

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

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# Risk Management Plan Concerning Risks of Coastal Floods Caused by Extremely High Ocean Waves

Kaštel Kambelovac pilot location

## 1. Introduction

The action of various natural processes and the impact of climate change leads to the occurrence of various natural disasters, some of which are undoubtedly related to human activity. There is a growing awareness in the world concerning the increase in human impact on the climate and climate change, therefore many countries and world organizations are trying to mitigate the consequences and reduce human impact. The European Union is also asking its members to tackle the mitigation of consequences related to climate change. Given that natural disasters are often unpredictable and unexpected, it is crucial to develop technologies and methodologies that can help combat natural disasters and find ways to prevent, manage and overcome numerous hazards that occur as a consequence.

With that in mind, under the Priority Axis 2 *Security and resilience* of the cross-border cooperation program INTERREG V-A Italy-Croatia 2014 – 2020, the project *Preventing, Managing and Overcoming Natural-Hazards Risks to mitiGATE economic and social impact* – **PMO-GATE** has been notified. The project involves Italian and Croatian regions in order to jointly find new ways to raise the level of protection and resilience to natural disasters that are specific to the areas where the project is implemented, and this primarily refers to floods caused by extremely high ocean waves, floods caused by rising sea levels, and earthquakes. Cooperation between countries is aimed at exchanging information and the integration of existing risk assessment, prevention, preparedness and response to natural disasters in order to avoid repeating the research that has already been conducted and improve the disaster risk management system as a whole. One of the goals of the project is to develop risk management plans and develop a warning system in order to increase safety and resilience to natural disasters. In this regard, the project activity *Improved Early Warning Systems for Individual Risks* seeks to implement smart communication systems in order to make them available to technicians and the public. The implementation of these systems enables the visualization and communication of risk scenarios to end users and obtaining timely details on the spatial distribution of vulnerabilities with the aim to prioritize interventions in the event of disasters. This document establishes a plan for managing floods caused by extremely high ocean waves. The plan includes a description of the spatial coverage of the pilot location, situation analysis and risk assessment, and it also defines key issues, vision and management goals, as well as possible management measures.

## 2. Spatial coverage of the pilot location

The Town of Kaštela is part of the Split-Dalmatia County. It borders the municipalities of Klis, Prgomet and Lećevica to the north, the Town of Solin to the east, the Town of Trogir to the west, and the City of Split at sea. The surface area of the town is 56.9 km<sup>2</sup>, of which the length of the coast is 23 km. The Town of Kaštela 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. Kaštel Kambelovac is a pilot location for the development of the *Risk Management Plan Concerning Risks of Coastal Floods Caused by Extremely High Ocean Waves*. The settlement is located between Kaštel Lukšić and Kaštel Gomilica at the foot of the Kozjak hill. The area of Kaštel Kambelovac is suitable for this project since it is diverse enough to be a *test bed* for the entire area of the Town of Kaštela.



Source: [www.geoportal.dgu.hr](http://www.geoportal.dgu.hr)

Figure 1 Orthophoto map of the spatial coverage of the Kaštel Kambelovac pilot location

### 3. Analysis of the situation in the field of management of risks concerning coastal floods caused by extremely high waves at the Kaštel Kambelovac pilot location

Analysis of the situation from the point of view of floods caused by extremely high waves 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

##### 3.1.1. Geographical indicators

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. 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 entire area is located on generally impermeable flysch deposits and is thus known for the large amounts of torrential waters that occur during heavy rains. The figure below shows the entire area of Kaštela on the hydrogeological map.

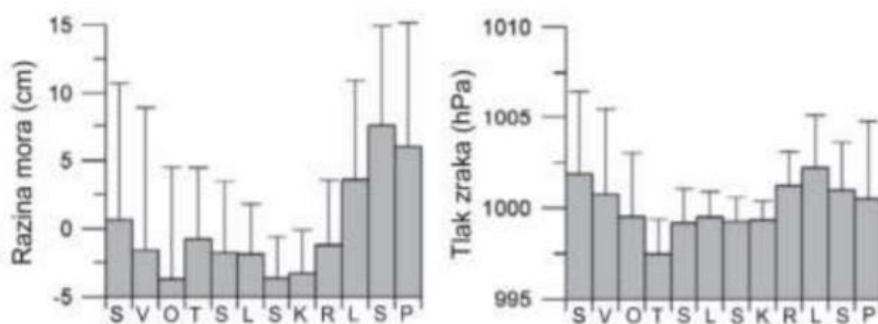


Source: Zone Management Plan of the Town of Kaštela

Figure 2 Hydrogeological map of the Town of Kaštela

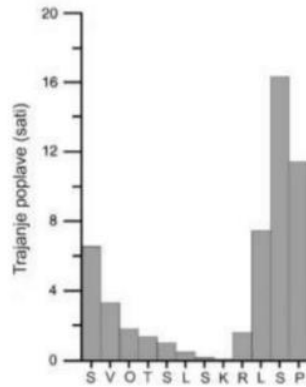


Sea levels are highly variable throughout the year, with the highest values recorded during late autumn and early winter. This is also the time of year when there is the highest probability of occurrence of extreme floods in the coastal area, which, with the extremely strong south wind, can cause major floods and endanger people and infrastructure. Storms and intense south winds are the result of strong cyclonic activities which result in extremely high waves which then often flood the coastal strip of the entire area of the Town of Kaštela. On the other hand, due to the persistent blowing of *bura*, which can reach significant speeds in the area of Kaštela and which, unlike the south, blows from the mainland to the sea, there is a high probability of the so-called *šćiga* or *seš* (type of a standing wave), which often occurs in bays such as the Kaštela Bay. They are common in the entire Adriatic area, and they last from 21 hours to one hour, which is their duration in the area of the Kaštela Bay. If they reach large amplitudes, they often cause floods and endanger the safety of people on land, but also at sea. They can occur as a result of sudden changes in air and wind pressure, as well as a result of disturbances that come from high seas. The graphs 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 3 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 4 Annual course of the flood duration (in hours)

The openness to the sea and the geographical position define the affiliation of the Town of Kaštela, and thus the pilot location of Kaštel Kambelovac, to the Adriatic-type Mediterranean climate zone. The climate is characterized by hot and dry summers and mild and humid winters with many sunshine hours and pronounced windiness. The average annual air temperature in this area is 15.9 °C, while the annual temperature range (mean temperature difference between the warmest and coldest months) is 17.5 °C. The area of the Kaštela Bay is quite windy and analyses in the area of Split have shown that winds stronger than 3 bf<sup>1</sup> 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.

### 3.1.2. Population

According to the first results of the 2021 census, the Town of Kaštela has 37,951 inhabitants, and considering that the area of the Town is 56.9 km<sup>2</sup>, the population density of the area is 666 inhabitants/km<sup>2</sup>, 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

<sup>1</sup> Beaufort scale for the evaluation of the wind strength by its effects

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
<b>Kaštel Kambelovac</b>	<b>5,076</b>
Kaštel Lukšić	5,254
Kaštel Stari	6,968
Kaštel Novi	6,537
Kaštel Štafilić	2,837

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

The table shows that the most populous settlement is Kaštel Stari, while the least populous one is Kaštel Štafilić. In the area of the Kaštel Kambelovac pilot location there are 5,076 inhabitants, which is 13.4% of the total population from the area of the Town of Kaštela. The age distribution of the population is divided into three categories: young (0-19 years of age), mature (20-59 years of age), and elderly (> 60 years of age). According to statistics from 2011, the young population accounts for 24.58% (9,506), mature 56.46% (21,831), and elderly 18.86% (7,330) of the total population of the Town of Kaštela. The table below shows the distribution of the population by sex and age at the Kaštel Kambelovac pilot location and the entire area of Kaštela. It is evident that, according to gender, there is slightly more female than male population in total, while within the age groups – young and mature – the male population is predominant.

Table 2 Population by age and sex

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

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

### 3.1.3. Transport connectivity

The area of the Town of Kaštela is part of the functional traffic region of northern and central Dalmatia through which the international Adriatic-Ionian Road corridor passes. Between Trieste and Kalamata, the corridor connects seven countries. Along the Adriatic coast, it connects the main seaports (Trieste, Koper, Rijeka, Zadar, Šibenik, Split, Ploče, Dubrovnik, Bar, Durrës, Igoumenitsa, Patras, Kalamata) and numerous pan-European corridors (V, Vb, Vc, and VIII). Below is a description of road, rail, air, maritime, and the public transport system according to the *Development Strategy of the Town of Kaštela 2016 – 2020*

#### 3.1.3.1. 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 (the Dr. Franjo Tuđman road) which stretches along the D8, but is closer to the coast and passes through the centers of the Kaštela settlements, resulting in a significant reduction of the share of transit traffic on said road. The only significant road that does not follow the east-west coast direction, but rather the north-south is the Kaštel Stari – Kladnice road over the Malačka pass, but which in terms of traffic intensity lags considerably behind the two above-mentioned roads. All coastal settlements are connected to the main longitudinal roads by local roads (L67058, L67059, to Kaštel Štafilić, L67060 to Kaštel Lukšić, L6762 to Kaštel Kambelovac, L67063 to Kaštel Gomilica, L67064 to Kaštel Sućurac). In addition to the considerable traffic load, there are also issues concerning the road network that have arisen as a result of the uncontrolled expansion of settlements due to the absence of integrated spatial planning. Insufficient space left for the road means that two vehicles cannot pass one another, or that access for public service vehicles has been obstructed, which results in human lives being endangered. The legal status of public roads and unclassified roads, and the manner of their use and planning of construction and maintenance,

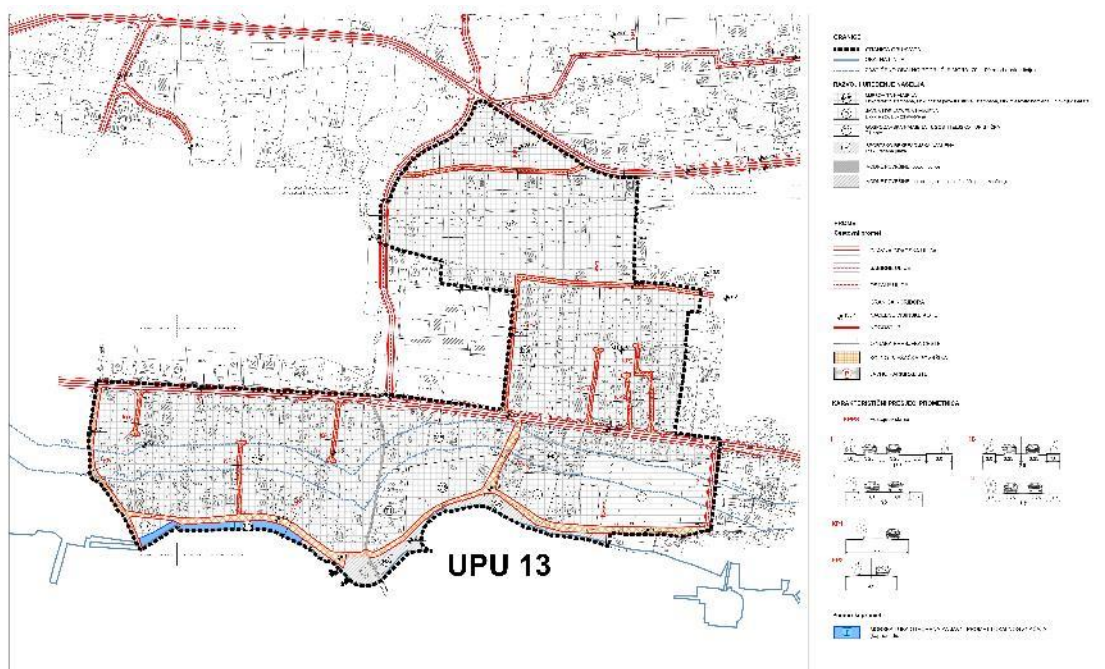
as well as concessions, financing and supervision are regulated by the Roads Act (OG 84/11, 22/13, 54/13, 148/13, 92/14, 110/19, 144/21).

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

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

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

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



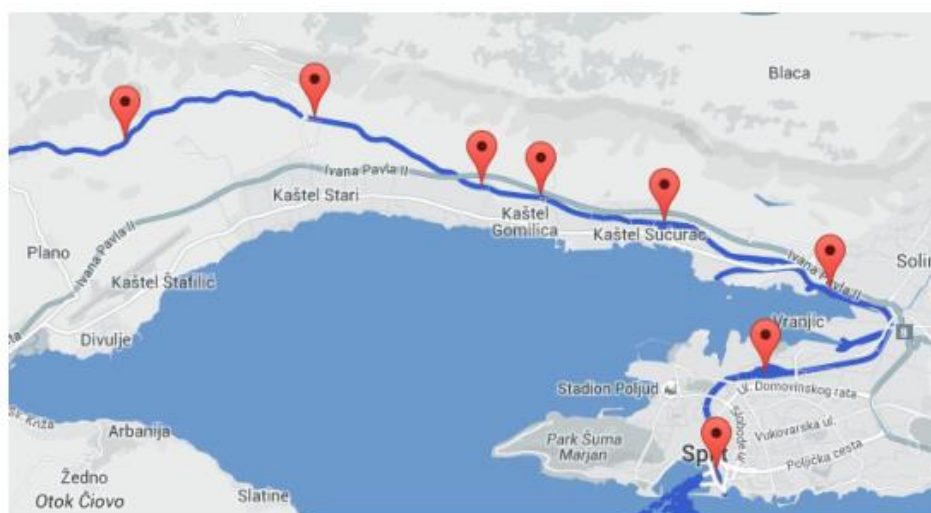
Source: [www.kastela.hr](http://www.kastela.hr)

Figure 5 Road infrastructure of Kaštel Kambelovac

### 3.1.3.2. 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 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.



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

Figure 6 Railway stations within the suburban railway

### 3.1.3.3. Air traffic

The Split Airport (Resnik) is located in the area of the Town of Kaštela and Trogir, and it covers an area of 95 ha, of which 75 ha is in the area of Kaštela, and 20 ha in the area of Trogir. In 2019, a new terminal was opened, and it covers an area of 3.6 ha. The Split Airport is the second largest and busiest airport in the Republic of Croatia; over three million passengers passed through it in 2019, which is an increase of 5.7%

compared to 2018 and an increase of 88.4% compared to 2014. The largest number of passengers is recorded during the summer months, especially in July and August.



Source: [www.googlemaps.com](http://www.googlemaps.com)

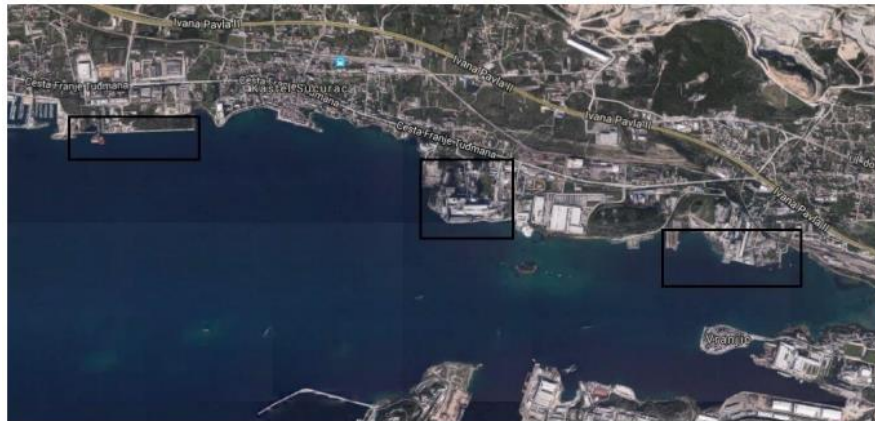
Figure 7 Satellite view of the Split Airport

#### 3.1.3.4. Maritime traffic

In the area of the Town of Kaštela, there are five ports open to public traffic, which are classified as Category III ports when it comes to their local importance. The ports are located in Kaštel Gomilica, Kaštel Kambelovac, Kaštel Lukšić, Kaštel Stari, and Kaštel Štafilić and are under the jurisdiction of the Port Authority of the Split-Dalmatia County, whose management is primarily regulated by the Maritime Domain and Seaports Act (OG 158/03, 100/04, 141/06, 38/09, 123/11, 56/16, 98/19). When it comes to freight traffic, the Kaštela Bay is divided into three port areas that are also under the integration of the Split Port Authority: Basin A (complex ex *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. The probability of pollution comes as a result of increased maritime traffic. The area of the Kaštela Bay has for decades been exposed to strong pressures of pollution due to municipal, torrent and industrial wastewater, as well as pollution due to marine traffic. The most exposed locations are along the coast, followed by other parts of the Kaštela Bay, the Trogir Bay and the Split Channel due to the fact that tidal currents spread pollution. From the point of view of the coast, significant pollution hazard is posed by sea currents from the area of Split, i.e. from the Brač Channel and partly from the direction of Trogir. It is not uncommon for large ships, but also for irresponsible boaters with small recreational boats, to illegally discharge contaminated water and wastewater from their vessels. Even though the Maritime Domain and Seaports Act (OG 158/03, 100/04, 141/06, 38/09, 123/11, 56/16, 98/19), the Ordinance on the Terms and Methods of Maintaining Order in Ports and Other Parts of Internal Waters and the Territorial Sea of the Republic of Croatia (OG 72/21), and the Ordinance on Ships, Boats and Yachts (OG 13/20, 52/20) define preconditions and methods for disposal and reception of wastewater from vessels, it is often the case that a large number of recreational boaters do not adhere to them, and often, due to the lack of infrastructure for the reception of wastewater, they end up in the sea by illegal discharge.



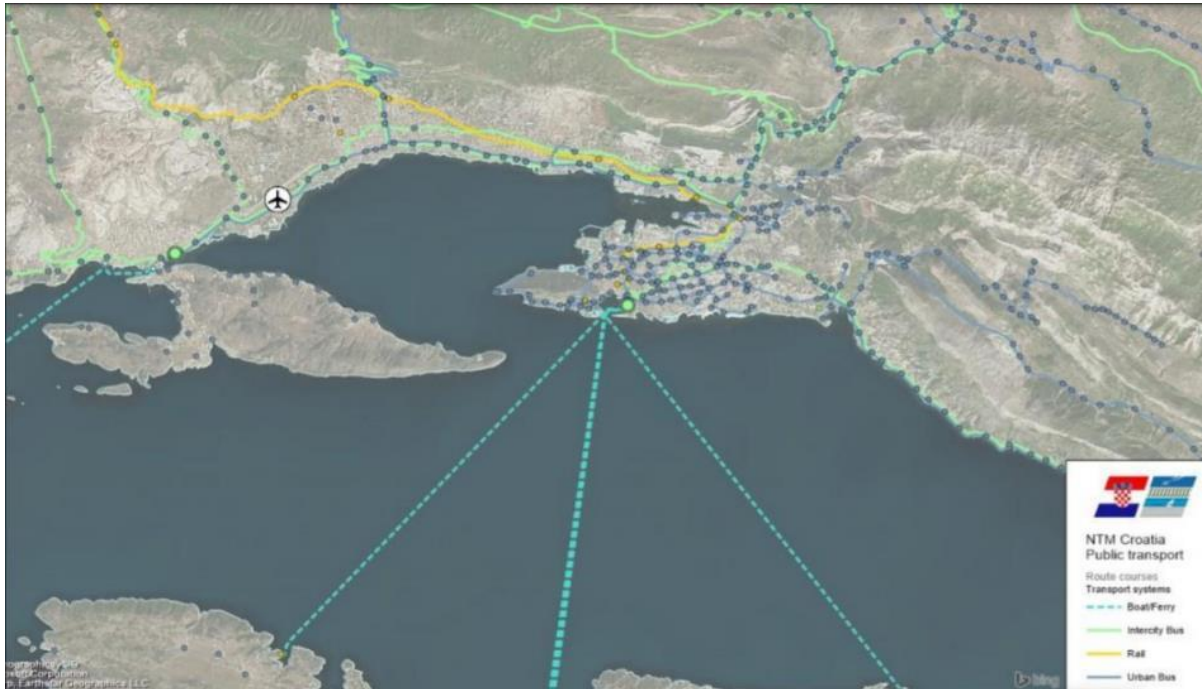


Source: Development Strategy of the Town of Kaštela 2016 – 2020

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

### 3.1.3.5. Public transport 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 9 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).

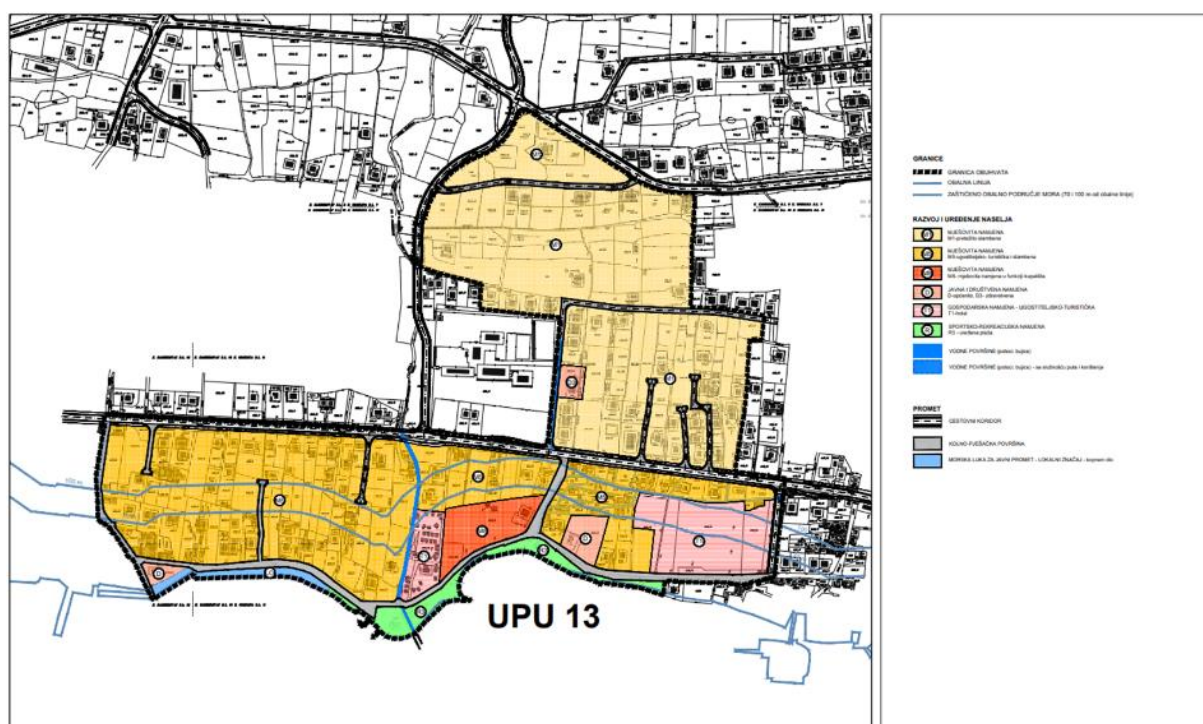
### 3.2. Social indicators

Kaštel Kambelovac covers an area of 45,000 square meters and has more than 400 buildings. It consists of a historic center (more in Chapter 3.4.3 *Cultural heritage*) with stone masonry buildings built between the 15<sup>th</sup> and 16<sup>th</sup> centuries and parts outside the historic center dating from the early 20<sup>th</sup> 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 construction method considers buildings built from 2005 onwards.

### 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, marked with the letters M and T.



Source: [www.kastela.hr](http://www.kastela.hr)

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

### 3.2.2 Buildings for residential and commercial purposes

In accordance with the Development Strategy of the Town of Kaštela 2016 – 2020, based on 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.

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.

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*). 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 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 proximity of the mainland (orientation: 1.0 NM<sup>2</sup>) is also important, where there is a port for fish farm boats or at least for boats intended for storage. 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 (2020 and 2021), it is recording continuous growth. 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. 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. 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.

According to recent data from 2019, the Split-Dalmatia County is also experiencing growth in the tourism sector each year. 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

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<sup>2</sup> An approximate distance of one nautical mile from the coast is sufficient for a timely emergency response.

total of 116,128 arrivals and 638,713 overnight stays, which accounts for a share of 3.2% of arrivals and 3.5% of overnight stays in the total number at the level of Split-Dalmatia County. 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 the data on the utilization of coastal space in the area of the Town of Kaštela.



Table 4 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
<b>Kaštel Kambelovac</b>	<b>700</b>	<b>0</b>	<b>1,440</b>
Kaštel Lukšić	770	0	730
Kaštel Stari	500	0	900
Kaštel Novi	780	0	0
Kaštel Štafilić	500	0	4,300

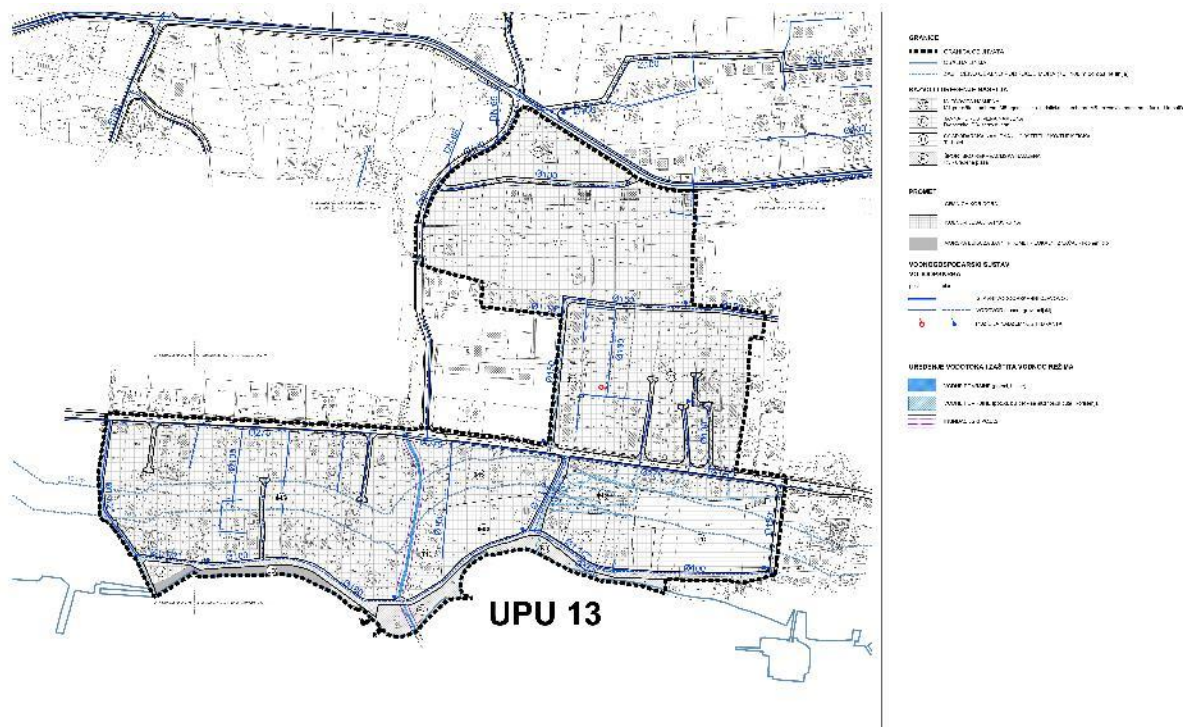
Source: Coastal Zone Management Plan of the Town of Kaštela

The 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.

### 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 m<sup>3</sup>, 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.

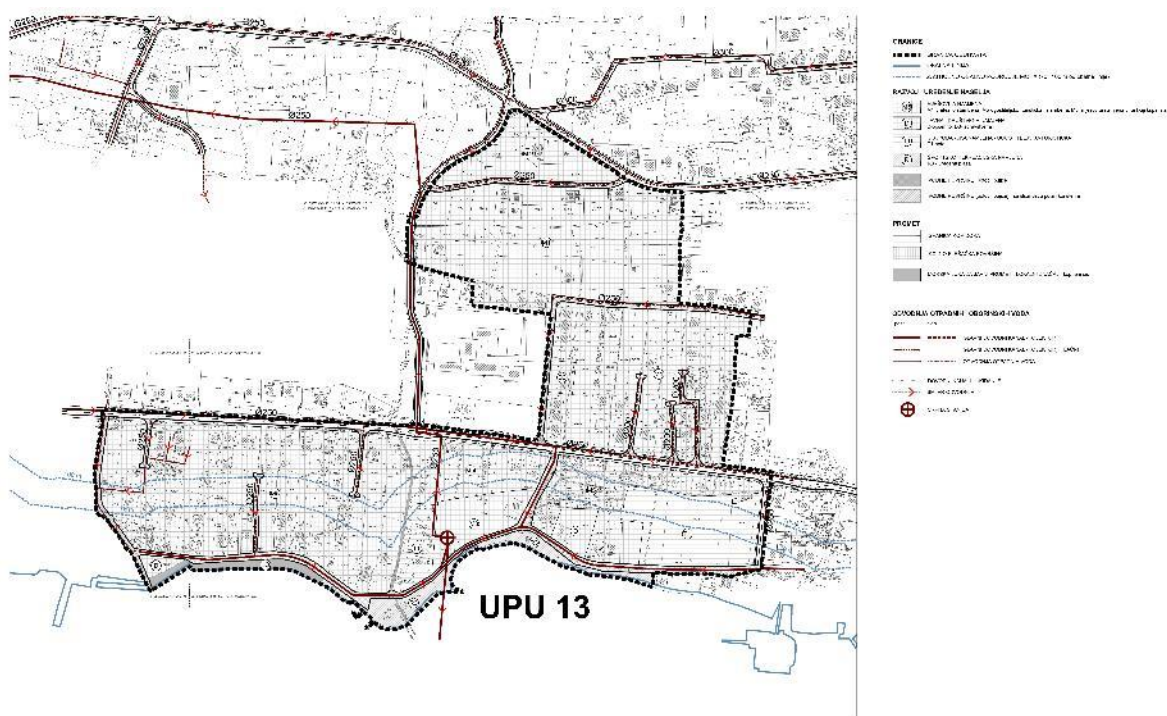


Source: [www.kastela.hr](http://www.kastela.hr)

Figure 11 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](http://www.kastela.hr)

Figure 12 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 m<sup>3</sup>), 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:

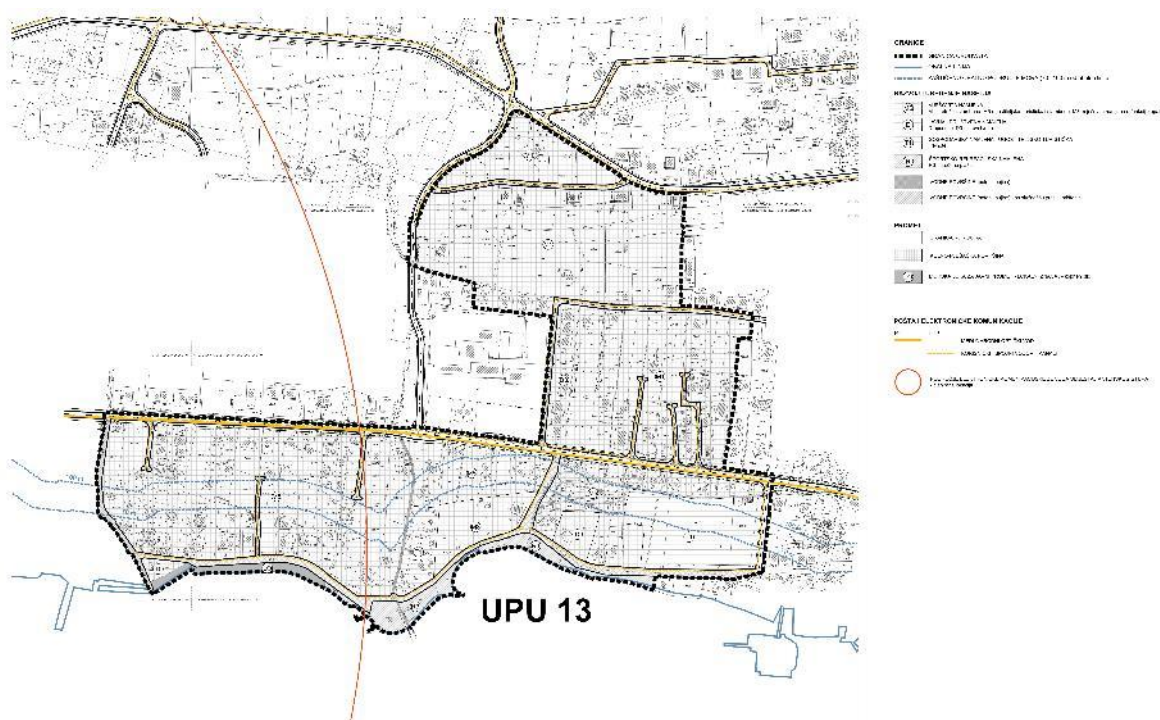
- 2\*110 kV Kaštela substation 1 – Trogir substation (route length 16.6 km, conductor Al/Č240/40mm<sup>2</sup>) built in 1983 and enables power transmission of 204 MVA.
- 2\*110 kV Kaštela substation 1 – Konjsko substation (total route length 12.5 km, conductor Al/Č240/40mm<sup>2</sup>) built in 1989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



### 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.



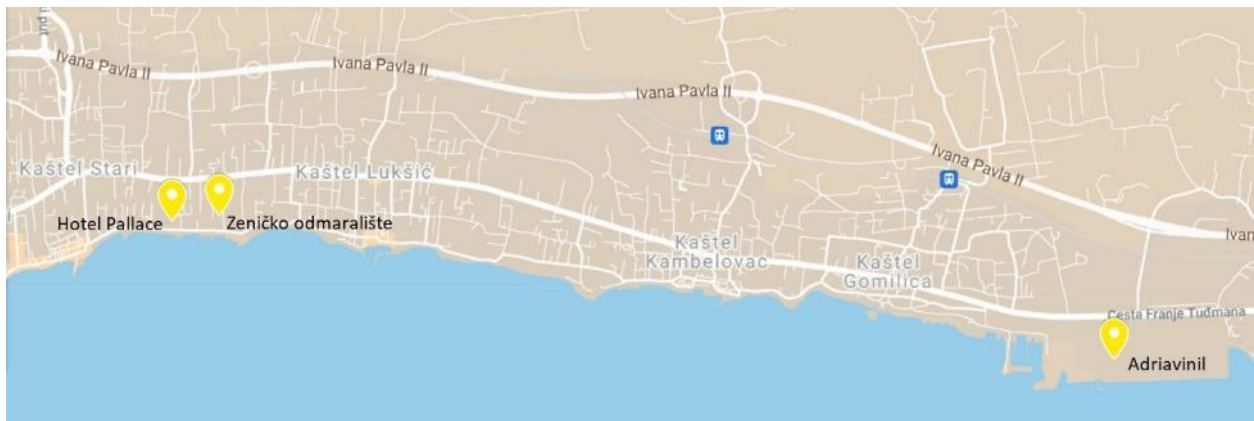
Source: [www.kastela.hr](http://www.kastela.hr)

Figure 14 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. *Brownfield* areas in Croatia are not covered by special legislation and, in the context of the development of cities and urban areas, a new purpose for

such areas within the existing urban plans and development strategies will be required. 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 m<sup>2</sup> 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](http://www.google.com/maps)

Figure 15 *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 from 2017 to 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. Pursuant to the Nature Protection Act (OG 80/13, 15/18, 14/19, 127/19), there are five protected areas in the area of the Town of Kaštela, of which three are monuments of park architecture and two are natural monuments. Monuments of park architecture are:

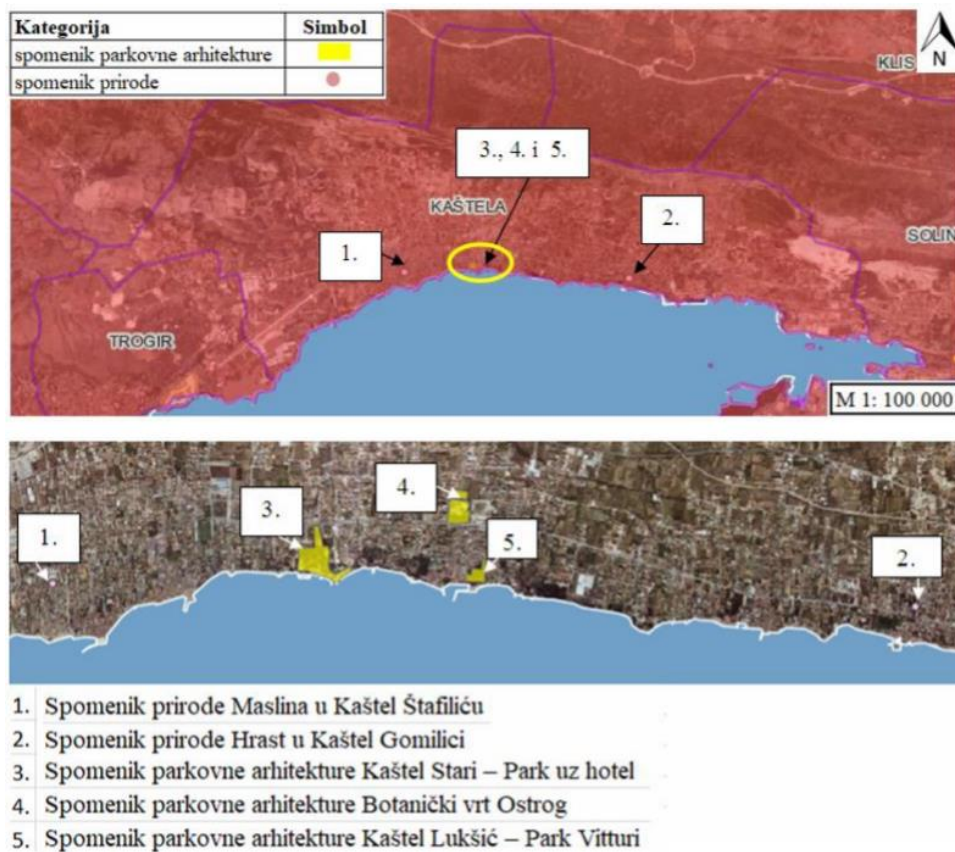
- the school botanical garden of the *Vjeko Butir* Elementary School
- the Vitturi Park in Kaštel Lukšić
- the Park in Kaštel Stari.

Natural monuments are:

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

The figure below shows the protected areas in Kaštela.





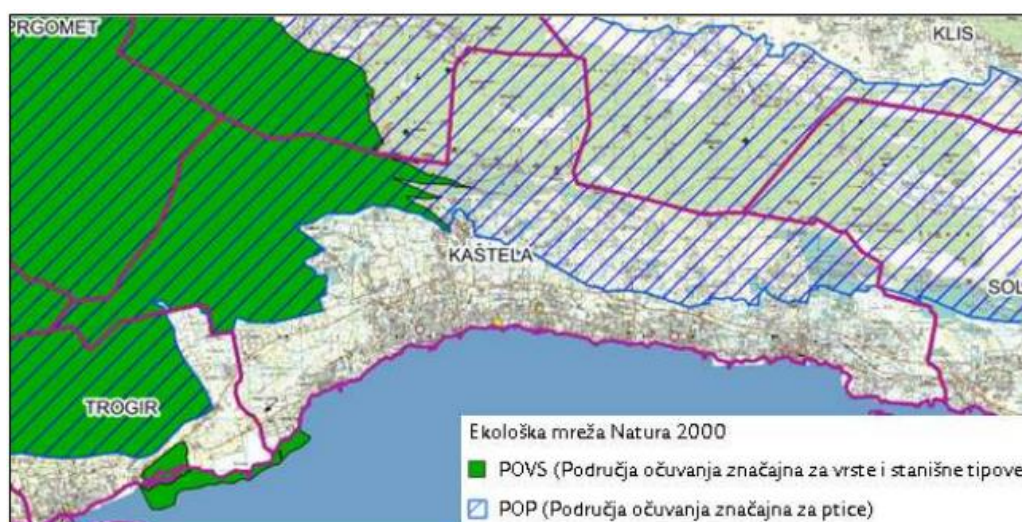
Source: Waste Management Plan of the Town of Kaštela for the period from 2018 to 2023

Figure 16 Map of protected areas

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.

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 17 Areas of the Natura 2000 Ecological Network

### 3.4.2. Biodiversity

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

predominant in the Kozjak area is characterized by colder climate, and its representatives are the European hop-hornbeam, oriental hornbeam, downy oak, and Dalmatian black pine.

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

For the context of biodiversity, in addition to the flora, it is important to note the fauna in the area of the Town of Kaštela. The fauna mostly consists 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 7<sup>th</sup> 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 15<sup>th</sup> century. In the period from the 15<sup>th</sup> to the 17<sup>th</sup> 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 5 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	<b>Church of Saints Michael and Martin, Church of St. Michael of Lažani and the tower on Krug, the Cambi tower and country villa, the Cambi family oil mill, the building of the former ballet school, Mala and Velika Piškera, Kaštel Lippeo</b>	<b>Urban complex of the Kaštel Kambelovac settlement</b>	/
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	/

Settlement	Type of cultural property – immovable cultural goods		
	Individually	Cultural and historic elements	Museum material
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, 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 15<sup>th</sup> 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 15<sup>th</sup> century by the inhabitants of the village of Kruševik, while the Lippeo Castle was built in the 16<sup>th</sup> 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 20<sup>th</sup> 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 18 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 6 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
<b>Kaštel Kambelovac</b>	<b>12</b>	<b>17</b>	<b>16</b>	<b>87</b>	<b>132</b>
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
<b>Total</b>	<b>105</b>	<b>60</b>	<b>97</b>	<b>517</b>	<b>779</b>
<b>Percentage</b>	<b>13.48%</b>	<b>7.70%</b>	<b>12.45%</b>	<b>66.37%</b>	<b>100.00%</b>

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).

### 3.5 Indicators of operational capability

According to the Civil Protection System Act (OG 82/15, 118/18, 31/20, 20/21), local self-government units and operational forces of the civil protection system are obliged to maintain and update a database on members, capabilities and resources of their operational forces, and submit the said data to the Line Ministry once a year, by March of the following year at the latest. The list of operational forces is particularly important in cases of accidents due to various causes, natural disasters and the like. 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. The description of individual operational forces in the area of the Town of Kaštela, and thus the pilot location, is provided below.

#### 3.5.1 Civil Protection Headquarters

The Civil Protection Headquarters of the Town of Kaštela consists of 12 members and represents a professional, operational and coordinating body that provides professional assistance and prepares protection and rescue actions. It is established in order to manage and coordinate the activities of operational forces and overall human and material resources of the community in cases of imminent threat, disasters and major accidents with the aim of preventing, mitigating and eliminating the consequences of disasters and major accidents in the area of the Town of Kaštela. The Headquarters is managed by the Chief of the Civil Protection Headquarters, and in case of major accidents, the role is taken over by the mayor. Also, in the area of the Town of Kaštela, the Headquarters collects and processes

early-warning information on the possibilities of major accidents and disasters and develops the civil protection system, manages the response of the civil protection system, informs the public and proposes the adoption of decisions regarding the termination of measures and activities in the civil protection system.

### 3.5.2 Operational forces of the fire brigade

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

Table 7 Operational forces of the fire brigade

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

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

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

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

### 3.5.6 Civil protection units and commissioners

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

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

Settlement	Population	Number of commissioners	Number of deputies
Kaštel Gomilica	4,881	16	16
<b>Kaštel Kambelovac</b>	<b>5,027</b>	<b>17</b>	<b>17</b>
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
<b>Total</b>	<b>38,667</b>	<b>129</b>	<b>129</b>

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 9 Minimum amount of required equipment and number of people

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

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

## 4 Analysis of the exposure of the pilot location to flood hazards caused by extremely high ocean waves

Global climate change in the world caused primarily by the accelerated development of the world economy based on fossil fuels has led to an increase in the level of greenhouse gases in the atmosphere. Its consequences are visible in the increase in air temperatures, sea levels, precipitation regimes and other negative phenomena. Sea level rise and high ocean waves are closely related to climate and climate change in recent years, and the analysis of the exposure of the pilot location to flood hazards caused by extremely high ocean waves is observed in terms of the impact of climate change on various pilot location features. Due to the impact of climate change, the average sea level will be on the rise in the future, which will potentially endanger infrastructure and the population. Following the above, the exposure analysis based on data from previously designed project deliveries seeks to identify critical points and develop flood risk management plans. Due to its specific location on a narrow coastal strip and low altitude, the entire area of the Town of Kaštela is exposed to floods. For the Kaštel Kambelovac pilot location, the spatial distribution of critical zones most exposed to the influence of extremely high ocean waves is analyzed and shown below. It shows that the entire coastal strip is in danger of flooding.



Figure 19 Spatial distribution of critical zones most exposed to extremely high ocean waves at the Kaštel Kambelovac pilot location

For certain scenarios with the influence of different winds, analyses with extensive numerical modeling were conducted in order to obtain different wave heights and areas of exposure on the coast. Analysis of exposure of buildings to risk was obtained using data on various wave risk scenarios combined with field modeling in order to obtain a risk index for extremely high ocean waves and to identify the most

vulnerable points on the coast of the pilot location. The figure below shows the risk scenario for floods caused by extremely high ocean waves.

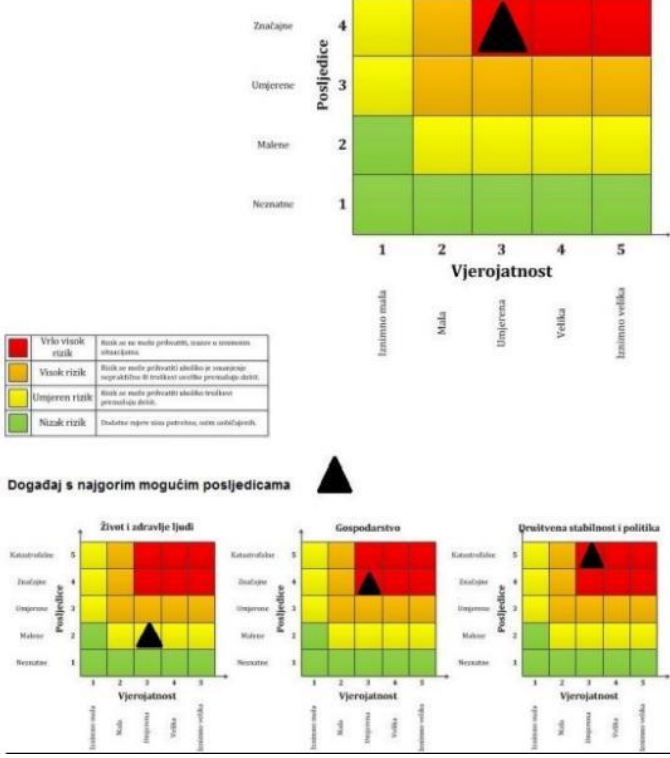
**MATRICE RIZIKA**

**RIZIK:**

Uspor

**NAZIV SCENARIJA:**

Pojava uspora na području Grada Kaštela



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

Figure 20 Risk matrix for floods caused by extremely high ocean waves

Given the fact that the formation of extremely high ocean waves is influenced by the strength, duration and wind direction, data obtained using the anemometer located on Marjan defined the most common and strongest winds that cause extremely high ocean waves in the area of the Kaštel Kambelovac pilot location.

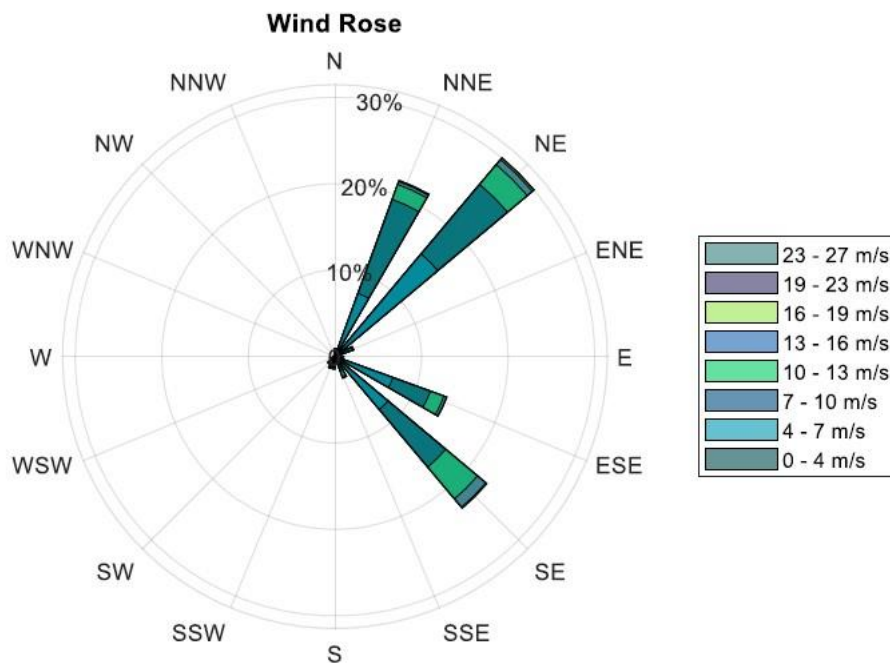


Figure 21 Wind rose for the pilot location with data collected using the anemometer on Marjan

Tidal oscillations also play an important role in the formation of extremely high ocean waves. The measuring station located at the *Institute of Oceanography and Fisheries* in Split records tidal oscillations on a regular basis, and the collected data are used to estimate the maximum heights of a tidal wave that can hit the pilot location. Also, it is possible to estimate residual tidal oscillations that did not occur due to the tide. The figure below shows the sea level oscillation obtained for the pilot location.

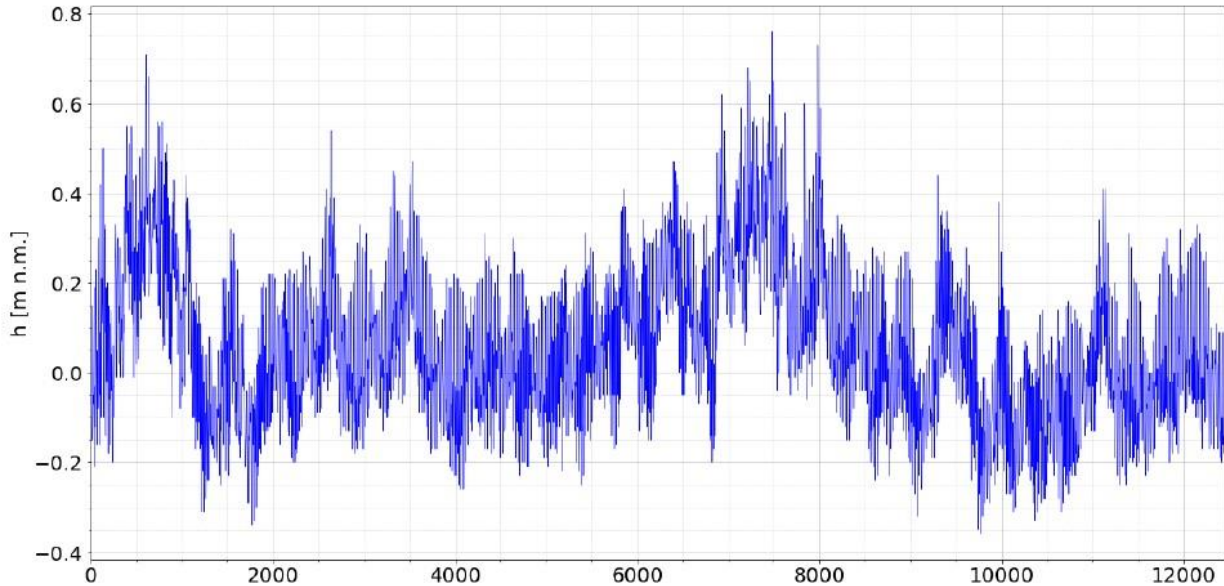


Figure 22 Sea level oscillations measured at the Institute of Oceanography and Fisheries in Split

#### 4.1. Analysis of possible consequences of extremely high ocean waves

##### 4.1.1. Coast and coastal infrastructure

The highest probability of coastal flooding in the area of the Kaštela Bay is during late autumn and early winter. When we take into consideration the strong southeast wind and the waves it causes, there is a high probability of endangerment of the coastal infrastructure in the area of the Town of Kaštela. Due to the fact that splashing of the waves can reach several meters in height, lower parts of the promenades and the coast are frequently flooded. Extremely high ocean waves make the intensity of the flood even more pronounced, therefore the sea level rises and sinks the coastal infrastructure and the urban area, which calls for additional measures in order to protect endangered areas. The exposure of infrastructure of risk areas is analyzed by risk assessments showing the impact of floods in quantified form. Based on the obtained data it is possible to define the most endangered areas and determine defense and protection measures. The figure below shows the exposure by zones in the area of Kaštel Kambelovac.



Source: Coastal Zone Management Plan of the Town of Kaštela

Figure 23. Cartographic representation of coastal flood threat zones

According to the *Coastal Zone Management Plan of the Town of Kaštela*, three zones of threats from coastal flooding have been identified:

- Zone 1 – includes areas up to 1 m above sea level (red, Figure 23)
- Zone 2 – includes areas from 1 to 2 m above sea level (orange, Figure 23)
- Zone 3 – includes areas from 2 to 3 m above sea level (yellow, Figure 23)

Zone 1 includes 28 ha of areas already exposed to coastal floods. The distribution and areas of zones 1, 2, and 3 in the area of Kaštel Kambelovac are shown in the table below.

Table 10 Flood zones in the area of the pilot location in Kaštel Kambelovac

Flood zone (area in ha)	Zone 1 (0 – 1 m above sea level)	Zone 2 (1 – 2 m above sea level)	Zone 3 (2 – 3 m above sea level)	Total (ha)
Kaštel Kambelovac	3.79	4.30	3.99	12.09

Source: Coastal Zone Management Plan of the Town of Kaštela

Flooding and splashing of the waves also cause coastal erosion, which can cause its damage and collapse after prolonged exposure to the influence of the waves. Naturally, similar effects, depending on the



quality of construction, can be expected in other coastal facilities, especially in those in the strict centers of some settlements of the Town of Kaštela that were built a hundred or more years ago, and which have therefore not been adapted to sea level rise in the past, which is visible due to the type of construction material and construction techniques that were used. Therefore, they must be further reinforced and protected from the coastal erosion, which includes regular monitoring of the state of the coast and timely decision concerning the remediation in case of damages. The figure below shows the vulnerability categories of buildings in the historic center with regards to floods caused by extremely high ocean waves at the pilot location.



Figure 24 Vulnerability categories of buildings in the historic center with regards to floods caused by extremely high ocean waves at the Kaštel Kambelovac pilot location

In addition to the built areas, the beaches in the area of the Town are constantly endangered by the coastal erosion, therefore it is necessary to put in place appropriate protection of the beaches. Also, due to the action of the strong south wind, there is a possibility of a tidal wave. Its consequences, which, in terms of coastal flooding, can cause damage by flooding the basements of buildings along the coast, also cause damage to boats and pollute the coast. According to the *Action Plan in the field of natural disasters for 2020 of the Town of Kaštela*, it is recommended that during the construction and reconstruction of local operational shores, the edge of the shore be raised by a fence wall which would be at least 60 cm high.

#### 4.1.2. Transport infrastructure

The roads are located very close to the coast, especially within the settlements, and in some places they pass through the coast. Also, road D8 (Adriatic Highway), the Dr. Franjo Tuđman road (the Old Kaštela Road) and the railway are located within 2 km from the coast, and the Split Airport has access to the sea. Therefore, due to the position of roads which are in the immediate vicinity of flood zones, unfavorable weather conditions and extremely high ocean waves can cause short-term traffic jams (short-term floods due to waves) or long-term traffic jams (deterioration of transport infrastructure due to splashing of the waves).

#### 4.1.3. Water and municipal infrastructure

Climate change will significantly affect the increased air temperature during the summer period, which also causes a decrease in the amount of precipitation. Therefore, the reduced amount of rainwater will negatively affect the availability of drinking water in the summer months when the pressure on the public water supply is the most intense, which will increase the frequency of water reductions. Also, given the existing level of construction of the area, unplanned construction, and the capacity and poor condition of existing rainwater drainage systems, there is a risk of frequent torrential floods. When extremely high ocean waves occur, there is a possibility of coastal floods, which can also cause flooding of coastal water infrastructure. Floods caused by extremely high ocean waves will prevent the discharge of wastewater and lead to sewage spills on the surface, which will consequently affect not only the infrastructure, but the health of the population as well.

#### 4.1.4. Fishing and mariculture infrastructure

The occurrence of extremely high ocean waves, as stated above, can cause damage to the coast and coastal infrastructure, which includes fishing ports as well. Also, they can cause damage to the boats and consequently lead to pollution of the coast and sea. Apart from the vessels, extremely high ocean waves are also not suitable for mariculture infrastructure, which primarily refers to fish and shellfish farms. Due to the strong impact of ocean waves, damage on the infrastructure can pose a significant danger to workers.

#### 4.1.5. Energy and telecommunications infrastructure

According to the analysis of the situation, the energy infrastructure includes power lines and transformer stations in the area of Kaštel Kambelovac, which are located relatively close to the coastline. On the other hand, the analysis of the telecommunications infrastructure indicates that the entire area of Kaštela is covered by broadband Internet access, and the international fiber optic guide, user lines, interconnectors, and channels are also located near the coast. Telecommunication infrastructure is located underground, and it is well known that such infrastructure is also laid below sea level. The energy infrastructure can be laid below sea level as well, so that the islands are supplied with electricity and telecommunications. However, 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 caused by extremely high ocean waves, especially transformer stations, user lines, interconnectors, and cables on facilities located near the coast and at low altitudes. In such cases, waves can cause short circuits, electricity shortage and Internet access interruptions if the infrastructure is not insulated and resistant to water, salinity and corrosion.

#### 4.1.6. Buildings

The Town of Kaštela is located on the coast, which is highly urbanized. In the narrow coastal zone there are buildings for private (residential) and public purposes (schools, health care institutions, social welfare institutions), as well as business buildings and facilities. Due to the effects of climate change in the future and rising of sea levels, floods and destruction of all types of buildings are possible as a consequence. Even now parts of the facilities right by the sea are damaged by the action of splashes of waves, which, depending on the quality of construction, may collapse. Also, due to the increase in the frequency of extremely high ocean waves and the resulting floods, as well as due to the possibility of urbanization that will not take into account the proper capacity of drainage of (sea) water, the vulnerability of buildings in the Town of Kaštela is likely to increase in the future. Therefore, it is important that drainage systems are provided with sufficient capacities in future reconstructions and planning of construction of residential and commercial buildings, as well as with the implementation of solutions for protection from extremely high ocean waves, as well as floods that occur as a consequence.

#### 4.1.7. Cultural heritage

The cultural heritage of the Town of Kaštela is mostly present in the narrow coastal zone and it is thus exposed to the ocean waves. This particularly applies to parts with critical infrastructure: 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. The richness of the cultural heritage of the Town of Kaštela is precisely the age difference between the buildings, the method of construction, and the use of various materials in their construction. The oldest buildings were built in the 15<sup>th</sup> century. Inside the historic center of the pilot location is the Cambi Tower from the 16<sup>th</sup> century, as well as the Church of Saints Michael and Martin from the 19<sup>th</sup> century. Given the location, they are subject to the foundation erosion like all other coastal structures, which may ultimately endanger their stability. With the occurrence of extremely high ocean waves, it is possible to multiply the threat to stability, therefore it is necessary to take appropriate measures in order to protect these facilities. The figure below shows a map of the Kaštel Kambelovac pilot location with the endangered area of the historic center.

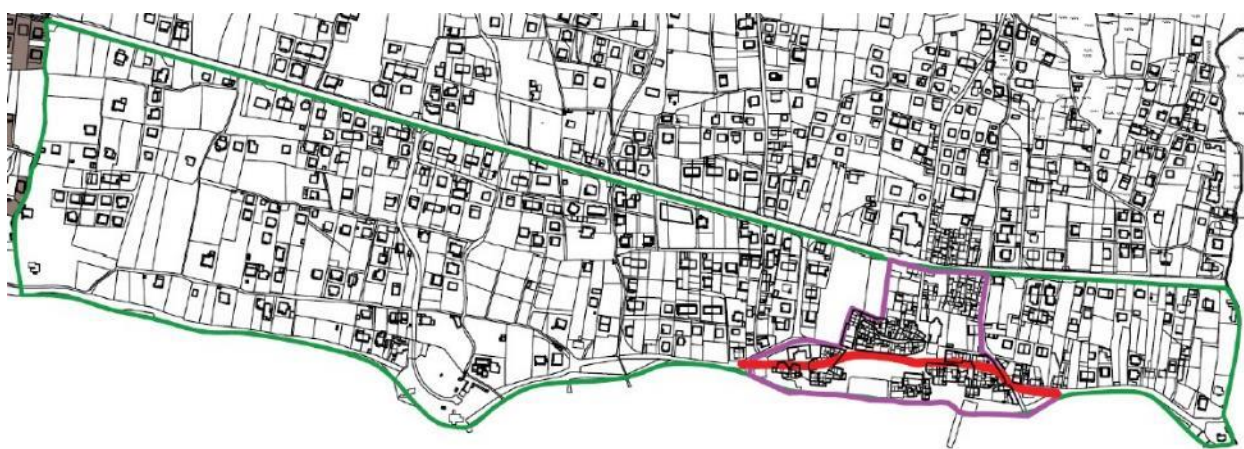


Figure 25 Planning view of the pilot location in Kaštel Kambelovac (green line) with the line of the natural coastline (red line) and the historic center (purple line)

#### 4.1.8. 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). Climate change will lead to changes in the system of plant and animal

species. Organisms more resistant to high temperatures and prolonged drought periods will be more resistant than those sensitive to changes in environmental parameters. This will also affect the cultivation of certain plant cultures. The influence of extremely high ocean waves can lead to flooding of the part of the ecological network that is located along the coast. When it comes to the protected areas in the area of Kaštela, extremely high ocean waves can cause flooding and their destruction. Prevention of such events can be achieved by taking the necessary measures in order to protect against such extreme events.

#### 4.1.9. Agricultural areas

With the rapid urbanization of the area of Kaštela, most of the agricultural land and the former Kaštela field has been transformed from an agrarian to a residential zone. Part of the agricultural land left in the coastal strip refers mostly to small areas and is mostly privately owned. The influence of extremely high ocean waves can lead to coastal floods, and consequently to the destruction of agricultural land and its crops, which are located in flood zones.

#### 4.1.10. 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 extremely high ocean waves. 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. Extremely high ocean waves 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 extremely high ocean waves 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 floods (or extremely high ocean waves) cause release of residual substances and substances dangerous for the environment into the sea or soil.

#### 4.1.11. Population and visitors

Due to the said issues with unplanned construction, insufficiently developed infrastructure that is not suitable for quality protection from extremely high ocean waves, as well as insufficiently developed

communication network between operational services that are active during disasters, the population and visitors of the Town of Kaštela are significantly endangered by extremely high ocean waves. Also, during disasters caused by the risks that extremely high ocean waves pose, 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 extremely high ocean waves 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 management of the risks of floods caused by extremely high ocean waves took into consideration the current situation, legislation and the existing planning and strategic management framework of various indicators in the Town of Kaštela or the Kaštel Kambelovac pilot location, where available. The analysis of the exposure of the pilot location observes the impact of possible hazards caused by extremely high ocean waves, as well as floods that occur as a result, on various features of the area. In this regard, the occurrence of extremely high ocean waves has been identified as a consequence of future climate change. Both analyses identified key issues in management of floods caused by extremely high ocean waves, as well as management of the state of infrastructure summarized below:

- 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
- concentration of economic infrastructure in the coastal strip
- coastal erosion, damage to coastal infrastructure and beaches caused by ocean waves
- unsatisfactory level of construction of infrastructure for protection against extremely high ocean waves
- 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
- unsatisfactory roads and road infrastructure within the settlements
- deagrarization of the Kaštela field as a consequence of urbanization and lack of adequate protection from maritime impact
- 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 climate change.

Analyses of the situation have shown that the area of Kaštel Kambelovac, i.e. the Town of Kaštela as a whole, is a high-risk area sensitive to climate change and natural hazards such as extremely high ocean waves and floods that may occur as a consequence. This is due to the development of the town in a narrow coastal area, as well as systematic illegal construction, unplanned expansion of urban areas without adequate infrastructure, and continuous embankment of the coast which endangers natural habitats, cultural heritage and biodiversity. Therefore, there is a need to develop a systematic and sustainable management model for the area of the Town of Kaštela, especially when it comes to exposure to natural hazards caused the action of extremely high ocean waves.

## 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 previous analyses of the situation and the identified key issues. They are based on an integrated approach to managing the risk of floods caused by extremely high ocean waves considering the forms of infrastructure management and operational capabilities. Therefore, the vision is as follows:

***Kaštel Kambelovac is an area of enhanced resistance to the risks of floods caused by extremely high ocean waves, 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 and geomorphological 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 a high risk of floods caused by extremely high ocean waves. 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 floods caused by extremely high ocean waves. Due to the configuration of the field and the lack of spatial planning in the event of disasters caused by extremely high ocean waves, human lives are significantly endangered. Extremely high ocean waves cause damage to transport, water and municipal, electricity and telecommunications infrastructure, which makes crisis situations even more challenging. It follows from the above that the first goal is to create a framework for effective infrastructure management and spatial planning.



## 2. Improvement of risk management systems

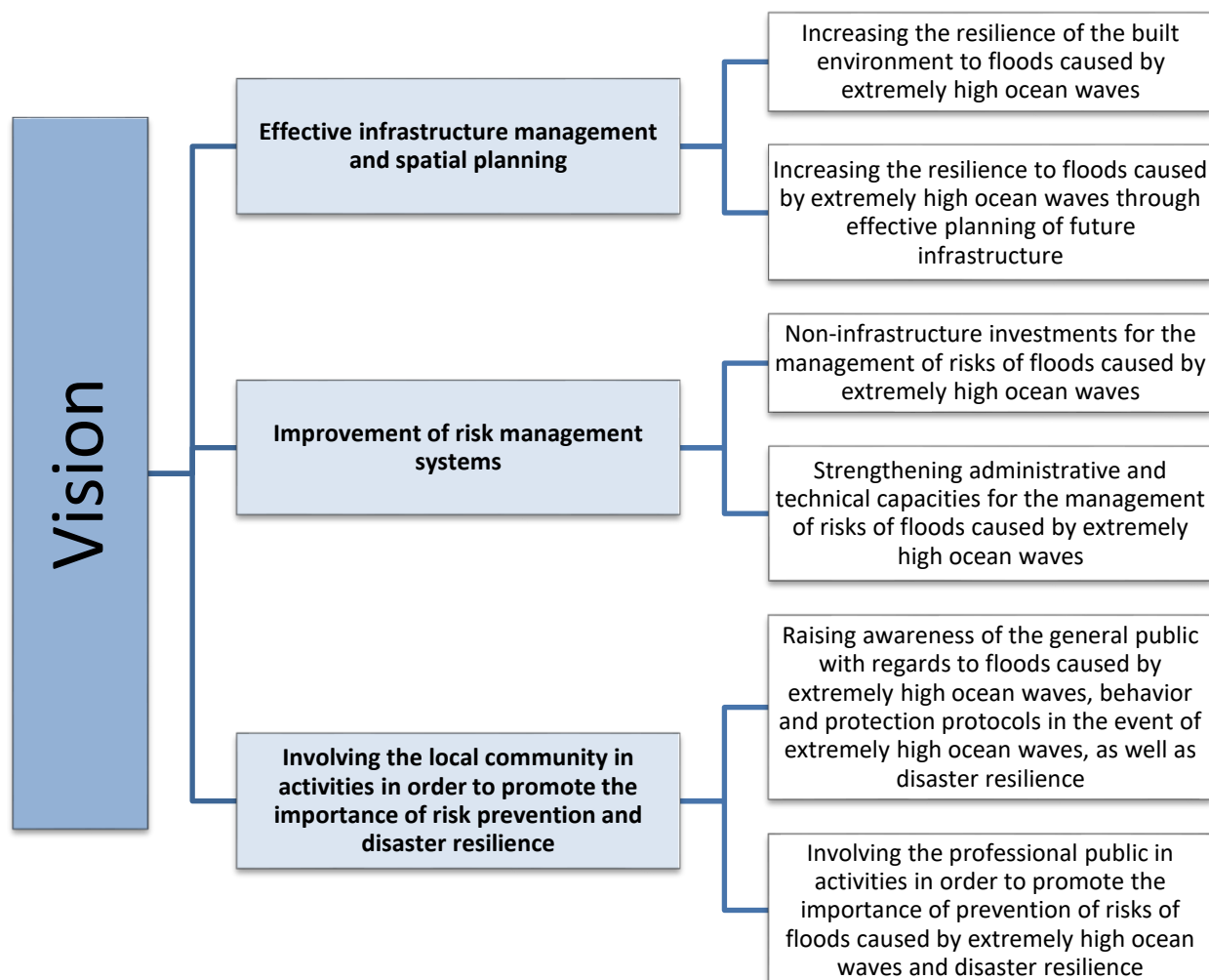
The risk management system in the Town of Kaštela is flawed and underdeveloped, and given the fact that this is a high-risk area sensitive to hazards caused by natural disasters, it is evident that the implementation of a quality and timely management system is necessary. The *Action Plan in the field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

Comprehensive defense and protection of the population from floods caused by extremely high ocean waves 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 floods caused by extremely high ocean waves. 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 risks of floods caused by extremely high ocean waves 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.



<b>Goal 1:</b>	<b>Effective infrastructure management and spatial planning</b>
<b>Measure 1.1:</b>	<b>Increasing the resilience of the built environment to floods caused by extremely high ocean waves</b>
<b>Description:</b>	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. Among other things, it is exposed to floods caused by extremely high ocean waves. 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 collapse under the influence of extremely high ocean waves, 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 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 floods caused by extremely high ocean waves 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 coastal flood threat zones, with an emphasis on zones with a high category of vulnerability.
<b>Time frame:</b>	2030
<b>Area:</b>	Kaštel Kambelovac
<b>Project developers:</b>	Town of Kaštela
<b>Stakeholders involved:</b>	Split-Dalmatia County
<b>Activities:</b>	<p>1.1.1. Investments in adaptation and increase of resilience of critical infrastructure with regards to the coastal flood 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 buildings for public and social purposes to floods caused by extremely high ocean waves and mitigating their effects</p> <p>1.1.3. Infrastructure operations on buildings along the coast aimed at reducing the risk of floods caused by extremely high ocean waves (strengthening of the structure, construction of groins, breakwaters, wave breakers, remediation of jeopardized buildings)</p>

<b>Goal 1:</b>	<b>Effective infrastructure management and spatial planning</b>
<b>Measure 1.2:</b>	<b>Increasing the resilience to floods caused by extremely high ocean waves through effective planning of future infrastructure</b>
<b>Description:</b>	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 is effective infrastructure management and spatial planning in order to increase resilience to floods caused by extremely high ocean waves. The dynamics and priorities of the

<b>Goal 1:</b>	<b>Effective infrastructure management and spatial planning</b>
<b>Measure 1.2:</b>	<b>Increasing the resilience to floods caused by extremely high ocean waves through effective planning of future infrastructure</b>
	implementation of individual activities should take into account the coastal flood threat zones, with an emphasis on zones with a high category of vulnerability.
<b>Time frame:</b>	2030
<b>Area:</b>	Kaštel Kambelovac
<b>Project developers:</b>	Town of Kaštela
<b>Stakeholders involved:</b>	Split-Dalmatia County, Vodovod i kanalizacija d.o.o., Hrvatska elektroprivreda d.d., Hrvatski Telekom d.d.
<b>Activities:</b>	<p>1.2.1. Investments in adapting and increasing the resilience of the new water and municipal, electricity, telecommunications, and transport infrastructure with regards to the risks of floods caused by extremely high ocean waves</p> <p>1.2.2. Spatial planning of alternative traffic routes with regards to coastal flood zones</p>

<b>Goal 2:</b>	<b>Improvement of risk management systems</b>
<b>Measure 2.1:</b>	<b>Non-infrastructure investments for the management of risks of floods caused by extremely high ocean waves</b>
<b>Description:</b>	The pilot location in Kaštel Kambelovac is an area located on a narrow coastal strip that is densely populated and at high risk of 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, 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 risk management system of floods caused by extremely high ocean waves.
<b>Time frame:</b>	2030
<b>Area:</b>	Kaštel Kambelovac
<b>Project developers:</b>	Town of Kaštela
<b>Stakeholders involved:</b>	Split-Dalmatia County
<b>Activities:</b>	<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>

<b>Goal 2:</b>	<b>Improvement of risk management systems</b>
<b>Measure 2.2:</b>	<b>Strengthening administrative and technical capacities for the management of risks of floods caused by extremely high ocean waves</b>
<b>Description:</b>	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 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 adaptation of infrastructure to the risks of floods caused by extremely high ocean waves. Therefore, it is imperative to strengthen the capacity of decision-makers with regards to the hazards caused by natural disasters in the form of various educations and to encourage the integration of adaptation measures into the necessary documentation. Additionally, it is important to ensure the technical preparedness of operational forces in order for them to respond in a timely manner, as well as the appropriate level of human resources.
<b>Time frame:</b>	2030
<b>Area:</b>	Kaštel Kambelovac
<b>Project developers:</b>	Town of Kaštela
<b>Stakeholders involved:</b>	Split-Dalmatia County, operational forces in the civil protection system, Ministry of the Interior
<b>Activities:</b>	<p>2.2.1. Integration of adaptation measures to risks of floods caused by extremely high ocean waves in the spatial planning documentation (remediation and/or reconstruction of critical infrastructure, planning according to zones of exposure to the influence of extremely high ocean waves etc.)</p> <p>2.2.2. Organization of trainings to strengthen the capacity of decision-makers with regards to the dangers of floods caused by extremely high ocean waves and ways to mitigate their consequences</p> <p>2.2.3. Development of rescue and evacuation plans with regards to the coastal flood zones</p> <p>2.2.4. Improvement of the training system for operational forces and frequent emergency rescue drills</p> <p>2.2.5. Performance of regular checks on the correctness of technical equipment of operational forces</p>

<b>Goal 3:</b>	<b>Involving the local community in activities in order to promote the importance of risk prevention and disaster resilience</b>
<b>Measure 3.1:</b>	<b>Raising awareness of the general public with regards to floods caused by extremely high ocean waves, behavior and protection protocols in such events, as well as disaster resilience</b>
<b>Description:</b>	Floods caused by extremely high ocean waves occur mainly due to extremely strong winds combined with unfavorable weather conditions. Even though the weather is relatively predictable and some scenarios can be predicted, it is extremely important to work 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 floods, the formation of extremely high ocean waves, as well as possible consequences they may bring. By raising awareness, the general public is involved in activities to promote the importance of risk prevention and disaster resilience, thus creating the preconditions for efficient spending of resources and a sustainable society.
<b>Time frame:</b>	2030
<b>Area:</b>	Kaštel Kambelovac
<b>Project developers:</b>	Town of Kaštela, University of Split
<b>Stakeholders involved:</b>	General public
<b>Activities:</b>	<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 management of risks of floods caused by extremely high ocean waves 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 the event of floods caused by extremely high ocean waves 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>

<b>Goal 3:</b>	<b>Involving the local community in activities in order to promote the importance of risk prevention and disaster resilience</b>
<b>Measure 3.2:</b>	<b>Involving the professional public in activities in order to promote the importance of prevention of risks of floods caused by extremely high ocean waves and disaster resilience</b>
<b>Description:</b>	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 the risk of floods caused by extremely high ocean waves and disaster resilience, and especially the professional public, are basic prerequisites for increasing protection and resilience of various areas and their inhabitants.
<b>Time frame:</b>	2030
<b>Area:</b>	Kaštel Kambelovac
<b>Project developers:</b>	Town of Kaštela, University of Split
<b>Stakeholders involved:</b>	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
<b>Activities:</b>	<p>3.2.1. Organization of scientific conferences in cooperation with the academic community</p> <p>3.2.2. Implementation of activities in order to improve the system of prediction and monitoring of floods caused by extremely high ocean waves based on the input of experts in the field</p> <p>3.2.3. Implementation of applied research activities in cooperation with public administration and scientific organizations</p> <p>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</p>