earthquakes, especially user lines, interconnectors, and cables on facilities located near the coast and at low altitudes.

4.1.5. Buildings for private and public purposes

Due to the narrow coastal strip with a high degree of urbanization, a large number of buildings for private (residential buildings, houses and agricultural facilities) and public purposes (schools, kindergartens, public institutions) and other buildings and facilities were built relatively close to the sea. Also, a large number of buildings are built of stone and lime binders, and are, as such, exposed to combined risks. Even now parts of buildings located by the sea are being damaged primarily due to the fact that they were not built in accordance with the exposure to floods and waves, and an earthquake would lead to their collapse. With planned construction and proper processes related to capacities in the future, it is important to adjust the reconstruction of existing and construction of new buildings to the combined risks in order to increase the resilience of infrastructure and population and to consequently avoid unwanted consequences.

4.1.6. Economic infrastructure

Fishing ports, harbors, as well as factories from various industrial domains are located in the coastal strip, which are exposed to combined risks and consequences that such an event will cause. Earthquakes and floods can cause great damage to industrial plants, economic zones and agricultural land, and lead to coastal and marine pollution. The combination of earthquakes and floods is extremely dangerous for industrial plants because, in addition to the significant damage that an earthquake would cause to the infrastructure of the plants, wastewater generated by industrial processes could overflow and end up in the sea, which would cause immense pollution. Also, relocating factories and plant facilities is an extremely expensive and time-consuming process that is difficult to implement. 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. Combined risks may cause permanent soil contamination and its unserviceability. Additionally, agricultural facilities such as greenhouses, tunnels, and agricultural equipment warehouses are in danger. Therefore, keeping in mind the combined risks, planned construction will be necessary in the future, as well as, if possible, the relocation of the economic zone away from the coastal zone in order to increase the resilience of the coastal economy and reduce potential damages and threats for the population and the environment.

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). The combination of earthquakes and floods can cause damage to these areas, as well as changes in the plant and animal ecosystem. It is also likely that some animal species will be permanently displaced considering the fact that their habitat will be directly endangered.

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 combined risks. 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. Combined risks 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 combined risks 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 combined risks cause 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 combined 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 is extremely endangered by combined risks. Also, during disasters caused by combined risks, 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 combined risks 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 field of combined risk management showed the current situation with the main characteristics of the area, as well as social, economic, and natural and cultural indicators, and indicators of operational capabilities of the Town of Kaštela and the Kaštel Kambelovac pilot location. The exposure analysis of the pilot location presented the methodology for assessment of the exposure to combined risks with the corresponding assessment scales and scenarios for the impact of combined risks on the main infrastructure and natural characteristics of the area. As part of both analyses, key issues in infrastructure management and other relevant factors have been identified and summarized below:

- coastal embankments and systematic construction of the coast during development

- unplanned and illegal construction of housing developments
- pollution and devastation as a consequence of industrialization
- high density of buildings and population in a narrow coastal strip
- coastal erosion, damage to coastal infrastructure and beaches caused by ocean waves
- construction of infrastructure that is not in accordance with the exposure to combined risks
- congestion of the electric network due to unplanned and extensive construction
- concentration of economic infrastructure in the coastal strip
- unsatisfactory construction of water and municipal infrastructure with high system losses and insufficient level of connection of the population to the public sewerage system
- unsatisfactory state of railway infrastructure
- underdeveloped maritime transport and inadequate infrastructure
- impassable and narrow city roads
- *brownfield* areas located by the coast
- catastrophic consequences for the population, infrastructure and the environment in the event of combined risks
- negative impacts of urbanization on environmental and natural heritage degradation
- unsatisfactory level of protection of cultural heritage
- potential biodiversity loss of terrestrial and marine ecosystems and crops caused by combined risks.

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 combined risks. The fact that the town 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 combined risks.

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 aforementioned analyses of the situation and the identification of key challenges. They are based on an integrated approach to combined risk management through aspects of infrastructure management and operational capabilities. Therefore, the vision is as follows:

Kaštel Kambelovac is an area of enhanced resistance to combined risks, where measures of infrastructure management, spatial planning, information and protection of the population and management of operational capabilities 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

Due to its specific geographical location, geomorphological, hydrological and other features, as well as the high degree of urbanization, the Kaštel Kambelovac pilot location is sensitive to various natural disasters. The analyses have shown that it is located in an area that is exposed to combined risks. The main factors of exposure include the following: high population density, unplanned construction, and historic sites that have not been built in such a way that they are protected against combined risks. Due to the configuration of the field and the lack of spatial planning in the event of disasters caused by combined risks, human lives are significantly endangered. The combination of earthquakes and floods causes damage to transport, water and municipal, electricity and telecommunications infrastructure, which makes crisis situations even more challenging. Therefore, the first goal is to create a framework for effective infrastructure management and spatial planning.

2. Improvement of risk management systems

The risk management system in the Town of Kaštela is flawed and underdeveloped, and given the fact that this is a high-risk area sensitive to hazards caused by natural disasters, it is evident that the implementation of a quality and timely management system is necessary. The *Action Plan in the field of natural disasters for 2020 of the Town of Kaštela* in Croatia prescribed a system of civil protection

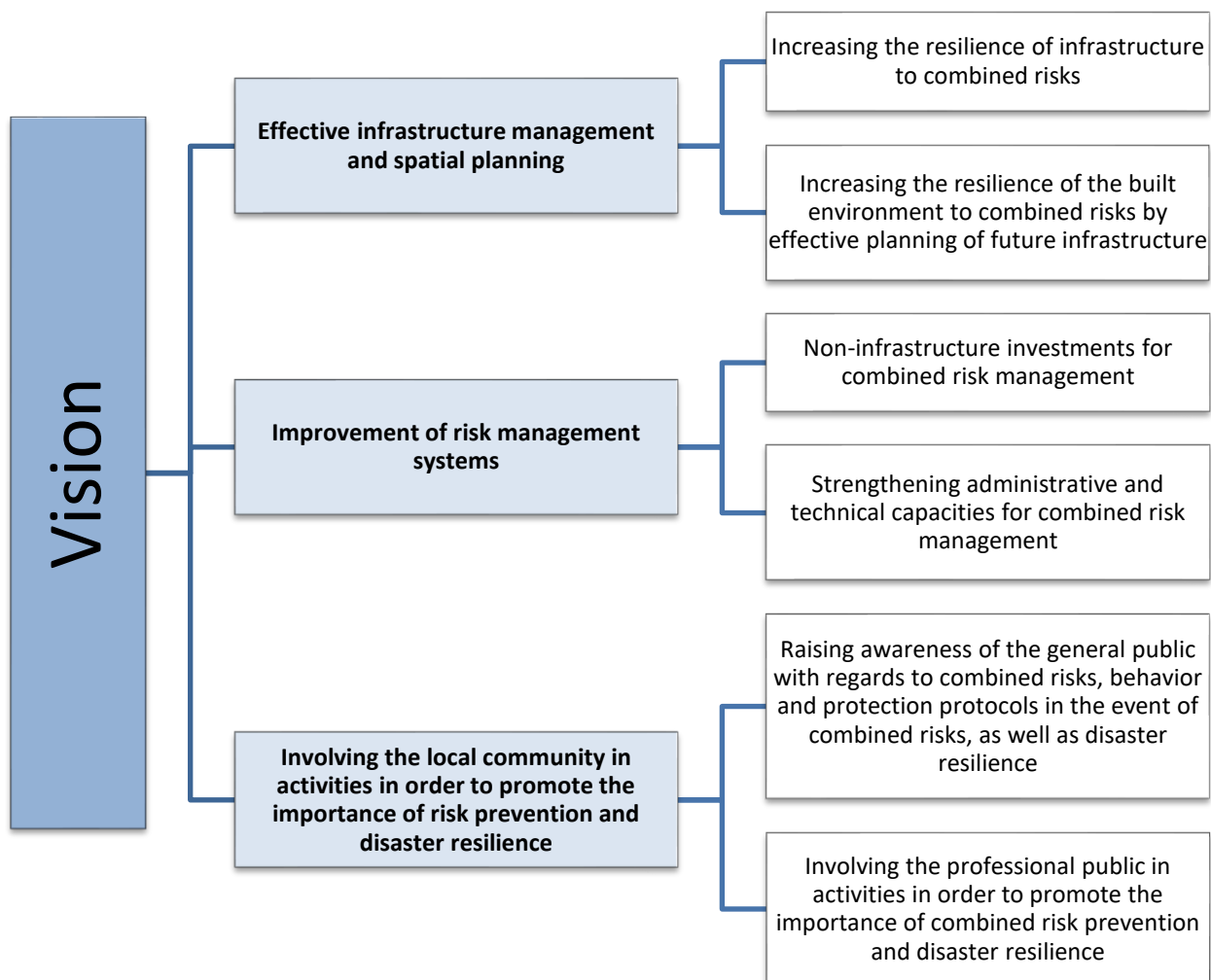
measures, however, the information and communication system is under-developed or non-existent. Hence, there is a need to strengthen the capacity of decision-makers to act in a timely manner in crisis situations, which ultimately leads to the identification of another goal.

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

Defense and protection of the population from combined risks also consists of maintaining various programs that are used to inform the population on dangers through projects, policies, and measures in order to strengthen resilience. This primarily refers to preventive action and timely response in case of disasters caused by combined risks. For a quality defense strategy, the participation of all social stakeholders is crucial in order to jointly increase the possibilities for defense and protection of infrastructure and the population. The third goal arises from the above-mentioned assumptions and encourages the involvement of the local community of the Kaštel Kambelovac area in activities which serve to promote the importance of risk prevention and disaster resilience.

7. Management measures

Activities that help achieve set goals in the management of combined risks at the pilot location have been designed in the form of management measures. The set goals can be achieved through one or more measures. The diagram below summarizes the goals and measures, and the tables provide a detailed overview of the measures and their relevance in relation to goals, project developers, time frame, stakeholders and activities.



Goal 1:	Effective infrastructure management and spatial planning
Measure 1.1:	Increasing the resilience of the built environment to combined risks
Description:	<p>Due to the fact that the area of the Kaštel Kambelovac pilot location is located on a narrow coastal strip and an area which, in addition to being densely populated, is exposed to various types of risks related to natural disasters, and there is a danger that a combination of several types of risks may pose. The core of the pilot location, which is the most exposed to the risk of disasters, is also an area with the largest number of older buildings that have not been built in accordance with the possible risks. They may suffer significant damages under the influence of combined risks, and some of them are significant for the cultural heritage due to their age, therefore the potential damage is even greater. Also, in some places, other infrastructure is outdated, such as transport, energy or water and municipal infrastructure whose damage and/or collapse due to the influence of various disasters may cause interruptions in the supply of drinking water and food, communication and the like. Therefore, it is essential to invest in existing infrastructure, either buildings or other elements, in order to reduce the potential impact of combined risks and contribute to the efficient management of all types of infrastructure. The dynamics and priorities of the implementation of individual activities should take into account the combined risks vulnerability zones, with an emphasis on the area of buildings with a high category of vulnerability.</p>
Time frame:	2030
Area:	Kaštel Kambelovac
Project developers:	Town of Kaštela
Stakeholders involved:	Split-Dalmatia County
Activities:	<p>1.1.1. Investments in adaptation and increase of resilience of critical infrastructure with regards to the combined risks vulnerability zones (insulation of energy infrastructure, reconstruction of the old water supply network, remediation of run-down transport infrastructure, protection against corrosion)</p> <p>1.1.2. Investments in adapting and increasing the resilience of public and social purpose buildings to combined risks and mitigating their effects</p> <p>1.1.3. Infrastructure operations on buildings aimed at reducing combined risks (strengthening of the structure, construction of groins, breakwaters, wave breakers, remediation of jeopardized buildings)</p>

Goal 1:	Effective infrastructure management and spatial planning
Measure 1.2:	Increasing the resilience of the built environment to combined risks by effective planning of future infrastructure
Description:	The concentration of a large number of buildings on the narrow coastal strip characterized by unplanned and illegal construction, underdeveloped and insufficiently widespread water and municipal, electricity, telecommunications, and other types of public infrastructure is a specific feature of the Town of Kaštela and of the Kaštel Kambelovac pilot location as well. Due to unplanned and illegal construction, the street network has been developed in a dysfunctional way, and roads are narrow and impassable, which is a significant issue for public services during natural disasters, which can lead to loss of human lives. Therefore, the goal in the future is effective infrastructure management and spatial planning in order to increase resilience to combined risks.
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. Inclusion of the combined risk analysis of newly built buildings in the necessary project and technical and study documentation</p> <p>1.2.2. Investments in adapting and increasing the resilience of new water and municipal, energy, telecommunications and transport infrastructure with regards to combined risks</p> <p>1.2.3. Spatial planning of alternative traffic routes with regards to vulnerability of the zones to combined risks</p>

Goal 2:	Improvement of risk management systems
Measure 2.1:	Non-infrastructure investments for combined risk management
Description:	The pilot location in Kaštel Kambelovac is an area located on a narrow coastal strip that is densely populated and at high risk of various natural disasters. Even though the <i>Action Plan in the field of natural disasters for 2020 of the Town of Kaštela</i> defines protection measures during natural disasters, action in case of combined risks has not been defined. In that context, there is still room for improvement and modernization of the information and communication system of civil protection and public alert in order for all management measures to be implemented in a timely and effective manner, as well as to improve the combined risk management system.
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>

Goal 2:	Improvement of risk management systems
Measure 2.2:	Strengthening administrative and technical capacities for combined risk management
Description:	The <i>Action Plan in the field of natural disasters for 2020 of the Town of Kaštela</i> prescribes various civil protection measures for various individual types of natural disasters. The plan also defines the competent bodies, institutions, and services for response in crisis situations. However, the existing spatial planning documentation does not encompass measures of infrastructure adaptation to combined risks. 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 capital training.
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:	<ul style="list-style-type: none"> 2.2.1. Integration of combined risk adaptation measures into the spatial planning documentation (remediation and/or reconstruction of critical infrastructure, planning according to zones of exposure to combined risks etc.) 2.2.2. Organization of trainings to strengthen the capacity of decision-makers with regards to the dangers caused by combined risks and ways to mitigate their consequences 2.2.3. Development of rescue and evacuation plans with regards to the exposure to combined risks 2.2.4. Improvement of the training system for operational forces and frequent emergency rescue drills 2.2.5. Performance of regular checks on the correctness of technical equipment of operational forces

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 combined risks, behavior and protection protocols in the event of their occurrence, as well as disaster resilience
Description:	The dangers that combined risks pose need special attention considering the fact that they can cause large-scale disasters, and their consequences may persist for years to come. Therefore, it is extremely important to work as soon as possible on measures of prevention, resilience, and mitigation of consequences that such disasters can cause. The consequences may significantly endanger not only the economy and infrastructure, but also human lives. It is important to educate the general public on combined risks and their possible consequences. By raising awareness, the general public is involved in activities in order to promote the importance of combined risk prevention and increasing disaster resilience. This way, an opportunity for efficient use of resources and a sustainable society is created.
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 combined 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 combined risks and other natural disasters</p> <p>3.1.3. Production of promotional materials and their distribution to the local population along with ways to contribute to the sustainability of the coastal area</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 combined risk prevention and disaster resilience
Description:	Climate change and its consequences, as well as ways to combat it, have for quite a long time been the subject of numerous meetings between European and world leaders. Today, the changes are even more pronounced, therefore the incidence of natural disasters is even higher. Hence, the United Nations, the European Union, and the World Meteorological Organization seek to promote awareness, prevention, and adaptation to climate and non-climate risks through various programs and projects. As a member, Croatia is implementing various policies and measures to this effect. Involving the local community in activities to promote the importance of preventing combined risks and disaster resilience, and especially the professional public, are basic prerequisites for increasing protection and resilience of various areas and their inhabitants.
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 system of prediction and monitoring of the occurrence of combined risks based on the input of experts in the field of natural disaster risk management 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