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3.2.6 Definition or proposal of actions to be carried out to integrate local and EC directives on flood risk management plans

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SVEUČILIŠTE U SPLITU
FAKULTET GRAĐEVINARSTVA, ARHITEKTURE I GEODEZIJE

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Summary

1. Introduction

1.1. Brief presentation of Activity 3.2

Activity 3.2 within Work Package 3 of PMO-GATE project relates to the assessment of flooding in coastal urban areas due to extreme waves exposure. Significant number of objects along the coastline are potentially exposed to flooding due to the impact of extreme waves on the sea surface generated by severe winds. Within this activity, an extreme waves flooding exposure analysis is performed for the particular test site of Kaštel Kambelovac. Furthermore, this activity addresses the main weak points potentially exposed to extreme waves flooding, which in combination with extreme waves exposure maps are used for flood risk assessment on the particular test site. In addition, existing flood risk management plans are evaluated along with the relevant EU legislation. Finally, a set of actions is defined in order to harmonize local flood risk management plans with EU requirements.

1.2. Test site – Kaštel Kambelovac

Along the Croatian coast, flooding endangers many low-lying coastal areas potentially exposing significant number of objects to flood hazard. Many historical buildings and/or areas are located along the coastline, which are potentially endangered by coastal flooding as well and subject to significant consequences and damage. The City of Kaštela area is endangered by sea flooding due to its low-lying topography and significant number of cultural and household objects located near the coastline. The particular test site in PMO-GATE project is Kaštel Kambelovac, one of the seven settlements that form the City of Kaštela. This area covers around 45000 square meters and includes more than 400 objects.

The benefit of the chosen area reflects through diversity of objects considering construction, architecture and material, built from the 15th century until today. According to Marasović [1] the oldest objects in the area date back to 1467. These buildings were made of stone with a wooden floor construction, and they remained preserved until today with minor modifications over the years. Historical part of the Kaštel Kambelovac is founded in the 16th century around the Tower of Cambi, as well as the church of St. Mihovil and Martin from the 19th century with a bell tower from 1860. This particular area is a mixture of private and public facilities, mostly built as masonry and concrete buildings. Plan view of the selected area is shown in Figure 1, where the green line defines the border of the test site, purple one defines the border of historical part, while the red line shows position of the natural coastline.

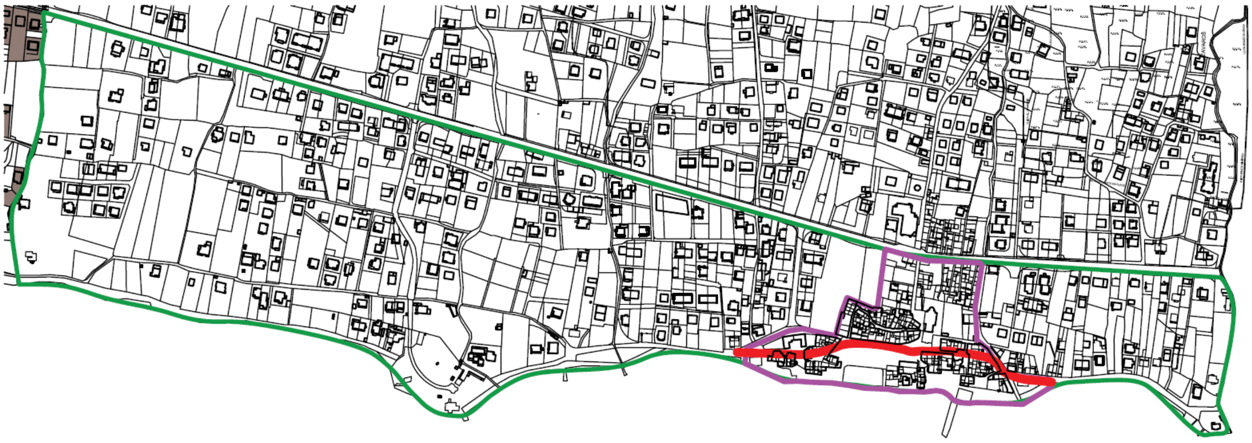

Figure 1. Plan view of the selected area (green line) with the mark of the natural coastline (red line) and the historical part (purple line)

Coastal flooding is considered one of the major threats for coastal urban areas. This is especially related to low-lying coastal areas such as City of Kaštela, where significant part of the city is located near the coastline. High population density in the coastal area of City of Kaštela, together with a large number of buildings and other assets makes this area highly vulnerable. Coastal flooding in the City of Kaštela is becoming more frequent and recent events caused damage to different assets, exposing the weak points within buildings and existing infrastructure.

2. Actions for integration of local and EC directives on flood risk management plans

Integration of local and EC directives on flood risk management plans considers fulfilment of EU requirements provided by Floods Directive [2] on a local scale. First of all, it considers the preliminary flood risk assessment procedure where available data and previous analyses are collected and analyzed. In the next step flood hazard and flood risk maps are developed for different scenarios associated with probability of occurrence. Based on the flood risk assessment results, a set of objectives and associated measures is developed for mitigation of adverse consequences. Finally, implementation of flood risk management plan considers administrative steps such as involvement of different stakeholders, public participation as well as strategic environmental impact assessment.

2.1. Conclusions of the preliminary flood risk assessment

According to Floods Directive, the first step in its implementation is to perform a preliminary flood risk assessment. The preparation of this step can be based on different available documents, which are related to analyses conducted earlier. The goal of preliminary flood risk assessment is to identify flood-prone areas and to collect all available data related to flooding. Considering the Kaštel Kambelovac test site, analyses conducted within different official documents listed in the Deliverable 3.1.5 [3], have shown that this particular area is prone to flooding. This can serve as a solid basis for further steps in implementation of Floods Directive. Preliminary analyses demonstrated that Kaštel Kambelovac area could be exposed to coastal flooding and associated risks. However, approaches presented in available documents used for flood risk assessment are significantly different. Hence, the primarily step is to establish a harmonized approach for flood hazard and risk assessment for further application.

2.2. Flood hazard and flood risk maps

In order to fulfil Floods Directive requirements, Member States are obliged to prepare flood hazard maps, covering the area which could be flooded and considering, at least three scenarios associated with the probability of occurrence:

- floods with a low probability, or extreme event scenarios;
- floods with a medium probability (likely return period ≥ 100 years);
- floods with a high probability, where appropriate.

Although according to Floods Directive for coastal areas where an adequate level of protection is in place states that the preparation of flood hazard maps shall be limited to the flooding scenario with a low probability or extreme events, for Kaštel Kambelovac area there is no adequate level of protection implying that three scenarios are required. Coastal flooding is caused by a combination of different natural events; high tide, atmospheric pressure drop and sea surface waves, which causes sea level to rise and overtop the coastal infrastructure flooding the urban area. The total sea level is equal to:

$$h_{sea} = h_{mean} + h_{tide} + h_{res} + h_{wind}$$

Mean sea level, marked as h_{mean} is related to sea level with a certain elevation above which high tide rises along with other effects. Mean sea level serves as a referent level for estimation of sea level oscillations. Tidal component, marked as h_{tide} is related to tidal oscillation, h_{res} is related to residual sea level coming mostly from atmospheric pressure variations, and h_{wind} is related to sea level component coming from sea waves occurrences. Considering Floods Directive requirements with different probability of occurrence scenarios, wind is considered as a stochastic variable which can be described with a probability distribution. From the distribution, different wind scenarios (different return periods) can be extracted and transferred into a deep-sea wave. The deep-sea wave is transferred into the shallow sea wave by applying numerical models, which calculate the wave transformation in front of the coastline. Tidal component is described as a periodic function consisted of tidal constituents, and maximum tide should be estimated for use in the flood exposure scenarios, while the residual sea level in this case can be selected as the maximum recorded.

Data collection considering coastal flooding analysis for Kaštel Kambelovac is primarily related to relevant historical sea level oscillations data from the tidal gauge station, which is located on the Marjan peninsula in the City of Split (Figure 2). Data about wind velocity and directions is usually collected on a hourly scale, based on wind frequency and velocity contingency can be estimated. This data can be used for estimation of relevant sea level used for flood hazard analysis. In order to perform the flood hazard analysis, a digital terrain model is required to estimated water depth at each part of the pilot site for different flooding events.

Considering the flood risk assessment maps, for Kaštel Kambelovac test site main assets are located near the coastline and they are related to different household, public and historical buildings. Based on the flood hazard maps it can be determined which objects are exposed to flooding. For these objects a vulnerability assessment should be performed, in order to estimate the potential damage. Vulnerability assessment is performed based on two general elements; the level of exposure (1), considering the flood reach; and sensitivity (2), which considers the particular characteristics of each object such as building material, age, number of floors as well as overall building condition. Once the analysis is completed, the results need to be presented on a flood risk map showing the spatial distribution of flood risk on a particular test site. Given the flood risk assessment results, further steps in development of flood risk management plans can be performed.

Figure 2. Location of tide gauge and anemometer station

2.3. Development of objectives and measures in flood risk management plan

Flood risk management plan considers a range of measures within different stages of risk management cycle, which are developed in accordance with flood risk assessment results. The selection of measures must be performed by involving all relevant stakeholders; experts, decision-makers, government, civil protection and spatial planners. In order to define appropriate measures, one must develop a set of objectives that must be fulfilled during implementation of flood risk management plan. These objectives are related to flood risk management and reduction of adverse consequences, and they are estimated based on particular characteristics of endangered area, such as number of inhabitants, type of assets or cultural heritage. Given the characteristics of endangered area, these objectives are developed in order to define priorities for flood protection and reduction. Based on the developed objectives, mitigation measures (structural and non-structural) are selected for implementation by taking into consideration different criteria. Although cost efficiency criterion should be applied in order to ensure the sustainability of implement measures, other criteria such as social or environmental, must be taken into account.

Selected measures must ensure reduction of adverse consequences for human health, the environment, cultural heritage and economic activity. Furthermore, they should reduce the likelihood of flooding, if possible. Article 7 of the Floods Directive defines establishing of flood risk management plans as obligatory for all Member States, addressing that flood risk management plans must focus on prevention, protection and preparedness. Flood risk management measures can be classified into different categories, considering each phase of the risk management process.

a) Prevention

This set of measures is related to prevention of flood damage through reallocation of existing assets (where possible) and prevention of new development in flood prone areas. This can be performed through land use planning and spatial or urban development planning. In situations where existing assets are located in the flood prone area, measures can be directed towards improvement of existing properties and adaptation for reduction of potential consequences.

b) Protection

These mitigation actions are related to structural measures built for protection of area against flooding. In the coastal area, this is related to building of seawalls or raising height of the existing ones. It can be related to different objects and infrastructure for water regulation such as channels, drainage systems or retentions.

c) Preparedness

Preparedness phase of risk management is related to implementation or improvement of warning and flood forecasting systems, emergency response planning, building of temporary structures, evacuation as well as enhancement of awareness and preparedness of people to flooding.

d) Recovery

These measures are related to post-disaster recovery phase, where the most important goal is to restore normal state of the affected area by ensuring basic supplies, financial support and assistance.

2.4. Implementation of flood risk management plan

Implementation of flood risk management plan should be followed by several different steps. One of the major steps is the monitoring of flood risk management plan efficiency, which should be established in order to monitor the progress in implementing the plan. This can ensure that the flood risk management plan is adequately updated, if needed.

Communication between different stakeholders is crucial for successful implementation of flood risk management plan. This is especially related to administrative difficulties, since flood risk management in Croatia is under jurisdiction of Croatian Waters according to Water Act [4]. Different public authorities such as City of Kaštela, Civil Protection, Emergency Protection and Rescue must be involved and coordinated with Croatian Waters during the implementation of flood risk management plans. Furthermore, public participation is required since it raises flood awareness and increases the level of preparedness before the disaster strikes. By including the public in flood risk management plan implementation, the decision-making process is more transparent, which leads to higher level of acceptance and consequently to reduction of adverse consequences.

Finally, before the implementation of flood risk management plan, a Strategic environmental assessment procedure is required. A Strategic Environmental Assessment (SEA) is a systematic process for evaluating the environmental implications of a proposed policy, plan or programme. It is based on EU Directive [5] and evaluates cumulative effects appropriately addressing them at the earliest stage of decision making alongside economic and social considerations. The main phases of Strategic Environmental Assessment (SEA) are:

- SEA Screening, which is related to decision to undertake a Strategic Environmental Assessment procedure
- SEA Scoping, which considers identification and clarification of issues to be addressed by the Strategic Environmental Assessment
- SEA Study, providing the more detailed analysis of key issues

References

[1] Marasović K.; Kaštel Kambelovac,; Kaštelanski zbornik, 7, 35-61, 2003.g.

[2] DIRECTIVE 2007/60/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2007 on the assessment and management of flood risks https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32007L0060&from=EN

[3] PMO-GATE project, Deliverable 3.1.5., COLLECTION OF THE AVAILABLE FLOOD RISK MANAGEMENT PLAN FOR THE HR TEST SITE

[4] Water Act (NN 66/2019) https://narodne-novine.nn.hr/clanci/sluzbeni/2019_07_66_1285.html

[5] DIRECTIVE 2001/42/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 27 June 2001

on the assessment of the effects of certain plans and programmes on the environment https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32001L0042&from=EN