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Vulnerability assessment of embankments and bridges exposed to flooding hazards

Deliverable 7.3

Digital Newsletter 3

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VEILIGHEIDSREGIO ZUID-HOLLAND ZUID	Netherlands
INGEO BV	Netherlands
ZAVOD ZA GRADBENISTVO SLOVENIJE	Slovenia
Uprava Republike Slovenije za zaščito in reševanje	Slovenia

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Executive Summary

This report outlines the project activities performed in the third six months of the oVERFLOw project in accordance with Annex I of Grant Agreement no. 874421. The deliverable was foreseen to cover the period from 1st December 2020 (M13) to 31st May 2021 (M18).

However, due to the delay of some project activities as a result of the Covid-19 pandemics and the series of earthquakes that hit Croatia in 2020, a formal extension of the project duration by 8 month was agreed by DG ECHO and implemented through the Grant Agreement Amendment. Therefore, this digital newsletter effectively covers the project activities performed from 1st January 2021 (M14) to 30th June 2021 (M19).

It is the third of four digital newsletters that will be published in regular intervals every six months until the end of the project. An additional digital newsletter will be published at the official end of the project (31th July 2022) to summarize the activities performed in the additional 8 months. The content of this deliverable will be publicly available and will be shared through the project website and social media publications.

Keywords: Newsletter, project activities.

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1 Abbreviations and Acronyms

Abbreviation / Acronym	Description
CPA	CIVIL PROTECTION AGENCY
FCEZG	SVEUČILIŠTE U ZAGREBU GRAĐEVINSKI FAKULTET
IPK	INFRA PLAN KONZALTING J.D.O.O.
INGEO	INGEO BV
IMP	INFORMATION MANAGEMENT PLATFORM
GEKOM	GEKOM – GEOFIZIKALNO I EKOLOŠKO MODELIRANJE D.O.O.
VRZHZ	VEILIGHEIDSREGIO ZUID-HOLLAND ZUID
ZAG	ZAVOD ZA GRADBENISTVO SLOVENIJE
URSZR	UPRAVA REPUBLIKE SLOVENIJE ZA ZAŠČITO IN REŠEVANJE

2 Background

In accordance with Annex I of Grant Agreement no. 874421, ZAG is the lead beneficiary for preparing four six months project newsletters, which are aimed at giving regular updates on the performed project activities. This is the third of four foreseen newsletters and covers the project activities performed in the period from 1st January 2021 (M14) to 30th June 2021 (M19). Due to project duration extension, for additional 8 months, an additional newsletter will be published at the end of the project (31th July 2022).

3 Objective/Aim

The oVERFLOw project is funded under the European Union Civil Protection Mechanism framework, according to the following call topic UCPM-2019-PP-PREV-AG: Prevention in civil protection and marine pollution.

The objective of this deliverable is dissemination of project activities performed in the third six months of the project. The content of this deliverable will be publicly available and will be shared through the project website and social media publications.

4 Report on project activities

This report outlines the project activities performed in the third six months of the oVERFLOw project in accordance with Annex I of Grant Agreement no. 874421. The deliverable covers the project activities performed in the period from 1st January 2021 (M14) to 30th June 2021 (M19).

It was foreseen that an article on the demonstration of embankments related activities will be a part of the Digital Newsletter 1. However, due to delay of some project activities, this was not possible. The demonstration of embankments and bridge on-site investigations was thus partly included in Digital Newsletter 2. Additional investigations performed from January to June 2021 are described herein.

The activities performed in the third 6 months of the project were the following:

- On-line workshop on data transfer protocols between WPs – January 2021
- Meeting with South Holland CPA regarding implementation of IMP – February 2021
- Meetings with Karlovac Municipality for implementation of IMP – March and April 2021
- Submission of technical deliverables D2.2 in D2.3 – March 2021
- Investigations of embankments and bridges – February to May 2021
- Dissemination (CoMS conference, paper in journal Water, flyers) - March and April 2021
- Extension of project duration by 8 months – March and April 2021
- Monthly on-line consortium meetings

These activities will be described in more detail in the following chapters.

4.1 On-line workshop on data transfer protocols between WPs

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. The figure 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.

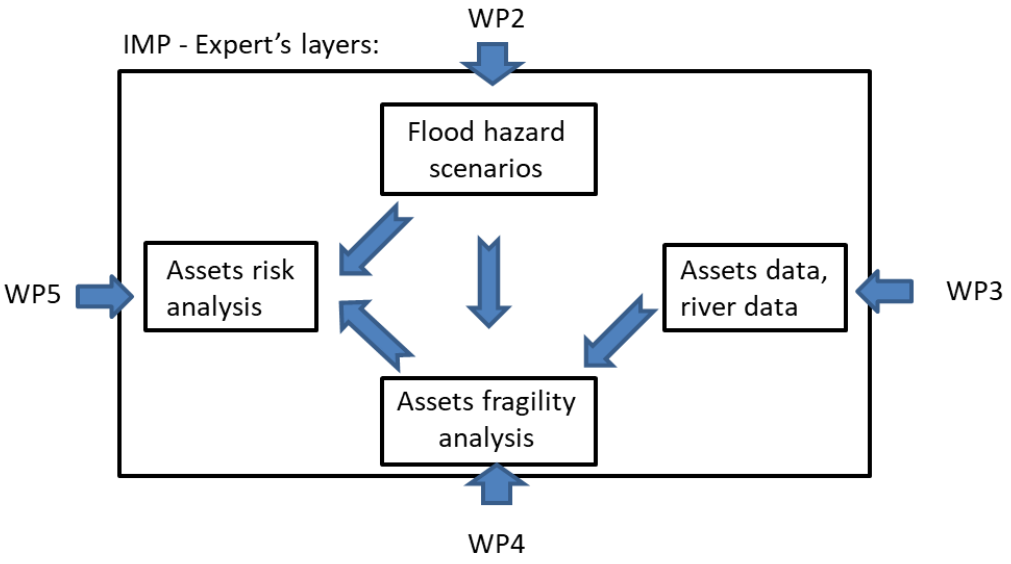

Figure 1: Data transfer protocol between WPs

4.2 Meeting with South Holland CPA for implementation of IMP

On 3rd February 2021, an on-line meeting was organized between representatives of ZAG (Andrej Anžlin, Mirko Kosič) and South Holland CPA – VRZHZ (Erik-Jan Roggekamp, Eddy van Well, Chi Brouwer) to discuss technical aspects of the implementation of the IMP to the case study area. On the meeting it was agreed that ZAG will set up a server to store the data used in the IMP. The data will be made available to South Holland's GIS system via a set of protocols. The result of the meeting was also a list of technical specifications that will ensure smooth transfer of data between the ZAG server and South Holland's GIS system.

4.3 Meetings with Karlovac Municipality for implementation of IMP and on-site investigations of bridges and embankments

On 25th March 2021, the representatives of oVERFLOw consortium (Irina Stipanović, Sandra Škarić Palić, Mirko Kosič (via Teams)) met with representatives of Karlovac Municipality (Marino Ivušić, Mladen Grčić) in Karlovac to discuss the activities related to the implementation of the IMP to the case study area. The representatives of the oVERFLOw project explained the data that will be displayed in GIS layer, whereas Mr. Marino Ivušić from Karlovac Municipality presented the capabilities of their GIS system.

The representatives of the oVERFLOw project also presented the progress of the project activities related to the numerical analyses and on-site investigations of the Banija Bridge. Newly gathered information from national archives, which among other include original plans of the predecessor of the current Banija Bridge from 1884, was also presented. On the meeting it was agreed that the technical specifications for implementation of IMP into the Karlovac Municipality GIS system will be discussed in a separate meeting. The meeting took place on-line on 28th April 2021. GIS experts from both sizes (Laurens Oostwegel – ZAG and Frane Glasinović – Karlovac Municipality) also

joined to discuss the technical aspects of data transfer from ZAG server to Karlovac Municipality GIS system.

4.4 Submission of technical deliverables D2.2 in D2.3

Following initial delay of the project activities in WP2, the members of WP2 are glad to report that deliverables D2.2 and D2.3 were finalized and submitted in March 2021.

Within D2.2, an analysis of downscaled climate data have been conducted for the two selected case study areas (City of Karlovac in Croatia, Rhine-Maas delta region in the Netherlands) for different climate change scenarios. Based on the results of downscaled climate data for IPCC climate scenarios RCP4.5 and RCP8.5, machine learning method has been applied to infer expected changes of water level and water flow (high-resolution information) at Karlovac case study area. For the Dutch case study, results of downscaled climate modelling regarding results of hydraulic models have been analysed in order to derive probable maximum floods with respect to different return periods. These results will be used for further vulnerability analysis of bridges and embankments in WP3 and WP4.

The first objective of D2.3 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.

Activities are currently underway for implementation of the IMP to the selected case study areas, which represents the final deliverable of WP2 (D2.4). It is foreseen that an initial version of IMP will be operational in July 2021. A short report will be issued on the activities related to the implementation of the IMP for the Karlovac Municipality and South Holland CPA.

4.5 Investigations of embankments and bridges

Embankments

In September and October 2020, UNIZAG GF visited Dutch and Croatian case study locations, as preparations for the site investigations. Stakeholder representatives were present.

Aerial photogrammetry and thermal scanning of the whole area case study area was performed in December 2020. This was followed by the generation of 3D point clouds and automatic generation of riverbank cross-section profiles. The extracted geometry is used for the conduction of series of vulnerability analysis with development of fragility curves for both Kupa riverbank sides, Figure 2.

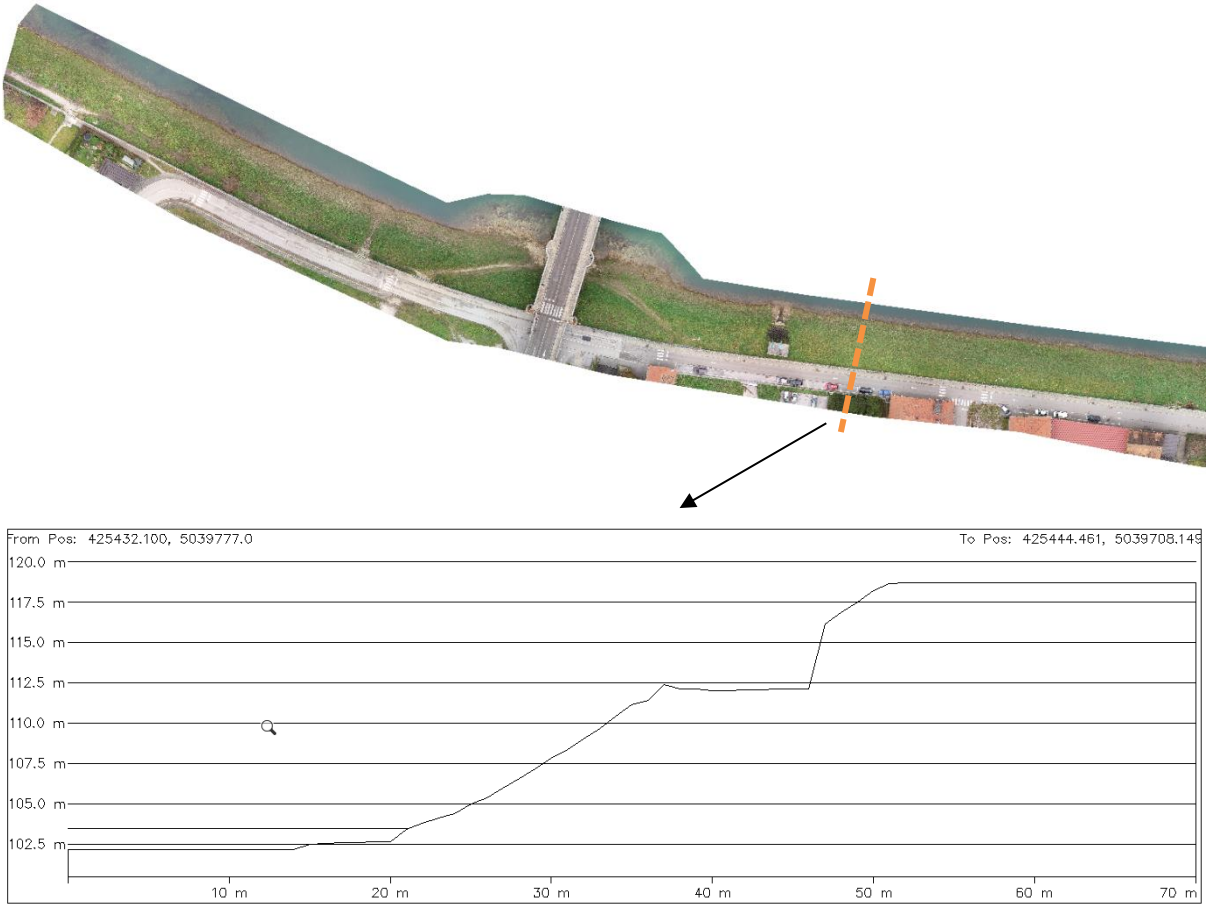

Figure 2: 3D point cloud model (top) with one extracted cross-section geometry (bottom) used in the vulnerability analysis

Additionally, to determine the riverbank subsoil conditions as well the variability of key soil parameters for vulnerability analysis, a drilling was performed along with soil sampling and laboratory testing, Figure 3.

Figure 3: Borehole drilling on the location of right riverbank of Kupa river (left) and core of the one of the drilled boreholes (right)

Additionally, the geophysical investigations of seismic refraction was used to supplement the knowledge of geological-structural and physical-mechanical characteristics of the riverbank subsoil, since it covers much larger volume when compared to discrete borehole drillings. The non-destructive seismic refraction method is based on an analysis of artificially created seismic waves that are generated from the surface, Figure 4, with the final result being the refraction profile containing the allocation of P velocities in subsoil. One refraction profile from the case study area is shown in Figure 4.

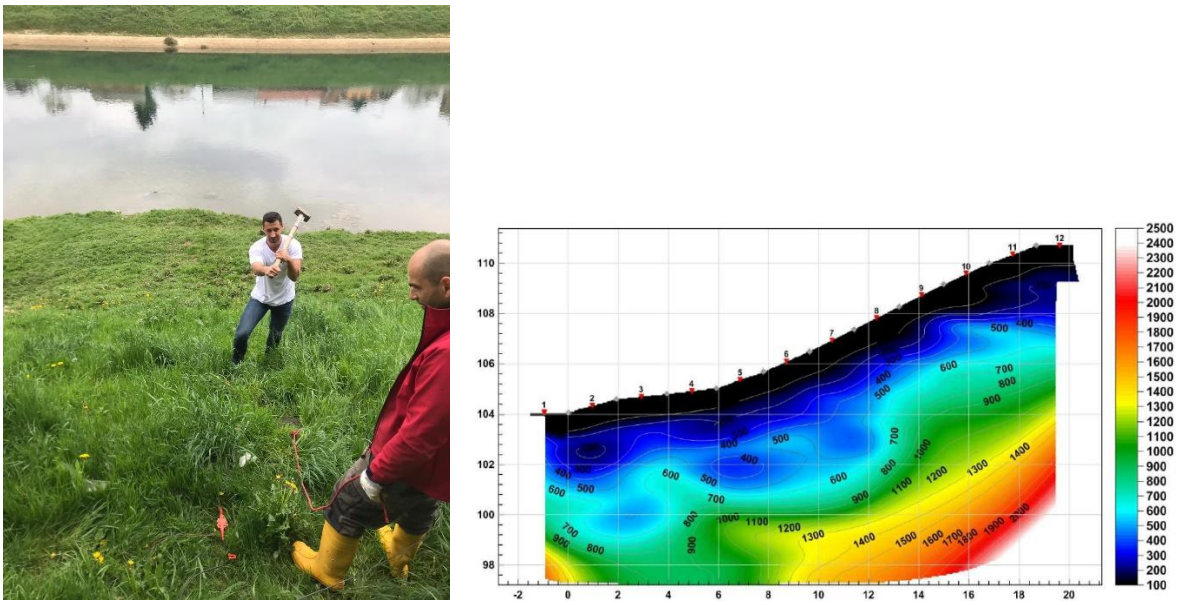

Figure 4: Acquisition of the geophysical data on the right riverbank of Kupa river (left) and one of the seismic refraction profiles (right)

Currently, the CPTU investigation campaign is finalizing, and these results will be used to supplement the current database, as they will provide continuous profile of soil along the investigation depth. To ease the implementation of the CPTU results in analysis for the subsequent development of fragility curves, UNIZAG GF developed a soil layering algorithm, which, merges thin layers detected by CPTU into the adjacent layers and thus overcomes the unreliable determination of the thin layers. Validation of this algorithm is shown on an example of a levee in north Croatia, Figure 5.

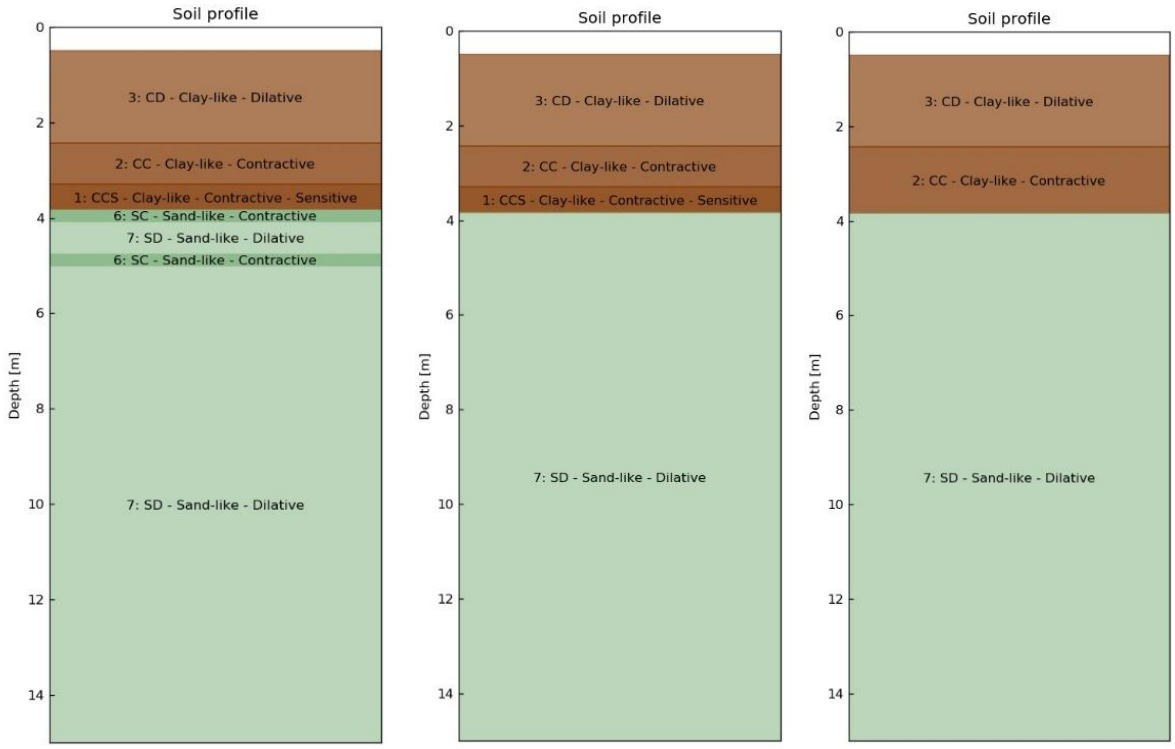

Figure 5: Obtained stratigraphy profile for minimum thickness of: 15 cm (left), 50 cm (middle) and 100 cm (right)

The database of the subsoil conditions for the Dutch case study dike section 17-3 Oud-IJsselmonde-Oostendam, is also established and is currently being used for the vulnerability analysis of the embankments. The CPTUs are obtained from the open-access database DINOloket https://www.dinoloket.nl/, while the geophysical investigations, used to supplement the existing database, are planned for the following month.

Bridges

On 17th December 2020, ZAG and its subcontractors performed a bathymetric survey of the Kupa riverbed and a drone inspection of the river channel for both case study bridges. The description of activities related to this task was presented in Digital Newsletter 2. Following the bathymetric and drone surveys, a 3D point cloud model of the two case study bridges and the riverbed was constructed. The obtained 3D models for the two case study bridges are presented in Figure 2 and Figure . This information will be used to define the geometry of the two bridges and riverbed for the purpose of numerical modelling in WP4.

An additional investigation campaign was undertaken on 9th March 2021, when members of ZAG performed ambient vibration measurements for the two case study bridges. The measurement of ambient vibration consists of recording the response of the bridge to random (unknown) vibrations resulting from nearby environment (e.g. wind, traffic etc.). The results of the measurements allow the identification of the bridge vibration frequencies and modal shapes, which represent important information for calibration of the numerical models for flood fragility analysis in WP4.

The system used to measure the response consists of a portable 220V power supply, portable computed with digital acquisition software, a switch with up to 8 channels and 12 three-axial accelerometers that measure accelerations in three orthogonal directions. The components of the system were connected together in an EtherCAT network.

The measurements were first performed for the Banija Bridge. In total, 12 accelerometers were placed on the bridge to measure its response to ambient vibrations. The employed distribution of sensors is presented Figure . The sensors were placed on the two main steel girders of the bridge at equidistant spacing of approximately 12 m. The ambient vibrations were recorded in ten 10-minite time windows. Selected pictures from the investigation campaign of the Banija Bridge are presented in Figure .

Ambient vibration measurements were also performed for Prilaz Većeslava Holjevca Bridge. In this case, a single daisy chain of 6 sensors was placed on the downstream size of the bridge due to difficulties in accessing the other side of the bridge with running traffic. Two accelerometers were placed in the first span of the bridge at 1/3 and 2/3 of the span length. One accelerometer was placed above the pier and three accelerometers were placed in the main span of the bridge, i.e. one the middle of the span and two at the location of the Gerber bearings. The ambient vibrations were recorded in four 10-minite time windows. Selected photos from the investigation campaign of the Prilaz Većeslava Holjevca Bridge are presented in Figure .

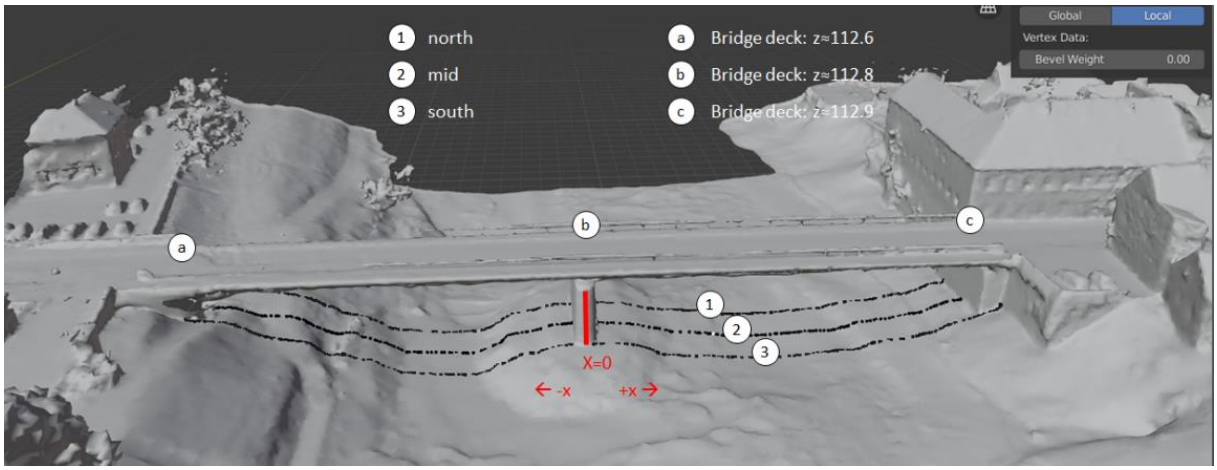

Figure 26: 3D model of the Banija Bridge and riverbed in proximity of the bridge

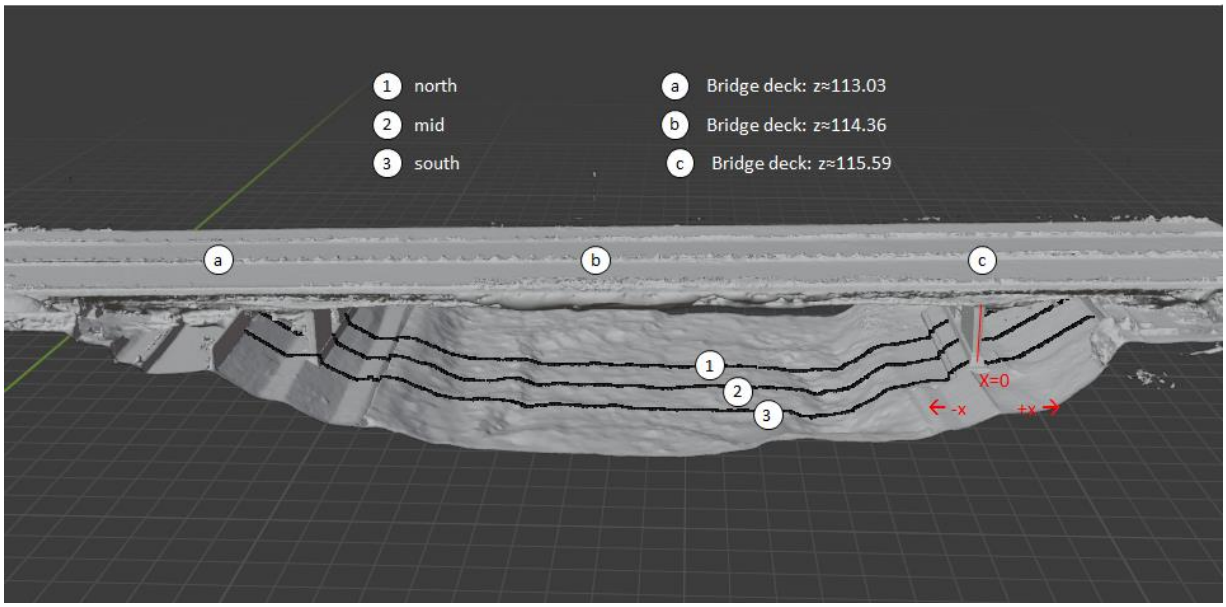

Figure 7: 3D model of the Prilaz Većeslava Holjevca Bridge and riverbed in proximity of the bridge.

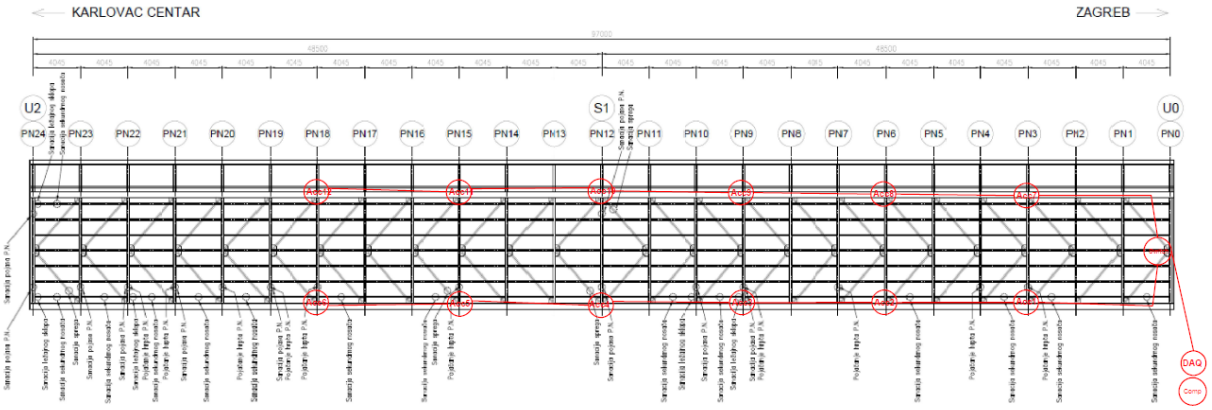

Figure 8: Distribution of accelerometers for ambient vibration measurements of the Banija Bridge.

Figure 9: Selected pictures from ambient vibration measurements of the Banija Bridge

Figure 10: Selected pictures from ambient vibration measurements of the Prilaz Većeslava Holjevca Bridge.

4.6 Dissemination activities

Flyers and brochures

The flyers and brochures of the oVERFLOw project were developed. Along with flyers and brochures which will be disseminated as printed materials and via electronic channels, the flipbook materials are posted on the project website, and can be also accessed via https://online.fliphtml5.com/bacor/muqb/

High-quality journal paper

UNIZAG GF published a paper 'Development of Fragility Curves for Piping and Slope Stability of River Levees' in the Special Issue 'Dam Safety, Overtopping and Geostructural Risks' of an open-access journal 'Water', indexed within Scopus, SCIE (Web of Science), Ei Compendex, GEOBASE, GeoRef, AGRICOLA, AGRIS, CAPlus / SciFinder, Inspec, and many other databases. Journal Rank is following: JCR - Q2 (Water Resources) / CiteScore - Q1 (Geography, Planning and Development), while the Impact Factor is 3.103 (2020); 5-Year Impact Factor: 3.229 (2020).

The paper was published on March 9th 2021.

The research funding source (project oVERFLOw) is highlighted at the end of the paper.

Paper URL: https://www.mdpi.com/2073-4441/13/5/738/htm

Paper DOI: https://doi.org/10.3390/w13050738

Dissemination of oVERFLOw project on CoMS conference

The oVERFLOw project was presented in the project dissemination showroom of the CoMS 2020/21 conference, which was held on-line between 20th and 21st April 2021. The conference was organized by ZAG – the Slovenian National Building and Civil Engineering Institute alongside with co-organizing institutions: the University of Zagreb, Faculty of Civil Engineering, the University of Novi Sad, Faculty of Technical Science, the BAM – Federal Institute for Materials Research and Testing and supported by sponsors and RILEM's Technical Activities Committee.

The CoMS conference was attended by more than 130 worldwide experts coming from 19 different, mostly European, countries. The programme was composed of six plenary and eight keynote lectures, 58 oral presentations and 16 posters. The conference proceedings were published in two volumes with volume one including 40 papers and volume two 20 papers. The oVERFLOw project showroom included the project brochure, presentation of the project and selected figures from project activities (see Figure).

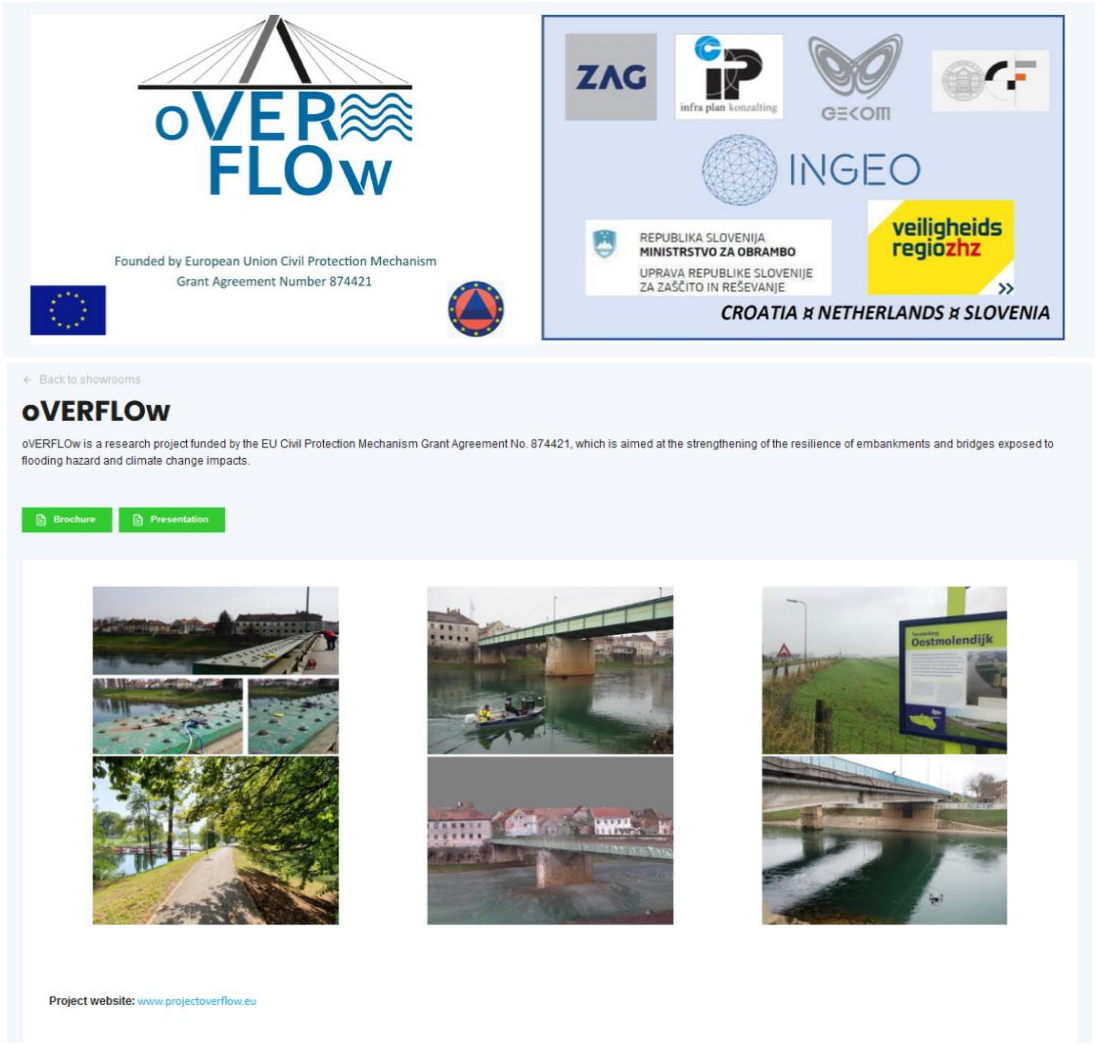

Figure 11: oVERFLOw showroom at CoMS 2020/21 conference

4.7 Extension of project duration by 8 months

On 30th March 2021, the oVERFLOw consortium issued a request for the change of action's duration due to unexpected circumstances which hinder the project implementation. Consortium requested an extension of project duration by 8 months, from 30th November 2021 to 31th July 2022.

Main reason for the request was omnipresent situation with COVID-19 which slowed down project activities. The foreseen site investigations were prolonged due to traveling restrictions. In addition, two earthquakes of high intensity (March 2020 and December 2020) have hit city of Zagreb and Sisacko – Moslavacka county, directly affecting three Consortium members as well the Croatian CPA, relevant services and stakeholders. This yielded difficulties in obtaining weather data from Croatian Meteorological Service, whose infrastructure was severely damaged by earthquake. Croatian CPA, as well the Croatian Waters as an important stakeholder for the implementation of project activities were in this period mostly dealing with the earthquake aftermath.

As part of the amendment, a new detailed elaboration of activities and delivery / realization dates were proposed. The Consortium's request was approved by DG ECHO on 22nd April 2021.

4.8 Monthly on-line consortium meetings

To have continuous discussion on the project implementation, the consortium members have an on-line monthly meeting, held on Thursday of the first week of the month. These meeting provide the platform for the exchange of the ideas and to provide an insight into ongoing activities of each consortium member.

5 Conclusions

This report outlines the project activities performed in the third six months of the oVERFLOw project in accordance with Annex I of Grant Agreement no. 874421.

The deliverable covers the project activities performed in the period from 1st January 2021 (M14) to 30th June 2021 (M19).

The deliverables covers several activities, from internal consortium workshops, meetings with South Holland CPA and Karlovac Municipality for implementation of IMP, submission of technical deliverables D2.2 in D2.3, investigations of embankments and bridges and dissemination activities (CoMS conference, paper in journal Water, flyers and borcuhres)

The progress of the project oVERFLOw can be followed on our web page:

https://projectoverflow.eu/

and oVERFLOw project social media profiles:

Facebook: https://www.facebook.com/OVERFLOw-project-108534450696939/

Twitter: https://twitter.com/oVERFLOWprojec1

LinkedIn: https://www.linkedin.com/in/overflow-project-541b101a0/