Ref. Ares(2021)1546758 - 01/03/2021

Funded by European Union Civil Protection
Grant Agreement Number 874421

Vulnerability assessment of embankments and bridges exposed to flooding hazards

Deliverable 2.3

Report on the Information Management Platform

Project Information

Grant Agreement No.	874421
Project Acronym	oVERFLOw
Project Full Title	Vulnerability assessment of embankments and bridges exposed to flooding hazards
Starting Date	1 December 2019
Duration	24 months
Call Identifier	UCPM-2019-PP-AG
Topic	UCPM-2019-PP-PREV-AG: Prevention in civil protection and marine pollution
Project Website	www.projectoverflow.eu
Project Coordinator	Prof. Meho Sasa Kovacevic
Organisation	Faculty of Civil Engineering, University of Zagreb
E-mail	msk@grad.hr
Telephone	+385 (1) 4639 250

Partner Information

Sveuciliste u Zagrebu Gradevinski Fakultet	Croatia
Infra Plan Konzalting	Croatia
GEKOM - geofizikalno i ekološko modeliranje d.o.o.	Croatia
VEILIGHEIDSREGIO ZUID-HOLLAND ZUID	Netherlands
INGEO BV	Netherlands
ZAVOD ZA GRADBENISTVO SLOVENIJE	Slovenia
Uprava Republike Slovenije za zaščito in reševanje	Slovenia

Document Information

Work Package	2
Deliverable Title	Report on the Information Management Platform
Version	3.0
Date of Submission	2/19/2021
Main Editor(s)	Mirko Kosič, Andrej Anžlin
Contributor(s)	-
Reviewer(s)	Irina Stipanović, Chi Brouwer
Citation	M. Kosič, A. Anžlin. (2021). oVERFLOw Deliverable 2.3: Report on the Information Management Platform

Document Classification:									
Draft		Final	**X**	Confidential		Restricted		Public	

History			
Version	**Issue Date**	**Status**	**Distribution**
1	1/14/2021	Draft	ZAG
2	1/29/2021	For consortium review	ZAG
3	2/19/2021	Final version	ZAG

The information contained in this report reflects the views of the Author(s) and the Commission does not accept responsibility for the use of this information.

Executive Summary

This deliverable is a report on the developed Information Management framework, its content, data type, and protocols. It represents one of the two outputs of task 2.3. The first objective of this deliverable is to document the process of reaching an agreement on the data to be included in the Information Management Platform (IMP). The second objective is to illustrate the concept how the IMP is going to operate and the processes of data transfer between different users of the IMP.

Keywords: Information management platform, GIS, operational layer for CPAs.

Table of Contents

Project Information 1

Partner Information 1

Document Information 2

Executive Summary 3

1 Abbreviations and Acronyms 5

2 Background 6

3 Introduction 7

4 Report on the meetings with CPAs and WP2 contributors 8

4.1 Meeting with representative of SLO CPA – 15th July, 2020, Ljubljana 8
4.2 On-line meeting with representatives of South Holland CPA – 29th October, 2020 8
4.3 On-line meeting with oVERFLOw experts – 5th November, 2020 9
4.4 On-line workshop on data transfer protocols between WPs – 12th January 2021 11

5 Review of existing IMP platforms in Slovenia, Croatia and Netherlands 12

5.1 Slovenia 12
5.2 Croatia 14
5.3 Netherlands 18

6 Agreement on data requirements for the IMP based on analysis of surveys results 23

7 Conceptual design of the IMP 24

8 Conclusions 26

9 References 27

Appendix A1: Questions for SLO CPA – Data to be included in the IMP 29

Appendix A2: Questions for South Holland CPA (VRZHZ)– Data to be included in the IMP 31

Appendix B: Questions for oVEFLOw experts – Data to be included in the IMP 33

1 Abbreviations and Acronyms

Abbreviation / Acronym	Description
IMP	INFORMATION MANAGEMENT PLATFORM
VRZHZ	VEILIGHEIDSREGIO ZUID-HOLLAND ZUID (in the following South Holland CPA)
URSZR	UPRAVA REPUBLIKE SLOVENIJE ZA ZAŠČITO IN REŠEVANJE (in the following SLO CPA)
CRO	CROATIA
SLO	SLOVENIA
CPA	CIVIL PROTECTION AGENCY
ZAG	ZAVOD ZA GRADBENISTVO SLOVENIJE
WP	WORK PACKAGE
GIS	GEOGRAPHIC INFORMATION SYSTEM
SMOK	SISTEM MONITORINGA OPAZOVANJA IN KONTROLE (Eng. *System for monitoring, alerting and management of SLO CPA*)
SPIN	SISTEM ZA POROČANJE O INTERVENCIJAH IN NESREČAH (Eng. *System for reporting on accidents and interventions of SLO CPA*)
SROK	PORTAL SMANJENJA RIZIKA OD KATASTROFA (Eng. *Disaster Risk Reduction Portal of CRO CPA*)
LIWO	LANDELIJK INFORMATIESYSTEEM WATER EN OVERSTROMINGEN (Eng. *National information system for water and floods in the Netherlands*)
LCMS	LANDELIJK CRISISMANAGEMENT SYSTEEM (Eng. *National crisis management system for the Netherlands*)

2 Background

In accordance with Annex I of Grant Agreement no. 874421, ZAG is the lead beneficiary for preparing deliverables D2.3 and D2.4. The deliverables are aimed at the development of the GIS web-based Information Management Platform (IMP). This document is the deliverable D2.3 and is a report on the development of IMP, its content, data type, and protocols. Deliverable D2.4 will be in the form of a separate operational layer within GIS platforms of CPAs and authorities from city of Karlovac and Rhine-Maas delta region.

3 Introduction

This deliverable is a report on the developed Information Management framework, its content, data type, and protocols. It represents one of the two outputs of task 2.3. The first objective of this deliverable is to document the process of reaching an agreement on the data to be included in the IMP. The second objective is to illustrate the concept how the IMP is going to operate and the processes of data transfer between different users of the IMP.

It is planned at this stage that the IMP is going to cover the selected case study areas Croatia (city of Karlovac) and in the Netherlands (South Holland region), and will operate in the GIS environment. The main purpose of the IMP is to facilitate the work of CPA by providing more detailed information on the development of flood events and expected performance of critical infrastructure, such as bridges and dikes. The platform will also provide useful information to identify vulnerable assets, which can be important for the design of flood prevention activities and retrofitting actions.

Additionally, the IMP will serve as a means for data transfer between experts of the oVERFLOw consortium involved in different WPs. The data requirements of these experts differ significantly from the data needed by end-users (CPAs and stakeholders). For example, the CPAs are more concerned with the simple performance indicators, which show if the operability/safety of the examined assets (bridges and dikes) is at risk due to flooding. On the other hand, the experts require detailed technical data to perform flood fragility and risk analysis. The platform should thus accommodate the needs of both groups.

An important step in the development of the IMP is the definition of the data to be included in the IMP. An agreement between end-users and experts was achieved based on one-to-one meetings. Survey questionnaires were also developed and used to identify specific needs of all involved parties. Transfer protocols ensure that the platform functions as a common link between experts working on different WPs. The transfer protocols between WPs were discussed and agreed on a workshop between WP2, WP3, WP4 and WP5 representatives. The result of the workshop was the flowchart on data transfer which ensures reliable integration of of data into the IMP and between WPs.

The deliverable is structured in the following way. After the Introduction (Section 3), a summary of the minutes of the meeting with CPAs and WP2 contributors is included in Section 4. In Section 5 follows the review of existing IMPs in the partners' countries (Slovenia, Croatia, and Netherlands). Section 6 documents the agreement on data standards to be included in the IMP. The agreement was reached based on the analysis of survey questionnaires, developed to assess the needs of CPAs and experts. The conceptual design of the IMP is elaborated in Section 7. The summary of main conclusions of the deliverable is documented in Section 8.

4 Report on the meetings with CPAs and WP2 contributors

4.1 Meeting with representative of SLO CPA – 15th July, 2020, Ljubljana

On 15th July 2020, a meeting was held between representatives of ZAG and Slovenian (SLO) CPA (Primož Uršič, *URSZR*). The meeting was held to get better insight in the mechanism for protection, rescue and relief used by the SLO CPA in case of flooding. The basis for the meeting was a survey questionnaire, which was developed with the aim of defining common aspects of the mechanism for protection, rescue and relief in different countries (see Appendices A1 and A2). The same questionnaire was also used for discussion with CPA representatives of other countries. The following topics were discussed during the meeting:

- Strategic documents that define the mechanism of response to floods
- Existing platform used by CPAs
- The system used for monitoring of safety/operability of bridges
- Areas of potential improvement of the current system by the development of IMP.

The inputs provided by the SLO CPA are documented in Appendix A1. The summary of the most important outcomes of the meeting is presented below:

- The basic strategic document that defines prevention, preparedness and response to flood hazard in Slovenia is the "National plan for protection and rescue in case of flooding" [1].
- The existing platforms used by the SLO CPA are: i) SMOK[1] [2], and ii) SPIN[2] [3]. The platform SMOK is used for tracking water levels and releasing alarms in case of flooding. The platform SPIN is more general and includes different threats in addition to flooding (traffic accidents, fires, pollution etc.)
- Alarms regarding the safety/operability of bridges are issued based on water levels. Visual inspection is also used. Currently, the SLO CPA does not have a list of flood critical assets.
- The safety of bridges and dikes is not monitored directly, but only indirectly based on water levels. The safety / operability of bridges could be predicted more accurately, if the actual vulnerability of these assets is taken into account in addition to actual water levels.

4.2 On-line meeting with representatives of South Holland CPA – 29th October, 2020

On 29th October 2020, a meeting between representatives of the South Holland CPA - VRZHZ (Mrs. Chi Brouwer and Mr. Eddy van Well) and representatives of ZAG was held. The topic of the

[1] *System for monitoring, alerting and management*
[2] *System for reporting on accidents and interventions*

meeting was a discussion about the protection and rescue mechanisms in the Netherlands for in the case of flooding. Very similar to the meeting with SLO CPA, the basis for the meeting was a survey questionnaire, which was aimed at defining the data needed by CPAs to respond in case of flooding. The following topics were discussed during the meeting:

- Strategic documents that define the mechanism of response to floods
- Existing platform used by CPAs
- System used for monitoring of safety/operability of bridges
- Areas of potential improvement of the current system by the development of IMP.

The main outcomes of the meeting are following:

- The strategic documents that define prevention, preparedness and response to flood hazard in Netherlands are the "National water program 2022-2027" [4], "National flooding risk review" [5] and "Regional Risk Profile" (e.g for South Holland region [6]).
- The existing platforms used by South Holland CPA are: i) Waterinfo [7], ii) LIWO[3] [8], and iii) LCMS[4] [9]. The Waterinfo platform provides current, expected and historical data regarding water level, water flow, sea tide and other meteorological data, such as temperature and wind speed. The LIWO platform provides interactive information regarding flood depth, flood scenarios, current (2019) and future (2050) flood probabilities, probability of break-through primary defences and evacuation scenarios. The LCMS is the national crisis management system and is used as a central system for emergency management.
- The safety/operability of dikes is monitored based on data from the VNK2 project [10], the LIWO platform and centralized information platform LCMS. Primary dikes are subjected to regular inspections and their condition is relatively well known. Less reliable data is available for secondary dikes. Because of sophisticated flood protection measures coupled with the deep foundations adopted, scour is not a risk factor in the case study area in the Netherlands.
- The current system of flood protection in the Netherlands is well established. Improvement of the current system is possible by integration of monitoring system into the platform, which would give more accurate insight into the safety of the dike based on their actual vulnerability. This would enable better predictions about the effects of flooding. The system should be implemented in an existing GIS platform.

4.3 On-line meeting with oVERFLOw experts – 5th November, 2020

On 5th November 2020, experts of the oVERFLOw consortium involved in WP4 and WP5 had a meeting to discuss the data standards to be included in the IMP. As foreseen in this deliverable, the IMP will serve two basic functions: i) it will provide a tool to support the work of CPAs, and ii) it will also provide a common platform for data exchange between experts of the oVERFLOw consortium. The goal of the meeting was to define the data required by different experts to perform their tasks. Very similar to the survey developed for the CPAs, a survey for experts was

[3] National information system for water and floods in the Netherlands
[4] National crisis management system for the Netherlands

also developed and used as the basis for the meeting. The following topics were discussed on the meeting:

- The input data required by different experts to performed fragility analysis of bridges and dikes
- The parameters to be used for measuring the performance of bridges and embankments / dikes
- The most effective way to present the obtained results to the CPAs.

According to the experts of the oVERFLOw project, the required data for fragility analysis of the bridges and embankments are following:

- global geometry of the structure,
- characteristics of the employed materials (mechanical and physical properties),
- riverbed profile,
- geotechnical data (soil data, foundation details),
- condition-assessment data based on previous inspections,
- historical data regarding previously performed remediation measures,
- flood height, flood duration, and flood velocity.

The experts agreed that the most suitable parameters to measure the performance of bridges and embankments are fragility curves and flood risk. The first represents the conditional probability of attaining a given performance level for a given intensity of the flood, whereas the latter one represents the probability of attaining a given performance level in a period of time (typical one year). The group of experts also agreed that this metrics may be too complicated to be shared with non-specialist. Thus, it was decided that the most effective way to represent the performance of bridges and dikes is to use a colour-coded scheme, which can be easily understood by user without background in civil engineering, given that the clear interpretation of colour coding and risk assessment are provided.

4.4 On-line workshop on data transfer protocols between WPs – 12th January 2021

On 12th January 2021, an online workshop on data transfer protocols was held between representatives of WP2, WP3, WP4 and WP5. The workshop was organized to discuss the interrelation between different WPs and to define data transfer protocols, which will ensure reliable transfer of data within the IMP and between WPs. The result of the meeting was the data transfer protocol presented in Figure 1.

Figure 1 illustrates how the IMP acts as a common platform for data transfer between different WPs, or different stages in risk assessment process for assets exposed to flood risk. In the following, the processes used to obtain the risk predictions for the examined assets are described. First, the WP2 provides flood hazard scenarios, which consider different assumptions regarding the development of climate changes. This data is stored in the IMP and is made available to other experts working on flood fragility (WP4) and risk analysis (WP5). The WP3 provides in-situ data regarding the examined assets (geometry, material, condition assessment and geotechnical data) and the data regarding the river/channel profile and flow characteristic (e.g. water height vs. discharge relations). These data are obtained based on existing project documentation, 3D drone survey, destructive and non-destructive testing of materials and soil, bathymetric survey of the riverbed, and measurements of the river flow. The data is then stored in the IMP and is then used as input for fragility analysis in WP4. The results of WP4 are the fragility curves for the examined assets, which are later used as input for risk analysis in WP5. In WP5, the assets fragility curves are combined with flood hazard scenarios from WP2 and are used to calculate consequences (direct and indirect impacts) expressed as risk for the selected assets.

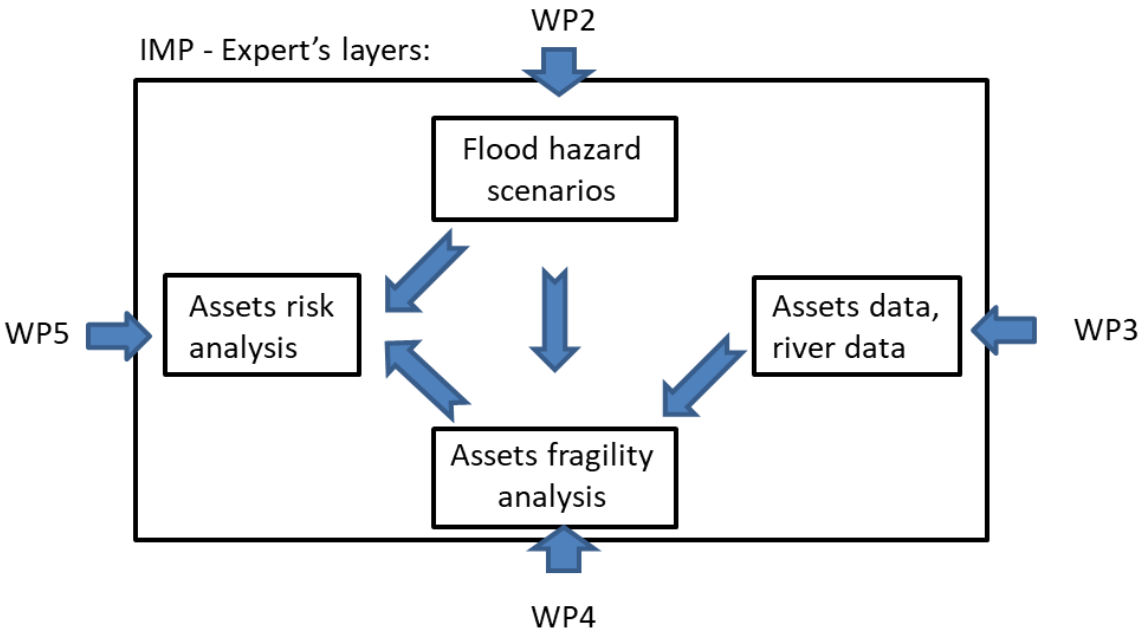


Figure 1: Data transfer protocol between WPs

5 Review of existing IMP platforms in Slovenia, Croatia and Netherlands

This section presents the review of existing IMPs in countries within the oVERFLOw consortium, i.e. Slovenia, Croatia and Netherlands. The data about the existing platforms was obtained on the meetings with CPA and survey questionnaires, presented in Appendixes A1 and A2.

5.1 Slovenia

In Slovenia, two platforms are used for the purpose of civil protection and disaster management in case of flooding. The first platform is the System for monitoring, alerting and management i.e. SMOK [2]. The second platform is System for reporting on accidents and interventions i.e. SPIN [3].

The SMOK platform [2]was developed by SLO CPA (URSZR) for monitoring of the Slovenian territory. The system includes information regarding: i) flows and water levels of rivers and the sea, ii) precipitations, iii) fires, and iv) landslides. In case of monitoring of waters, the system draws data from measuring systems of the Environmental Agency of the Republic of Slovenia (ARSO) and displays it with supplement of its own data. An overview of the data provided by the SMOK platform is presented in Figure 2.

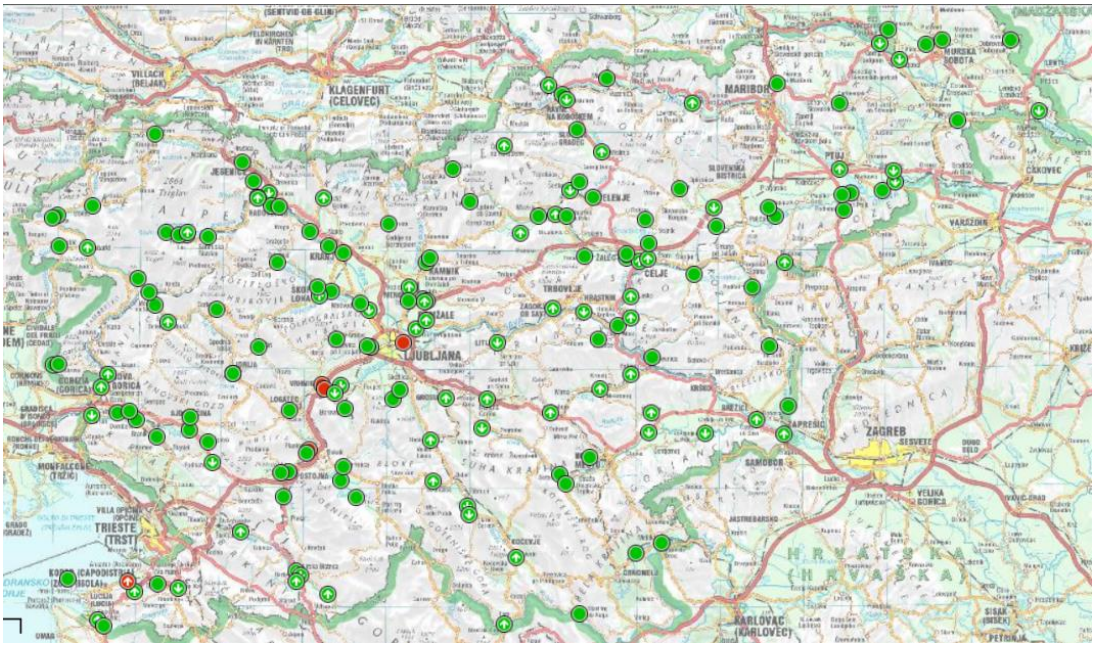


Figure 2: Layout of the SMOK system (retrieved from https://smok.sos112.si/)

The platform allows the display of the current water levels and discharges at measuring stations. Arrows on the control points indicate if the water level/discharge is currently raising or lowering. Color-coded scheme is used to display alarms indicating that water level/discharge at an

observation station exceeded a selected threshold value. For each station, the system allows the display of the graphs of the development of water level, discharge and temperature in the past 48 hours. A description of consequences of flooding with different intensities is also provided based on historical floodings. Some stations are also equipped with detailed information regarding flood hazard, geometry of the riverbed and measured relations between water height and discharge. The flood hazard is represented by relationship between water level/discharge and the return period associated with these quantities.

The SPIN platform [3]has a more general scope compared to SMOK. The system was developed by SLO CPA (URSZR) and it is intended to be used as a centralized system for storing information regarding accidents and related interventions for the entire territory of Slovenia. The system is composed of a public and a restricted part, which is used by CPA groups. The layout of the SPIN platform is present in Figure 3.

In addition to natural hazards such as flooding, earthquakes, landslides and fires, the platform also includes information regarding other accidents such as traffic accidents, explosions, pollution, disruptions of energy supply etc. All events are marked on the map, which allows monitoring of the interventions at the national scale. The system allows also the regeneration of daily and yearly reports regarding all interventions undertook in Slovenia. The statistic can be display by activity (e.g. flooding, fires), year of happening and involved intervention unit.

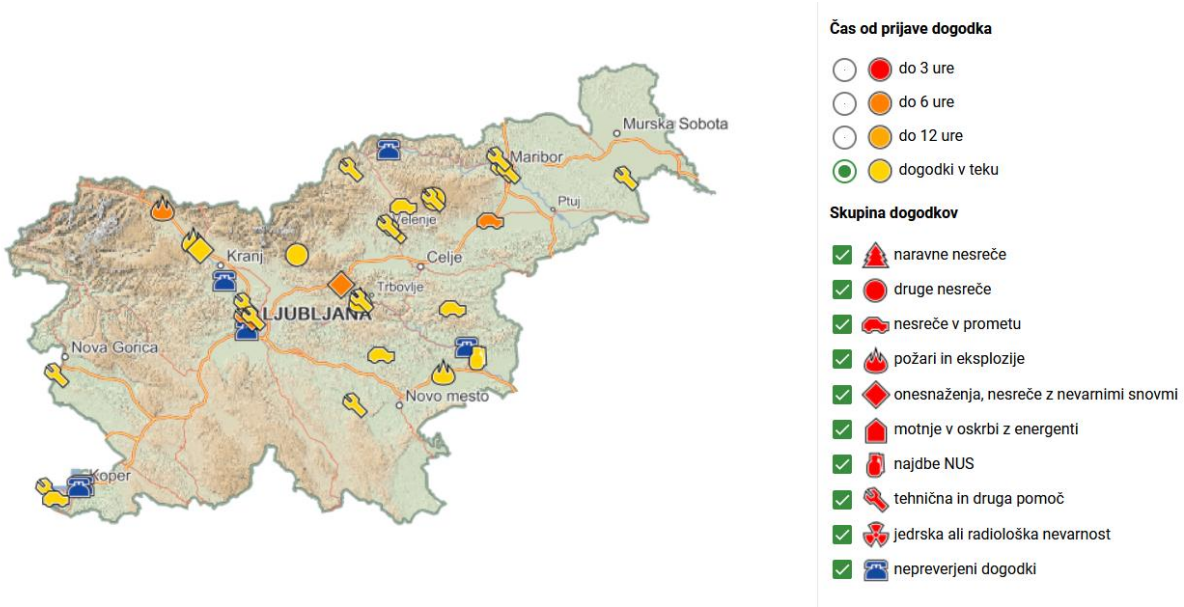


Figure 3: Layout of the SPIN system (retrieved from https://spin3.sos112.si/).

5.2 Croatia

There are three platforms relevant for flood hazard and civil protection in Croatia, namely Disaster Risk Reduction Portal SROK, water levels at measuring stations in the Republic of Croatia and GeoPortal which provides flood hazard and flood risk maps for the entire territory of Croatia.

The first platform is the SROK[5] (in Croatian "Portal smanjenja rizika od katastrofa") [11], which enables the review of identified threats, developed scenarios and the adoption / updating of major accident risk assessments for local and regional self-government units in Croatia. The SROK platform is under development of the Directorate of Civil Protection of the Ministry of the Interior of the Republic of Croatia (in short CRO CPA). The information regarding the SROK portal was obtained from CRO CPA web-page [12]. It consists of layers, cartographic representations and legends, share of adopted risk assessments, filters and graphical representations of threats and scenarios. The platform is still under development. When finished, it will include data on damages and losses, threats, vulnerabilities and risk management capacities. Currently, the platform enables the review of identified threats, developed scenarios and the adoption / updating of major accident risk assessments for local and regional self-government units. Figure 4 presents an example of the data from the SROK. The figure presents the availability of data and developed assessment risk assessment studies. In addition, the statistic regarding the availability of plan for civil protection and disaster management can also be found [11].

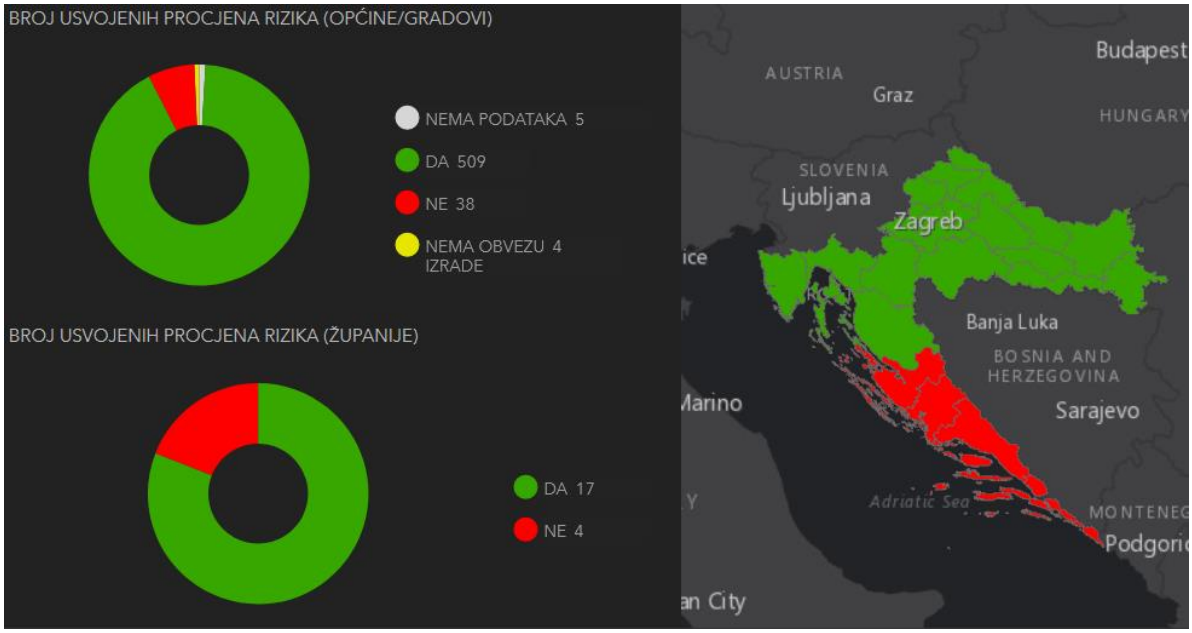


Figure 4: Data regarding the number of regions with developed risk assessment studies based on the SROK platform (retrieved from https://civilna-zastita.gov.hr/portal-smanjenja-rizika-od-katastrofa-srok/2751).

[5] Disaster Risk Reduction Portal

The second portal is presenting the current state of water levels at measuring stations in the Republic of Croatia [13]. They can be viewed on two levels; i) presentation of the map of the Republic of Croatia with the shown location of stations, as well as the measures taken currently conducted at a single station (from green – regular status to extraordainray status marked with red color), see Figure 5a, and ii) display of the list of measuring stations with the information on the water level and the trend (increasing or decreasing) and surcharge, see Figure 5b.

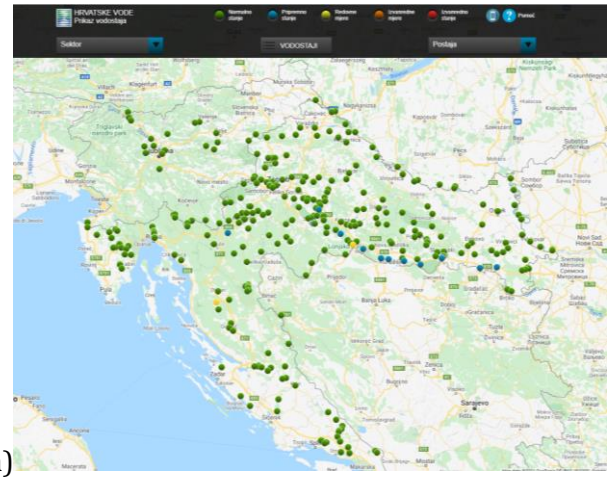
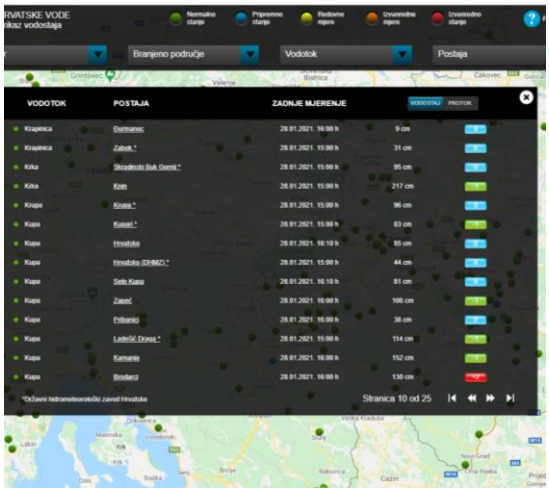
a)  b) 

Figure 5 Data about the current water levels at measuring stations in Croatia (retrieved from http://vodostaji.voda.hr/)

The third portal is GeoPortal [14] which was developed by the Croatian legal entity for water management (in Croatian "Hrvatske Vode"), which provides flood hazard and flood risk maps for the entire territory of Croatia. The platform can be accessed on web page https://preglednik.voda.hr/. The platform allows the display of flood maps for three scenarios: i) flood with high probability of occurrence (frequent floods), ii) flood with medium probability of occurrence, and iii) flood with low probability of occurrence (rare / extreme floods). The flood maps for the high- and low-probability floods are presented in Figure 6 and Figure 7. The flood maps represent the expected waters levels, which are described using color-code scheme with darker color higher water levels. Four intervals for water levels are show: i) water height < 0.5 m, ii) water height 0.5 – 1.5 m, iii) water height 1.5 – 2.5 m, and iv) water height >2.5 m.

The GeoPortal also offers possibility to display the flood risk maps to the flood scenarios described above, i.e. high, medium and low probability flood. The flood risk maps are developed for the entire territory of Croatia. However, in Figure 8 and Figure 9 the flood risk maps for the high- and low-probability floods are presented for the case study area in Croatia, city of Karlovac. The results show the consequences of the examined floods and are presented in terms of number of endanger households and disrupted activities. The number of endangered household is represented in three categories: i) less than 100, ii) between 100 and 1000, and iii) more than 1000. The maps serve the CPA to plan civil protection activities and crisis response.

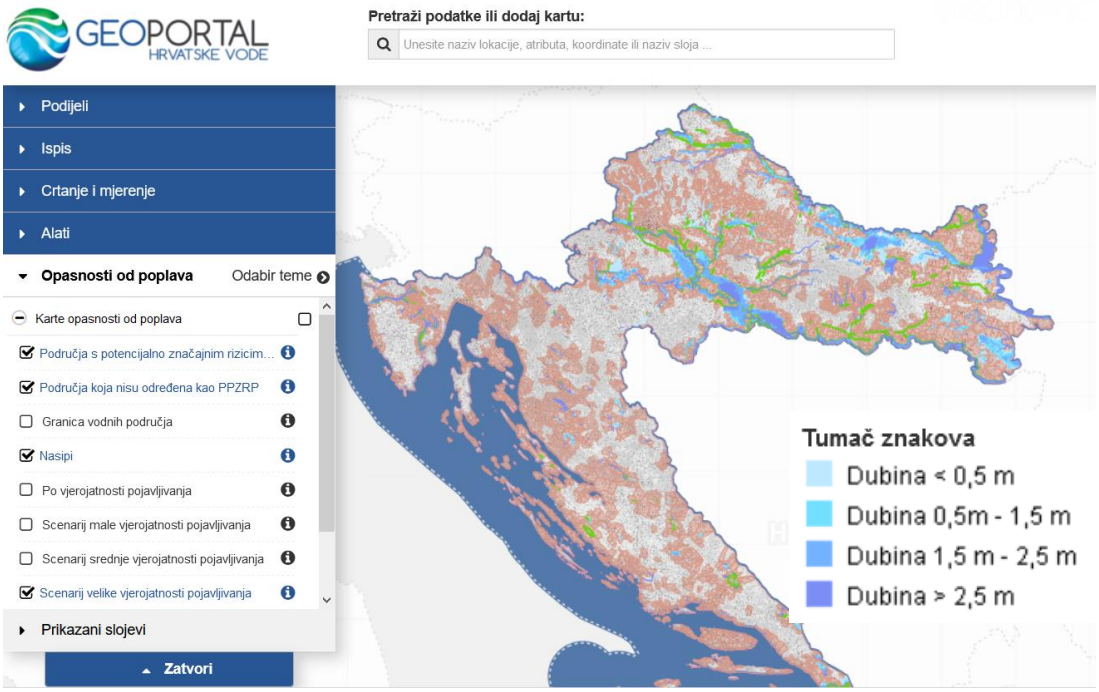


Figure 6: Flood map for the high-probability flood based on the GeoPortal data (retrieved from https://preglednik.voda.hr/).

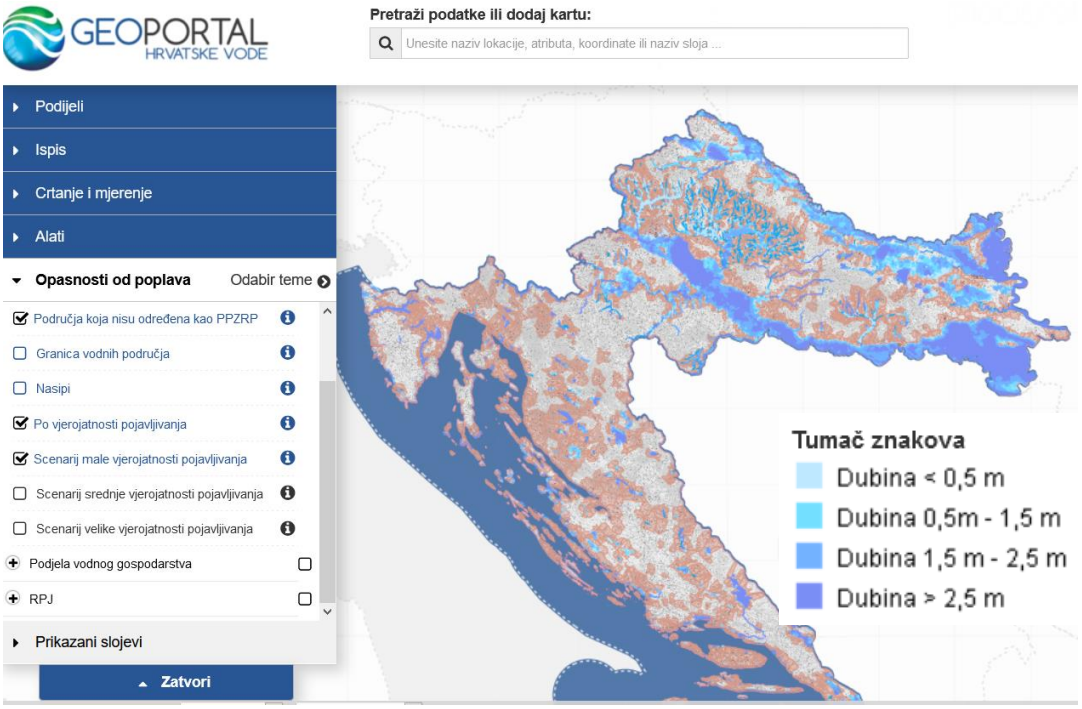


Figure 7: Flood map for the low-probability flood based on the GeoPortal data (retrieved from https://preglednik.voda.hr/).

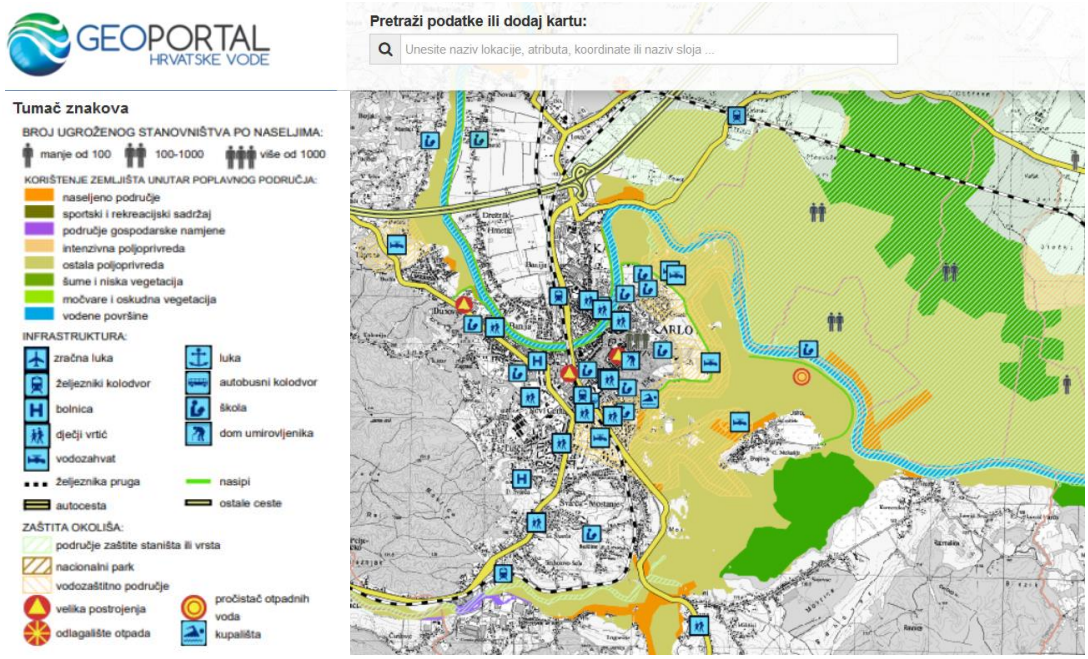


Figure 8: Flood risk map for the high-probability flood based on the GeoPortal data (retrieved from https://preglednik.voda.hr/).

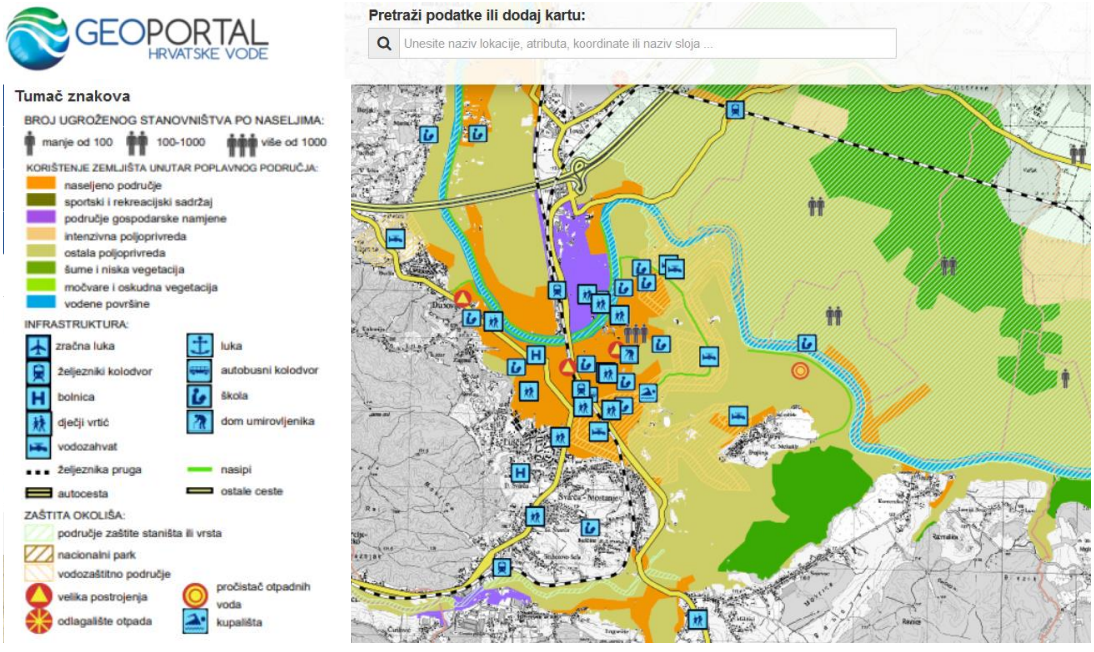


Figure 9: Flood risk map for the low-probability flood based on the GeoPortal data (retrieved from https://preglednik.voda.hr/).

5.3 The Netherlands

According to representatives of South Holland CPA, three platforms are mainly used to manage the flood hazard. The first platform is Waterinfo [7] which provides current, expected and historical data regarding national waters. The second platform is the LIWO [8] which provides interactive information regarding flood depths, flood scenarios, flood risk for primary dikes and evacuation scenarios. Both platforms were developed by the Netherlands Ministry for Infrastructure and Water Management (Rijkswaterstaat). The third platform is the LCMS [9], which is the Dutch nation-wide crisis management system.

The Waterinfo platform [7] provides current, expected and historical data regarding water level, water flow, sea tide and also other meteorological data, such as temperature and wind speed. An overview of the data provided by the platform regarding water levels in Netherlands is presented in

Figure 10. For each of the observation stations the platform uses a color-coded scheme to display the current state of water levels (see legend in

Figure 10): i) grey – possibly outdated information, ii) blue – no data available, iii) brown – low water level, iv) green – normal water level, v) light green – slightly increased water, vi) orange – increased water level, vii) dark orange – high water level , viii) red – extremely high water level. In addition to the current water level, the platform also provides past water levels (up to 9 days beforehand) and a prediction of the future water levels, up to 2 days ahead. The data can be represented in graphical and tabular form. An example of the obtained for a measuring station is presented in Figure 11. The platform also offers possibility to display the threshold water level used for colour-coded alarms (see Figure 11). Same data can also be obtained for the river discharges at several measuring stations.

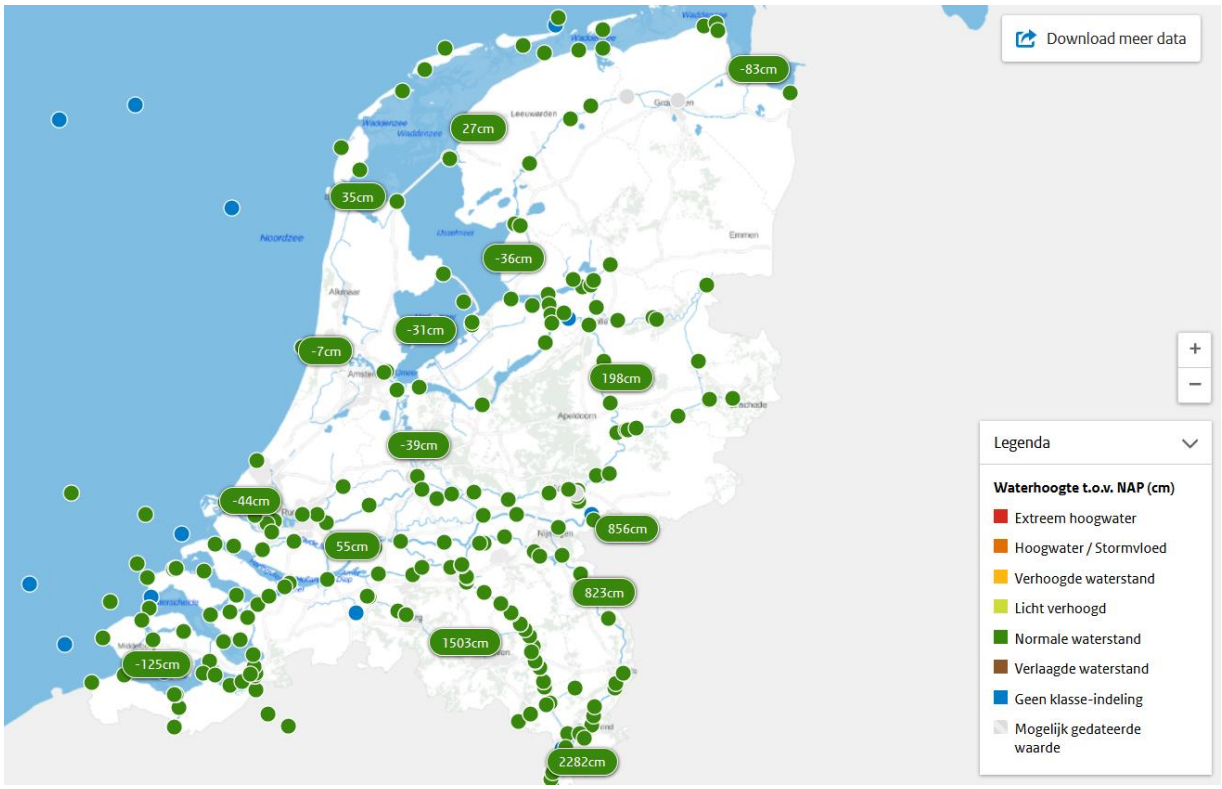


Figure 10: Overview of the Waterinfo platform display for water levels in the Nethetlands (retrieved from https://waterinfo.rws.nl)

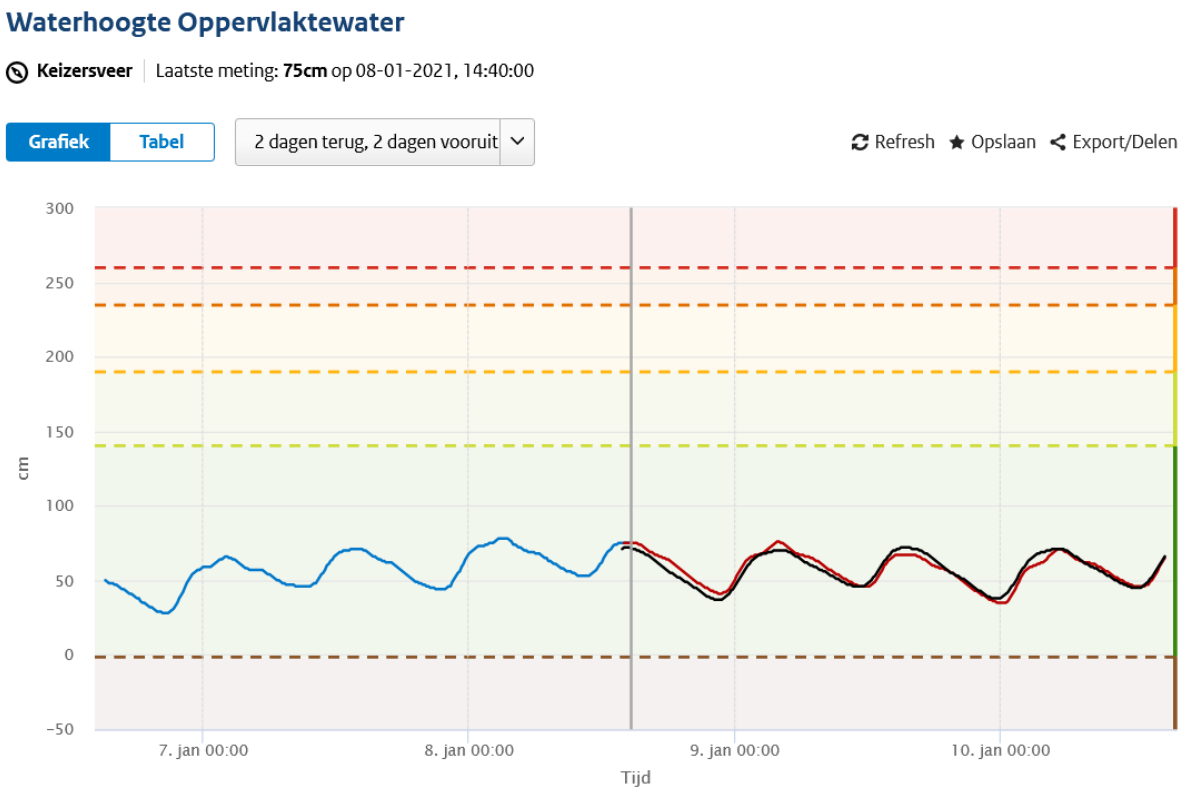


Figure 11: Example of the past and expected water levels for a measuring station from the Waterinfo platform (retrieved from https://waterinfo.rws.nl).

The LIWO platform [8] is the national information system for water and floods. It is a product of Water Management Center Netherlands (WMCN) and contains map layers for professionals who are involved in flood protection in the Netherlands. The platform provides interactive representation of flood depths, flood scenarios, flood probabilities, flood risk for primary defences and evacuation scenarios. The flood depth maps include data regarding the maximum expected water levels and water levels related to the breakthrough of primary or regional water defences (dikes).

Figure 12 presents the expected maximum water levels in Netherlands. The platform also allows the display of the water levels maps obtained by different projects. Flood scenarios maps can also be displayed. The user can selected the location of the breach in the dike and observe the resulting water levels.

Figure 13 shows an example of water levels with annual rate of occurrence of 1/10000, which results as a consequence of a breach in the dike at the location of the red dot. The LIWO platform also allows the display of current and future risk maps (see Figure 14), as well as more specific information regarding the annual failure probabilities of primary and regional dikes (Figure 15).

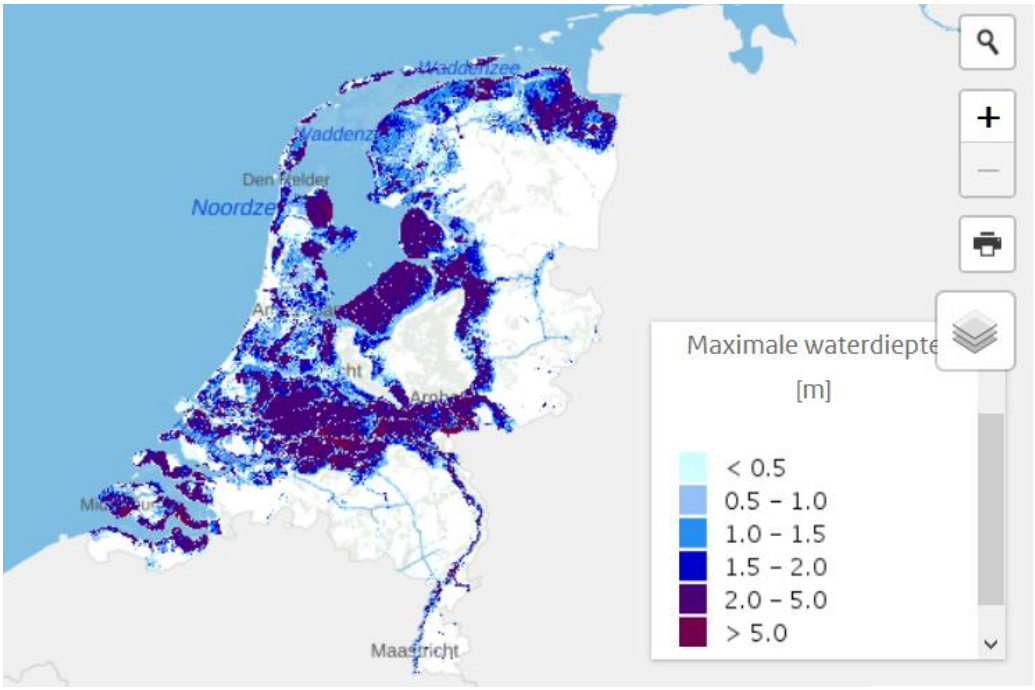
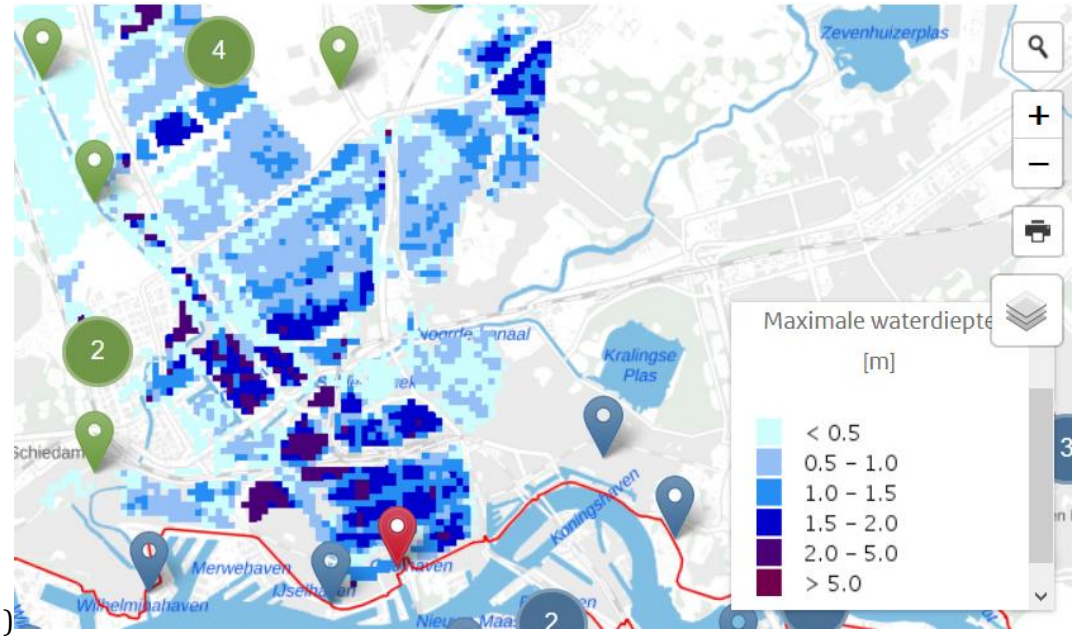


Figure 12: Maximum water levels in the Netherlands (retrieved from https://basisinformatie-overstromingen.nl/liwo/#/)



)

Figure 13: Example of water levels with probability of 1/10000 in case of a breach in the dike at location marked with the red dot (retrieved from https://basisinformatie-overstromingen.nl/liwo/#/)

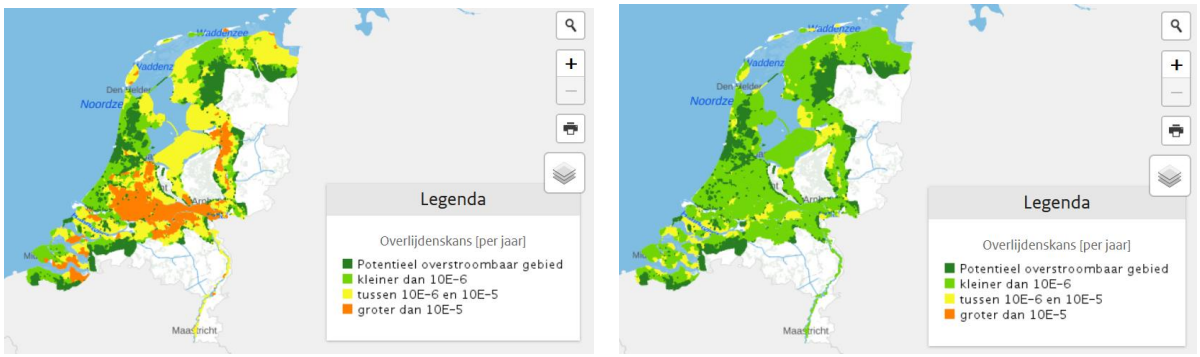


Figure 14: Current flooding risk in the Netherlands in year 2019 (left) and prediction for the year 2050 (right) (retrieved from https://basisinformatie-overstromingen.nl/liwo/#/).

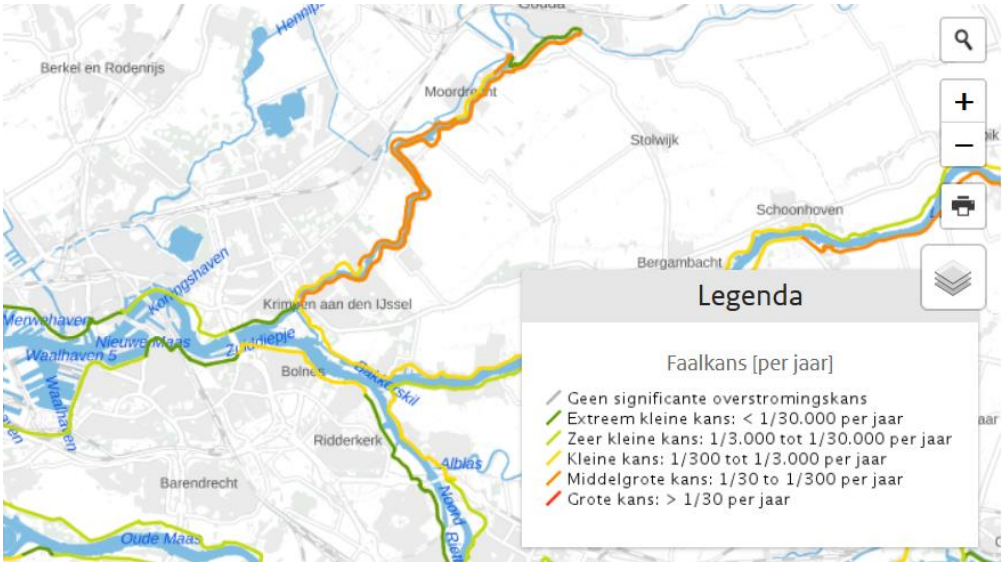


Figure 15: Example of the annual failure probabilities for primary dikes (retrieved from https://basisinformatie-overstromingen.nl/liwo/#/).

The LCMS [9] is the Dutch national crisis management system used to maintain and share a common operational picture supporting large-scale crisis management collaboration. The description of the platform was adapted from https://www.lcms.nl/about-lcms.

LCMS is a web-based collaboration environment with a very high level of availability and it is used by all 25 safety regions, the majority of the water boards, Rijkswaterstaat, and by an increasing number of emergency health care organisations, the Royal Military Police organisation and some drinking water providers. LCMS supports collaboration and sharing of information in a way that the decision-making under crisis circumstances is always based on an up-to-date, consistent and common operational picture. The system can be used to share information within an organisation as well as between organisations. It supports maintaining and sharing geographical as well as textual pictures. An overview of the technical set-up of one instance of the LCMS system, e.g. the LCMS system for the water boards, is depicted in Figure 16.

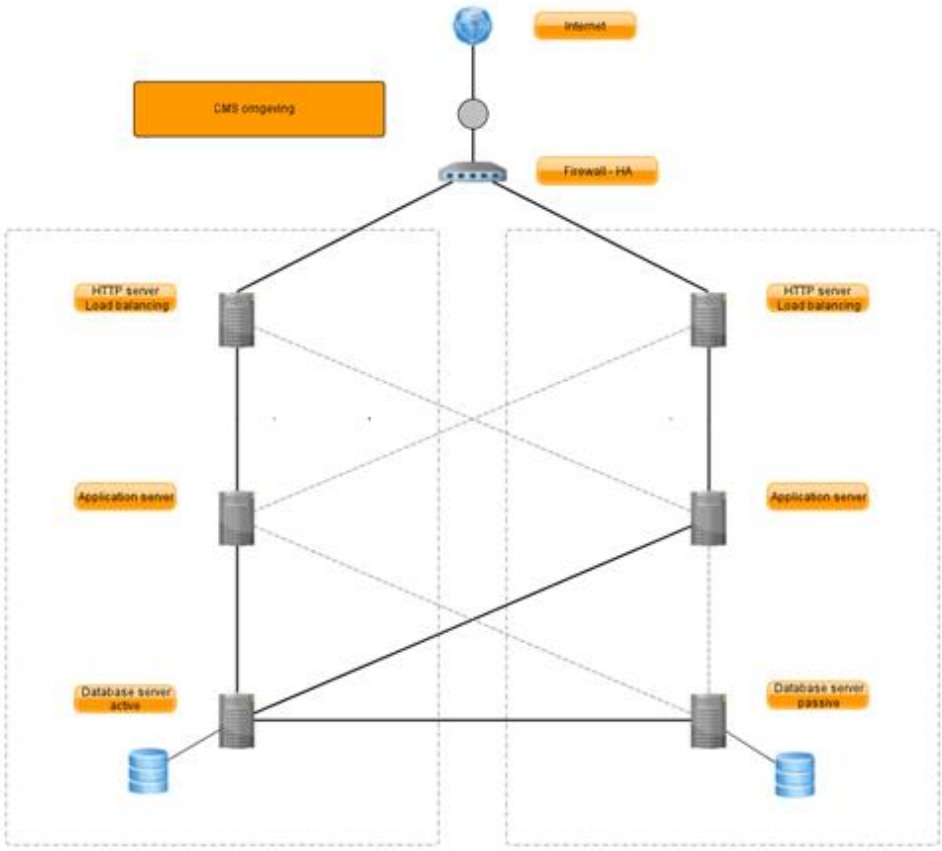


Figure 16: Overview of the LCMS system used by Dutch waterboards (retrieved from https://www.lcms.nl/about-lcms).

6 Agreement on data requirements for the IMP based on analysis of surveys results

The agreement on the data requirements to be included in the IMP was obtained based on the analysis of the responses provided by CPAs and experts to the survey questionnaires. The summary of most important conclusions is presented below.

- CPA representatives agree that more precise data regarding the operability / safety on bridges and dikes during flooding can help the planning of their prevention and response measures. For the South Holland CPA the operability of dikes is the sole concern from the perspective of this project. .
- To guide emergency response during flood events a real-time assessment of the safety / operability of bridges and dikes was found to be the most useful for CPAs. In addition the models developed in oVERFLOw coupled with long-term flood predictions can be used to identify vulnerable assets considering a range of climate change and flooding scenarios.
- The system used to display the operability / safety of bridges should be simple and easily understandable by users with no specific background in civil engineering.
- The needs of the CPAs and experts involved in the development of the IMP differ significantly. Data need by experts may be too technical to be of direct use for CPAs.
- Experts involved in fragility analysis within WP4 require detailed data regarding the geometry, materials and conditions of the assets (bridges and dikes), geotechnical data, and river data such as geometry of the river bed and/or height-discharge relations (H-Q curves).
- Experts agree that the vulnerability of the bridges / dikes will be measured in terms of fragility curves. These can be combined with prediction of water levels / river discharge to obtain a real-time prediction of the performance of these assets. Long-term performance prediction based on flood risk can be obtained by combining the flood hazard scenarios developed within WP2 with fragility curves from WP4.

Based on the presented conclusions regarding the requirements of the CPAs and experts it was concluded that the IMP should include the following data:

- The platform should operate in a GIS environment and should provide separate layers for CPAs and experts
- The CPAs' layers should include the real-time and long term safety assessment for the examined assets. The results should be based on an easily understandable color-scheme.
- The experts' layers will provide functionality to the platform and will serve as a means for data transfer between different research groups.
- Within the experts' layers the following data should be included: geometry, materials and conditions of the assets (bridges and dikes), geotechnical data, river data such as geometry of the river bed and/or height-discharge relations, and flood hazard scenarios developed in WP2.

The conceptual design of the IMP is elaborated l in Section 7.

7 Conceptual design of the IMP

The conceptual design of the IMP is presented in Figure 17**Error! Reference source not found.**. The IMP will cover the selected case study areas in Croatia) and the Netherlands. The GIS-based IMP is designed to perform two basic tasks: i) facilitate the work of CPA by providing more detailed information on the development of flood events and expected performance of bridges and dikes, ii) serve as a means for data transfer between different experts working on different WPs. In order to fulfill the needs of both, end users (CPAs and stakeholders) and experts, the platform will be equipped with multiple layers. The two basic sets of layers to be used by CPAs and experts are schematically presented by black windows on the left and right side of Figure 17.

Based on the analysis of the needs of CPAs', it was decided that two most useful layers for CPA are:

i) the real-time safety assessment of the examined assets based on the actual water levels (H)/river discharge (Q), and
ii) the long-term safety assessment of the examined assets based on flood risk, which represent the probability of attaining a given limit state in a selected period of time (e.g. in a year or in the life-time of the asset).

The first layer provides real-time visualization of the current performance of the assets and can be used by CPAs to guide emergency response during the flood events. The second layer provides the long-term safety assessment of the examined assets and can be used to identify vulnerable assets, required for design of flood prevention activities and/or retrofitting actions. Both layers intended to be used by CPAs will be presented using intuitive color scheme, which ensures that the IMP can be used also by users with no specific background in civil engineering.

The second set of layers will be used by the experts of the oVERFLOw consortium. These layers serve two functions, firstly to ensure functionality of the CPAs' layers, and secondly to represent a common interface for data transfer between experts working on different WPs, or at different stages in risk assessment process.

The real-time safety assessment is obtained by combining the data from water levels/ river discharge forecast with assets fragility curves. The prediction of water levels/river discharge is obtained by national meteorological surveys and is not directly computed within the platform. The long-term safety assessment is obtained by combining the climate change and flood hazard scenarios from WP2 with the assets fragility curves from WP4. The development of fragility curves require a large amount of in-situ data, which is provided by WP3. These layers include data regarding the geometry, materials and conditions of the assets (bridges and dikes), geotechnical data, and river data such as geometry of the river bed and/or height-discharge relations (H-Q curves).The data will be stored in the IMP as part of the experts' layers and will be made available to all experts and different stages in the risk assessment process.

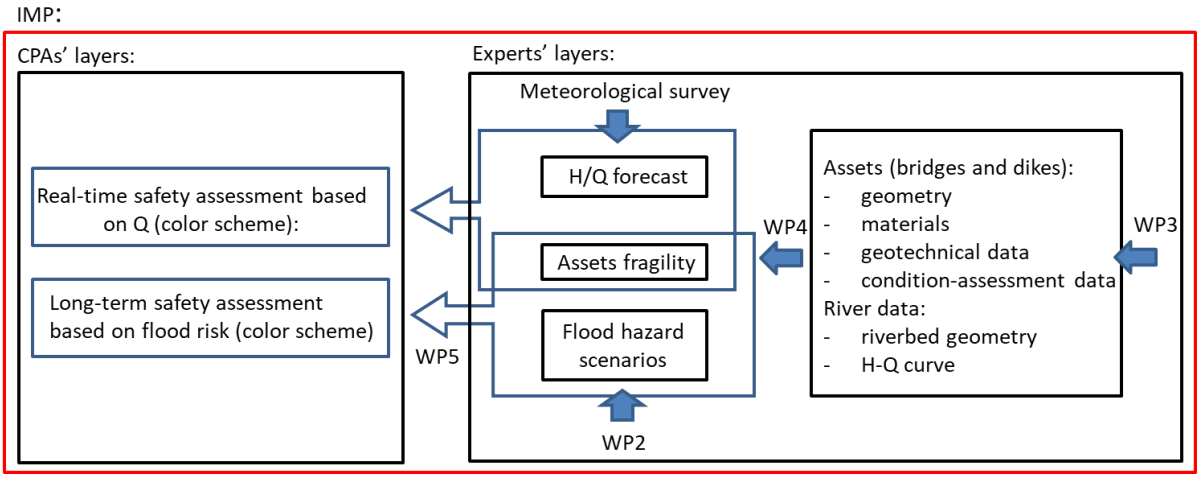


Figure 17: Conceptual design of the Information Management Platform (IMP)

8 Conclusions

This deliverable documents the conceptual development of the information management platform (IMP) for the oVERFLOw project. One of the most crucial aspects of the development of the platform was the definition of the input data. This task was competed based on interviews and workshops with CPAs and experts of the oVERFLOw consortium, which are documented in Section 4 of this report. The meetings were based on survey questionnaires, which helped to identify the requirements of both groups and identify existing GIS platforms, which were listed and shortly described in Section 5. The agreement on the data standards to be included in the IMP is outlined in Section 6, whereas the conceptual design of the IMP is illustrated in Section 7.

As elaborated in this deliverable, the IMP will cover the selected case study areas in Croatia) and the Netherlands and will operate in the GIS environment. The platform is designed to perform two basic tasks: i) facilitate the work of CPA by providing more detailed information on the development of flood events and expected performance of bridges and dikes, and ii) serve as a means for data transfer between experts of the oVERFLOw consortium. In order to fulfill the needs of both users, the platform will be equipped with separate layers for CPAs and experts. The layers intended to be used by CPAs will feature a real-time and a long-term performance indicator based on flood risk. The first is designed to help CPAs to plan emergency response during flood events, whereas the second can be used to identify vulnerable assets, which can be important for design of flood prevention activities and retrofitting actions. The results of both CPAs' layers will be presented with an easily understandable color-scheme. On the other hand, a set of separate experts' layers was designed to perform two different tasks. First, to ensure the functionality of the CPAs' layers and second, to represent a common interface for data transfer between experts of the oVERFLOw consortium. The data stored in the experts' layers can be shared between different contributors and as such can be seen as a common link between different WPs.

The conceptual design of the IMP will be used to guide the development of D2.4, which will be in a form of separate operational layers for CPAs and authorities from city of Karlovac and Rhine-Maas delta region.

9 References

[1] Republic of Slovenia (RS), Ministery of Defence, Administration of the RS for Civil Protection and Disaster Relief, "National plan for protection and rescue in case of flooding," 2018. [Online]. Available: http://www.sos112.si/slo/tdocs/drzavni_nacrt_poplave_2018.pdf. [Accessed 29. 1. 2021].

[2] Administration of the Republic of Slovenia for Civil Protection and Disaster Relief, "System for monitoring, alerting and management - SMOK," [Online]. Available: https://smok.sos112.si/. [Accessed 29. 1. 2021].

[3] Administration of the Republic of Slovenia for Civil Protection and Disaster Relief, "System for reporting on accidents and interventions - SPIN," [Online]. Available: https://spin3.sos112.si/. [Accessed 29. 1. 2021].

[4] Government of the Netherlands, Ministry of Infrastructure and Water Management, "National Water Plan 2016-2021," [Online]. Available: https://www.helpdeskwater.nl/onderwerpen/wetgeving-beleid/nationaal/nationaal-water-programma-2022-2027/. [Accessed 29. 1. 2021].

[5] Government of the Netherlands, Ministry of Infrastructure and Water Management, "Flood risk in the Netherlands," [Online]. Available: https://www.helpdeskwater.nl/onderwerpen/wetgeving-beleid/europese-richtlijn-overstromingsrisico/voorlopige-overstromingsrisicobeoordeling/. [Accessed 29.1 1. 2021].

[6] VRZHZ, "Regional risk profile," [Online]. Available: https://www.zhzveilig.nl/rrp/. [Accessed 29. 1. 2021].

[7] Netherlands Ministry for Infrastructure and Water Management, "Water Information System for the Netherlands - WaterInfo," [Online]. Available: https://waterinfo.rws.nl. [Accessed 29.1 1. 2021].

[8] Netherlands Ministry for Infrastructure and Water Management, "National information system for water and floods in the Netherlands - LIWO," [Online]. Available: https://basisinformatie-overstromingen.nl/liwo/#/. [Accessed 29. 1. 2021].

[9] "National crisis management system for the Netherlands - LCMS," [Online]. Available: https://www.lcms.nl/about-lcms. [Accessed 29. 1. 2021].

[10] "Flood Risk in the Netherlands, VNK2 Method," [Online]. Available: https://www.helpdeskwater.nl/secundaire-navigatie/english/waterlinks-and/. [Accessed 29. 1. 2021].

[11] Directorate of Civil Protection of the Ministry of the Interior of the Republic of Croatia, "Disaster Risk Reduction Portal - SROK," [Online]. Available: https://civilna-zastita.gov.hr/portal-smanjenja-rizika-od-katastrofa-srok/2751. [Accessed 29. 1. 2021].

[12] "Web site of the Directorate of Civil Protection of the Ministery of the Interior of the Republic of Croatia," [Online]. Available: https://civilna-zastita.gov.hr/. [Accessed 29. 1. 2021].

[13] Croatian legal entity for water management - Hrvatske Vode, "Current water levels in the Republic of Croatia," [Online]. Available: http://vodostaji.voda.hr/. [Accessed 29. 1. 2021].

[14] Croatian legal entity for water management - Hrvatske Vode, "GeoPortal," [Online]. Available: https://preglednik.voda.hr/. [Accessed 29. 1. 2021].

Appendix A1: Questions for SLO CPA – Data to be included in the IMP

1. How does you institution address the issue of flood hazard?

    a. Please list the strategic documents that define the prevention, preparedness and response to flood hazard?

    National plan for protection and rescue in case of flooding is the basic strategic document that defines prevention, preparedness and response to flood hazard.

    b. Which platforms are used for tracking flood hazard and for planning response to potential threat? Please describe briefly these platforms (which information are provided)

    Two platforms exist: i) SMOK, ii) SPIN. The platform SMOK is used for tracking water levels and releasing alarms in case of flooding. The platform SPIN is more general and includes different threats in addition to flooding (traffic accidents, fires, pollution etc.)

    c. What parameters are used to measure the flood hazard?

    Flood hazard is measured based on water levels. The platform SMOK is used to track the development of water levels and for releasing alarms. The prediction of water levels is released by Slovenian Environment Agency. The system for alarming uses a 4-level color scheme: i) green (normal conditions), ii) yellow (start of isolate overflow of rivers), iii) orange (floods), iv) red severe floods.

2. How is the safety of bridges and dikes monitored during floods?

    a. Does you institution have an inventory of flood-vulnerable assets? If yes, what procedure was used to construct such a list?

    SLO CPA does not have an inventory of flood-vulnerable assets, but areas more susceptible to flooding are known from past events.

    b. What procedure do you use to respond in the case of safety/operability issues of bridges and dikes?

    Slovenian Environmental Agency issues an alarm. The regional CPA unit than informs the operator of the facility about the danger. The situation is monitored and action is issued if necessary.

    c. How is the safety/operability of bridges and dikes represented in your system for response?

    Slovenian civil protection system does not directly address the safety of bridges. Alarms are issued only based on water levels.

3. Does the current system of prevention, preparedness and response address sufficiently the safety of bridges and dikes?

   a. Is the safety of bridges and dikes monitored sufficiently?

      The safety of bridges and dikes in not monitored directly, but only indirectly based on water levels.

   b. Which procedure or methodology in the current system can be improved and how?

      The safety of bridges could be incorporated in the current system for monitoring. In this ways, the safety / operability of bridges could be predicted more accurately.

   c. Are there any issues which lack coverage in the current system?

      The safety of bridges and dikes is monitored indirectly based on water levels only.

Appendix A2: Questions for South Holland CPA (VRZHZ)– Data to be included in the IMP

1. How does you institution address the issue of flood hazard?

   a. Please list the strategic documents that define the prevention, preparedness and response to flood hazard?

      i. *National water program 2022-2027*

      https://www.helpdeskwater.nl/onderwerpen/wetgeving-beleid/nationaal/nationaal-water-programma-2022-2027/

      National water program

      ii. *https://www.helpdeskwater.nl/onderwerpen/wetgeving-beleid/europese-richtlijn-overstromingsrisico/voorlopige-overstromingsrisicobeoordeling/ National flooding risk review*

      iii. *https://www.zhzveilig.nl/rrp/ Regional Risk Profile*

   b. Which platforms are used for tracking flood hazard and for planning response to potential threat? Please describe briefly these platforms (which information are provided)

      https://waterinfo.rws.nl/ and https://basisinformatie-overstromingen.nl/liwo

   c. What parameters are used to measure the flood hazard?

      Meteo, Tide, Discharge, Dikeguards and calculations made by the Dutch Water management centre and Rijkswaterstaat, Calculations of Regional Waterboards

2. How is the safety of bridges and dikes monitored during floods?

   a. Does you institution have an inventory of flood-vulnerable assets? If yes, what procedure was used to construct such a list?

      We are working on impact analyses of flood-vulnerable assets. The procedure used is the guidance impact-analyses, http://onswater.ifv.nl

   b. What procedure do you use to respond in the case of safety/operability issues of bridges and dikes?

      Regional contingency plans, flooding contingency plans, evacuation plans

   c. How is the safety/operability of bridges and dikes represented in your system for response?

We use the data of VNK2 and LIWO and we use our information management system, LCMS

3. Does the current system of prevention, preparedness and response address sufficiently the safety of bridges and dikes?

   a. Is the safety of bridges and dikes monitored sufficiently?

      There are inspections of the dikes on a regular base, and during high water levels.

   b. Which procedure or methodology in the current system can be improved and how?

      It is now depending on yearly inspection and in case of high water levels extra dike patrol. This could be improved by a monitoring system which shows the exact state of the dike, so there can be made better predictions about the effect of the water level on the dike, preferably shown in a GIS map.

   c. Are there any issues which lack coverage in the current system?

      It is al depending on models and interpretation of individual experts not actual data

Appendix B: Questions for oVEFLOw experts – Data to be included in the IMP

1. Please list the parameters needed for evaluation of the performance of bridges and dikes during flood events.

   ZAG answers for bridges:

   - Geometry and material characteristics of the bridge, including foundations

   - Soil characteristics for definition of soil-foundation interaction

   - Geometry of the river bed

   - Flood hazard data

   InGEO and FCEZG answer for embankments:

   - Overall Geometry, including slope angle, height, crest width

   - Geological, hydrogeological and geotechnical characteristics of soil in, beneath and next to the embankment

   - Maximum flood height and duration of the flood wave

   - Inspection and remediation records

2. Please list the failure mechanisms which will be included in the fragility analysis and relate them with considered load scenario.

   ZAG answers for bridges:

   - Failure can be related to failure of RC section, loss of support due to excessive deformation and instability due to scour at the pier foundation. Ageing of material can be an important aspect. Operability of the bridge can be affected by excessive displacements / deformations.

   - We plan to consider the following load scenarios: i) water pressure, ii) debris accumulation and impact on superstructure, iii) scour at the bridge pier

   InGEO and FCEZG answer for embankments:

   - Overtopping

   - Slope stability

   - Internal erosion (piping)

   - Uplift

   - Gullying

3. Which parameters of the flood are used to define the selected load scenarios? Do you plan to use a hydraulic or hydrodynamic to obtain more precise characteristic of the flood at the site under consideration?

ZAG answers for bridges:

- Water pressure and debris accumulation: related to the square of velocity of the flood, but also height is need to define the loaded parts

- Scour: velocity and height of the flood

- We do not plan to use hydraulic models to obtain the parameters of the flood (but we have to discuss with GECOM what data they can provide)

InGEO and FCEZG answer for embankments:

- Maximum flood height

- Duration of the flood wave

- We do not plan to use hydraulic models to obtain the parameters of the flood

4. What parameters are used to define the flood hazard? Which intensity measure will be used for fragility analysis?

ZAG answers for bridges:

- Parameters: flood height, velocity, discharge + return periods for these quantities

- We plan to use discharge as intensity measure; these will be then related to velocity and height

InGEO and FCEZG answer for embankments:

- Maximum flood height

- Duration of the flood wave

5. Please list the sources of variability presented in flood fragility analysis, i.e. which random and uncertain parameters affect the probability of exceeding a selected limit state for a given value of intensity measure.

ZAG answers for bridges:

- Hydraulic variability: for a given Q → variability in prediction of v, H

- Material properties uncertainty: uncertain parameters of concrete, reinforcing steel

- Geotechnical uncertainty: uncertain parameters of the soil (probably large)

- Scour prediction uncertainty: can be large, influence depends on the structure

- Water pressure uncertainty: for a given v → variability in pressure (importance of debris)

InGEO and FCEZG answer for embankments:

- Geotechnical parameters variability: hydraulic and strength parameters. These are the main factors influencing the behavior of the embankments.

- Layering variability below the embankment

- Uncertainties of the flood wave duration

6. How is the performance of the bridges/dikes measured?

ZAG for bridges:

- In terms of fragility curves which define the probability of exceeding a limit state of performance (operability, failure) given a hazard parameter (water height, velocity, discharge) – P (LS|IM)

- Or RISK of exceeding a limit state of performance P(LS): calculated by convolution of bridge vulnerability and flood hazard.

- These parameters are appropriate for communication between experts. For end-users a color scheme will be used to present the expected performance.

InGEO and FCEZG answer for embankments:

- In terms of fragility curves which define the probability of exceeding different limit states (failures) given the hydraulic head values on the river side of the embankment – analysis will provide insight into the probability of failure and reliability index for each failure mechanism

7. What format do you think it the most appropriate to present results to end users (CPAs, stakeholders)?

ZAG for bridges:

- Color scheme with markings of performance of the bridges to help CPA's decision making.

InGEO and FCEZG answer for embankments:

- Color scheme with markings of performance of the embankments with respect to the sensitivity to particular failure mechanism (this would be useful for experts) and separate scheme of overall performance to help CPA's decision making.