Ref. Ares(2022)5377584 - 26/07/2022

Funded by European Union Civil Protection
Grant Agreement Number 874421

Vulnerability assessment of embankments and bridges exposed to flooding hazards

Deliverable 7.14

Digital Newsletter 5

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	32 months
Call Identifier	UCPM-2019-PP-AG
Topic	UCPM-2019-PP-PREV-AG: Prevention in civil protection and marine pollution
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INGEO BV	Netherlands
ZAVOD ZA GRADBENISTVO SLOVENIJE	Slovenia
Uprava Republike Slovenije za zaščito in reševanje	Slovenia

Document Information

Work Package	7
Deliverable Title	Digital Newsletter 5
Version	1.0
Date of Submission	25/07/2022
Main Editor(s)	Mirko Kosič, Andrej Anžlin, Mario Bacic
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Reviewer(s)	Irina Stipanovic, Sandra Skaric Palic
Citation	Kosič M., Anžlin, A., Bacic, M. (2022). oVERFLOw Deliverable 7.14: Digital Newsletter 5

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

History			
Version	**Issue Date**	**Status**	**Distribution**
1	16/07/2022	For review	IPK
1	20/07/2022	For review	All partners

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Executive Summary

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

Considering the extended timetable of the project according to Grant Agreement Amendment, this digital newsletter covers the project activities performed from the January 1st 2022 (M26) to the July 31st 2022 (M32).

It is the last of the fifth digital newsletters published during the project. It represents an additional newsletter that covers the activities performed in the extended period of the project. The content of this deliverable will be publicly available and 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 six-month project newsletters aimed at giving regular updates on the performed project activities. It is an additional newsletter that covers activities performed in the extension period of the project from the January 1st 2022 (M26) to the July 31st 2022 (M32).

3 Objective/Aim

The objective of this deliverable is the dissemination of project activities performed in the last seven 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 activities performed in the last seven months of the oVERFLOw project in accordance with Annex I of Grant Agreement no. 874421. It covers the activities performed in the extension period from the January 1st 2022 (M26) to the July 31st 2022 (M32).

The activities performed were the following:

- Workshop in the city of Karlovac –May 5th 2022
- Forced-vibration test for the Banija Bridge in Karlovac –June 2nd 2022
- oVEFLOw Final Conference – July 14th to 15th 2022
- Dissemination activities

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

4.1 Workshop in the city of Karlovac –May 5th 2022

On the May 5th 2022, the oVEFLOw consortium organised a workshop in the city of Karlovac. The event was held at the Karlovac Municipality and aimed at presenting the project's outputs to the municipality's members. It was attended by representatives from FCEZG, IPK and ZAG, who presented their respective work. Mario Bačić from FCEZG introduced the representative of the Karlovac Municipality with the investigation works and results of vulnerability assessment of the embankment near the Kupa River, while Mirko Kosič from ZAG presented the investigation works and vulnerability assessment results for the two case study bridges. Irina Stipanović from IPK presented the results of the flood risk analysis of the city of Karlovac. The outcomes of the oVERFLOw project were well received, and the Karlovac Municipality expressed interest in further collaboration and extension of the performed studies. Selected photos from the workshop are presented in Figure 1 andFigure 2.

Figure 1: Workshop in the city of Karlovac (1)

Figure 2: Workshop in the city of Karlovac (2)

4.2 Forced-vibration test for the Banija Bridge in Karlovac – the 2nd of June 2022

On the June 2nd 2022, ZAG members revisited the city of Karlovac to perform additional in-situ investigations of the case study Banija Bridge. As previous ambient vibration tests were inconclusive concerning the horizontal vibration modes of the Banija Bridge, a forced-vibration test was performed using 2 APS 400 long-stroke shakers, which were used to excite the bridge in both horizontal directions (Figure 3). The forced-vibration test was performed with the same distribution of sensors as used for the ambient vibration measurements, which included 12 3-axial MEMS (see Figure 4). The long-stroke shakers were placed above the middle pier of the bridge on both sides of the bridge deck. The shakers were excited in phase to deliver the max possible horizontal excitation. Sweep frequency tests were first performed to determine the resonant vibration frequencies of the bridge. Several harmonic tests were then performed for the previously obtained resonant frequencies. The test results will help improve the calibration of the numerical model, which will result in a more precise estimation of the bridge flood vulnerability.

Figure 3: APS 400 long-stroke shaker used for forced-vibration test of the Banija Bridge (left) with its operation control system (right)

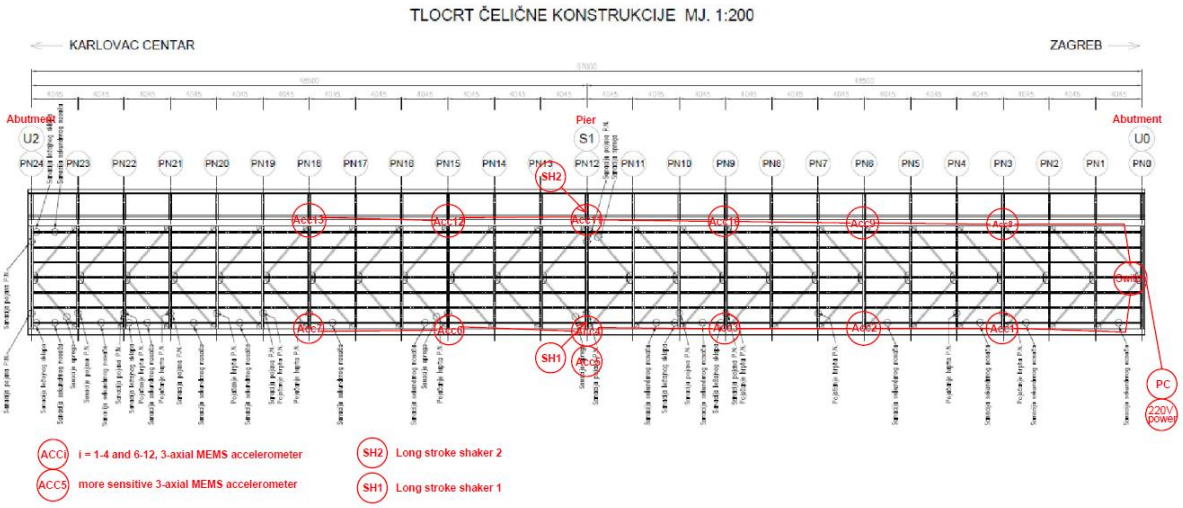

Figure 4: Disposition of sensors for forced-vibration test of the Banija Bridge

4.3 oVEFLOw Final Conference –July 14th & 15th 2022

The final conference of the oVERFLOw project was held in Plitvice Lakes on July 14th and 15th 2022. The conference was organised as a two-day event aimed at presenting the project's outcomes to the interested stakeholders and infrastructure managers.

The first day of the conference was devoted to the presentations of the project outcomes. After the welcome and introduction, Mario Bačić from FCEZG presented the performed in-situ investigations for the flood protection embankments in the case study area in the Netherlands and the city of Karlovac. The following presentations were on the flood vulnerability analysis of flood protection embankments. Kenneth Gavin from InGEO presented the vulnerability analysis of the Oostmolendijk in the Netherlands, which shows alarming signs due to cracking and excessive settlement. Mario Bačić continued presenting the results of the vulnerability assessment of the flood protection embankments in the city of Karlovac, which were found especially vulnerable to local slope stability issues due to the rapid drawdown of water levels.

The following presentations were on the flood vulnerability of bridges. Mirko Kosič from ZAG presented the in-situ investigations and results of flood vulnerability analysis of the two case study bridges in Karlovac. The vulnerability of the bridges was found to be highly related to the accumulation of debris, which not only increases the hydrodynamic forces on the bridges but also results in larger pier scour. The measures to alleviate the effect of flooding on the bridges were elaborate by Andrej Anžlin from ZAG, who presented an overview of possible adaptation measures.

After the lunch break, Sandra Skarić Palić from IPK demonstrated the risk forecasting tool, which is a significant outcome of the project as it provides a direct tool for infrastructure managers and civil protection agencies to implement the project results. The GIS-based risk forecasting tool combines vulnerability analysis results with possible consequences of flooding to quantify: i) expected monetary losses; ii) mapping of the vulnerability of critical infrastructure to identify

safe evacuation routes. The application of the risk forecasting tool was demonstrated for the case study areas in Croatia and the Netherlands.

After the demonstration of the risk forecasting tool, Chi Brouwer from VRZHZ presented the guidelines for the implementation of the outputs of the project in the Civil Protection Agency (CPA) protocols.

The first day of the workshop concluded with the discussion of the achievements of the oVERFLOw project. The workshop participants share the opinion that the project managed to achieve the ambitious goal put forward in the project proposal, despite challenging circumstances with the COVID pandemic and earthquake-induced disasters in Croatia, which significantly affected the project activities.

The last day of the conference was concluded with a discussion of future initiates for new UCPM project proposals and a guided excursion in the Plitvice Lakes national park. Selected photos for the final conference are presented in Figure 5.

Figure 5: Selected pictures from the oVERFLOw final conference.

4.4 Dissemination activities

Since publishing the 4th digital newsletter (December 2021), several dissemination activities have been performed. The most important dissemination activities in the last seven months are the following:

- FCEZG, IPK and InGEO participated in the 7th International Conference on Road and Rail Infrastructure (CETRA 2022), held in Pula (Croatia) between the 11th and 15th of May 2022. Following papers were presented:

  Stipanović, Irina; Škarić Palić, Sandra; Bačić, Mario; Kovačević, Meho Saša; Gavin, Kenneth; Ganić, Emir. Flood risks to critical infrastructure – case study of city of Karlovac // Proceedings of 7th International Conference on Road and Rail Infrastructure - CETRA 2022 / Lakušić, Stjepan (ur.). Zagreb: University of Zagreb, 2022. str. 603-610 doi:10.5592/CO/CETRA.2022.1474

  Bačić, Mario; Kovačević, Meho Saša; Jurić Kaćunić, Danijela; Librić, Lovorka; Car, Marijan; Gavin, Kenneth; Stipanović, Irina; Reale, Cormac. Classification of a flood protection infrastructure based on its vulnerability to various loads // Proceedings of 7th International Conference on Road and Rail Infrastructure - CETRA 2022 / Lakušić, Stjepan (ur.). Zagreb: University of Zagreb, 2022. str. 611-618 doi:10.5592/CO/CETRA.2022.1471

- FCEZG and InGEO published additional paper in high-quality journal Sensors:

  Kovačević, Meho Saša; Bačić, Mario; Librić, Lovorka; Gavin, Kenneth. Evaluation of Creep Behavior of Soft Soils by Utilizing Multisensor Data Combined with Machine Learning // Sensors, 22 (2022), 8; 2888, 21 doi:10.3390/s22082888

- ZAG prepared a research paper on bridge vulnerability analysis of the Banija Bridge, which is ready for submission in a high-quality journal *Engineering Structures* (the draft of the paper was submitted as D7.6)

- Layman's report was prepared and submitted as D7.7

- The official project video was prepared (D7.8) and was published on the project webpage and social media, see https://www.youtube.com/watch?v=qKRWhxQ52wI

- FCEZG and IPK published an article under the title 'The oVERFLOw project – a proactive approach to floods' describing the oVERFLOw activities. An article is published in journal Protection (https://zastita.info/hr/casopis/aktualni-broj/) in June 2022.

5 Conclusions

This report outlines the activities performed in the last seven months of the oVERFLOw project in accordance with Annex I of Grant Agreement no. 874421. The deliverable covers the period from the January 1st 2022 (M26) to July 31st 2022 (M32). It is the last of five digital newsletters published within the project. The content of this deliverable will be publicly available and will be shared through the project website and social media publications.

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/