Ref. Ares(2021)225033 - 11/01/2021

Funded by European Union Civil Protection
Grant Agreement Number 874421

Vulnerability assessment of embankments and bridges exposed to flooding hazards

Deliverable D7.11

oVERFLOw flyers and brochures

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	1
Deliverable Title	oVERFLOw flyers and brochures
Version	1.0
Date of Submission	11/01/2021
Main Editor(s)	Sandra Skaric Palic, Primoz Ursic
Contributor(s)	Irina Stipanovic, Martin Legisa
Reviewer(s)	Mario Bacic
Citation	S. Skaric Palic, P. Ursic. (2021). oVERFLOw Deliverable 7.11 oVERFLOW flyers and brochures

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

History			
Version	**Issue Date**	**Status**	**Distribution**
1	01/01/2021	For further input	All partners
2	11/01/2021	Final	All partners

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 presents flyers and brochures used for oVERLOw project dissemination, as specified in Annex I of Grant Agreement no. 874421.

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/

Keywords: flyer, brochure, dissemination

Table of Contents

Project Information 1
Partner Information 1
Document Information 2
Executive Summary 3
1 Project flyers 5
2 Project brochures 6

1 Project flyers

oVERFLOw - VulnERability assessment of embankments and bridges exposed to FLOoding hazards

Funded by European Union Civil Protection
Grant Agreement Number 874421

Call: UCPM-2019-PP-AG

(Prevention and preparedness in civil protection and marine pollution)

Topic: UCPM-2019-PP-PREV-AG

Type of action: UCPM-INT-AG

Grant Agreement Number: 874421

Project acronym: oVERFLOw

Project title: VulnERability assessment of embankments and bridges exposed to FLOoding hazards

#	Participants in the project	Country
1	University of Zagreb Faculty of civil engineering (FCEZG)	CRO
2	Infra Plan konzalting jdoo (IPK)	CRO
3	GEKOM – geophysical and ecological modelling (GEKOM)	CRO
4	VEILIGHEIDSREGIO ZUID-HOLLAND ZUID (VRZHZ)	NL
5	INGEO – BV	NL
6	Slovenian national building and civil engineering institute (ZAG)	SL
7	Administration of the RS for civil protection and disaster relief (URSZR)	SL

Project website: **www.projectoverflow.eu**

Programme:

UCPM 2019 PP AG , EU Civil Protection Mechanism

Project duration: 01-12-2019 – 30-11-2021

Total Cost : EUR 586 192

EU Contribution : EUR 498 260

Coordinator: University of Zagreb Faculty of Civil Engineering

www.projectoverflow.eu

CONSORTIUM

1 University ¤ 3 SMEs ¤ 1 Institute ¤ 2 CPAs

ZAG

infra plan konzalting

GEKOM

INGEO

REPUBLIKA SLOVENIJA
MINISTRSTVO ZA OBRAMBO
UPRAVA REPUBLIKE SLOVENIJE
ZA ZAŠČITO IN REŠEVANJE

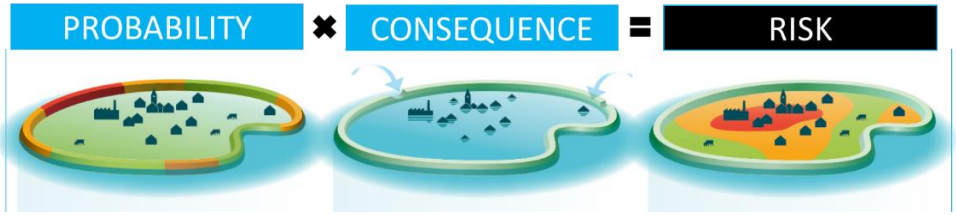
veiligheids regiozhz

CROATIA ¤ NETHERLANDS ¤ SLOVENIA

Funded by European Union Civil Protection
Grant Agreement Number 874421

Project background

In recent years Europe has experienced some of the largest flood events in its history. The resilience of a flood defence system is controlled by the weakest link. Whilst the risk based method for assessing flood defences VNK2 developed in the Netherlands is the state of the art, the determination of the probability of failure is critically dependent on a number of highly uncertain parameters. A number of recent collapses of major bridges due to scour shortly after inspection highlight the limitation of risk assessments based on periodic inspection. During flood induced failures the condition of a bridge or levee changes in a matter of minutes. The oVERFLOw project implements a number of technologies to reduce these uncertainties and move to real-time risk assessment.

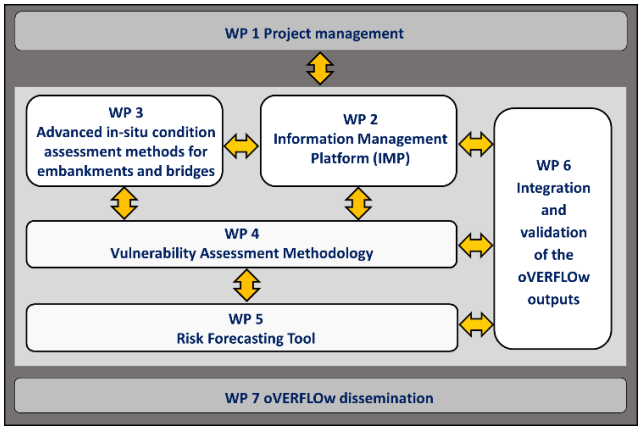


VNK2 Risk approach (Rijkswaterstaat VNK Project Office, The National Flood Risk Analysis for the Netherlands, 2014)

The overall objective of the oVERFLOw project is ***strengthening resilience to climate change impacts*** with the specific objective being the development of ***climate-resilient infrastructure***. This will be achieved by:

1. Reducing the known uncertainties in the VNK2 approach using techniques and procedures, e.g. non-intrusive geophysical techniques to quantify length effects, image processing using drone data to identify piping and additional sensors to provide real-time response of a critical infrastructure object (levee of bridge) during a flood event.
2. The technology is deployed and demonstrated at two pilot sites, at flood prone areas in the Netherlands and Croatia in order to (i) validate the new technologies and increase the TRL levels, (ii) transfer the state of the art risk based approach from the Netherlands to Slovenia/Croatia and (iii) to provide validation and buy-in from a range of stakeholders including CPAs, infrastructure owners, regional authorities and responsible bodies for cultural heritage and the general public.

The oVERFLOw project delivers results using the interactive structure shown in the project structure figure. The consortium consists of a multidisciplinary team, namely two civil protection agencies (SI and NI), research and educational institutions (University of Zagreb Faculty of Civil Engineering, Slovenian National Building and Civil Engineering Institute), and three research driven SMEs (Infra Plan consulting, GEKOM and InGEO). Four technical Work Packages consist of the following work streams



oVERFLOw project structure

WP2 Information Management Platform – GIS web based platform, implementation of historical data, climate change and flooding scenarios.

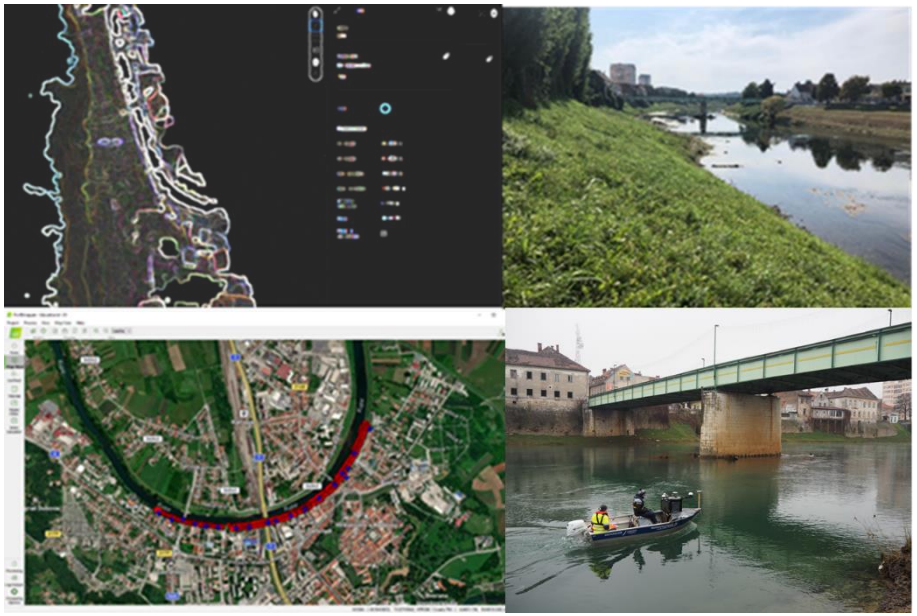
WP3 Advanced in-situ condition assessment methods for embankments and bridges – combines several rapid and reliable non-destructive methods of GPR, MASW and seismic refraction for assessing the condition of levees. For bridges the focus is on foundation scouring potential due to flood events with the vulnerability assessed through vibration based methods and drones.

WP4 Vulnerability assessment methodology –vulnerability assessment methodology using numerical models, with determination of levees and bridges failure triggering values based on their condition and loading / hazard scenarios.

WP5 Risk forecasting tool – develops a framework based on the VNK2 approach for the quantification of direct and indirect impacts of the hazard on the wider case studies area considering impacts to natural and cultural heritage assets. Integration into multi attribute utility theory based risk forecasting tool which will take into account multiple socio-economic objectives and assess the cascading effects of critical assets' failures.

The last Work Package **WP6** is aimed as validation of new methods.

WP6 Integration and validation



PILOT SITE 1 - Croatian case study – The city of Karlovac

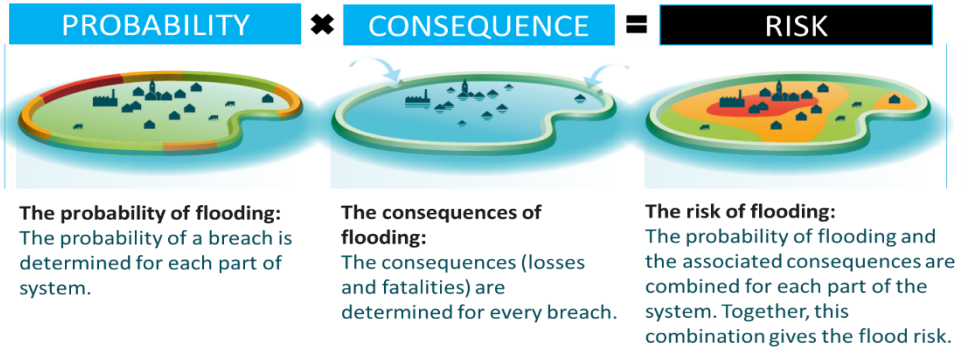
Integration and validation of the established inventory of critical infrastructure and the developed risk forecasting tool into existing GIS mapping of CPAs and authorities as separate operational layer. Set of guidelines is produced on how to integrate developed risk forecasting tool into existing emergency management plans for high-impact flooding events, adapted to needs of European CPAs. Climate change adaptation measures for prevention of flooding are proposed.

PILOT SITE 2 - Netherlands case study - Rhine-Maas delta region

WP5 Risk forecasting tool

In order to develop basis for the development of a tool for rapid risk forecast, this activity includes quantification of all direct and indirect impacts of flooding hazards, as well as a scenario of their cascading effects. The quantified impacts serve as the key performance indicators for multi-attribute utility theory. The impact assessment is done in accordance with relevant EU documents, i.e. European Directive 2014/52/CE which deals with impacts on environment and cultural heritage.

Floods in Slovenia, November 2012



The probability of flooding: The probability of a breach is determined for each part of system.

The consequences of flooding: The consequences (losses and fatalities) are determined for every breach.

The risk of flooding: The probability of flooding and the associated consequences are combined for each part of the system. Together, this combination gives the flood risk.

VNK2 Risk approach (Rijkswaterstaat VNK Project Office, The National Flood Risk Analysis for the NI, 2014)

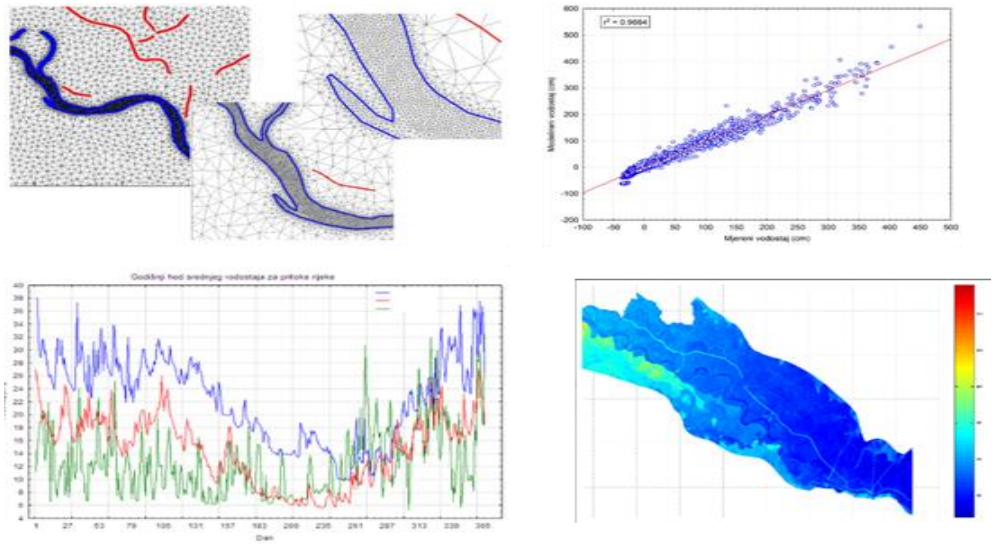
Development of the risk forecasting tool implies intersection of vulnerability assessment, i.e. developed fragility curves, for embankments and bridges with impact, information to provide a rapid and uniform risk forecast for selected areas. A multi-attribute utility theory serves as basis for risk forecasting tool.

The developed risk forecasting tool is applied on the selected case study areas (city of Karlovac wider area and Rhine-Maas delta region).

WP2 Information Management Platform (IMP)

Photo archive URSZR

GIS web based platform, that implements historical data, climate change and flooding scenarios for selected areas is established in WP2. In this WP downscaled climate change and flooding scenarios to define attributes for GIS web-based platform, are developed. An information management platform will be established to store all baseline attributes of embankments and bridges (e.g. age, geometry, materials, maintenance history, flood history related data, etc.), as well as the developed climate change and flooding scenarios. Also, protocols for data collection, storage and provision of information to different parties are being developed.

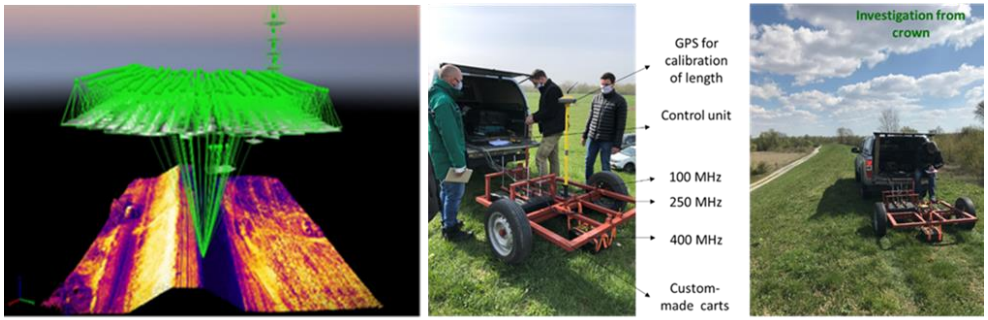


Hydrological analysis (hydrological models, water levels modelling and data, topography)

A separate operational layer within GIS platforms of CPAs and authorities from city of Karlovac and Rhine-Maas delta region is developed. It contains all relevant baseline data for embankments and bridges for the case study locations.

WP3 Advanced in-situ condition assessment methods for embankments and bridges

In order to collect data on condition of embankments in-situ investigation activities include several methods, and the focus is on rapid and reliable methods. Multi-geophysical approach is accompanied with static penetration test in order to define local mechanical and physical characteristics of embankments. Also, detailed visual expert assessment is conducted and a monitoring system is implemented. Unmanned aerial vehicle for both photogrammetry purposes and visual inspection of embankments is used. Additionally, UAV is equipped with thermal camera in order to determine moisture level in embankments. Further, remote monitoring protocols are developed to obtain key input data for a probabilistic based vulnerability analysis.



Point cloud of the embankment (left) investigation works on crown of the embankment (right)

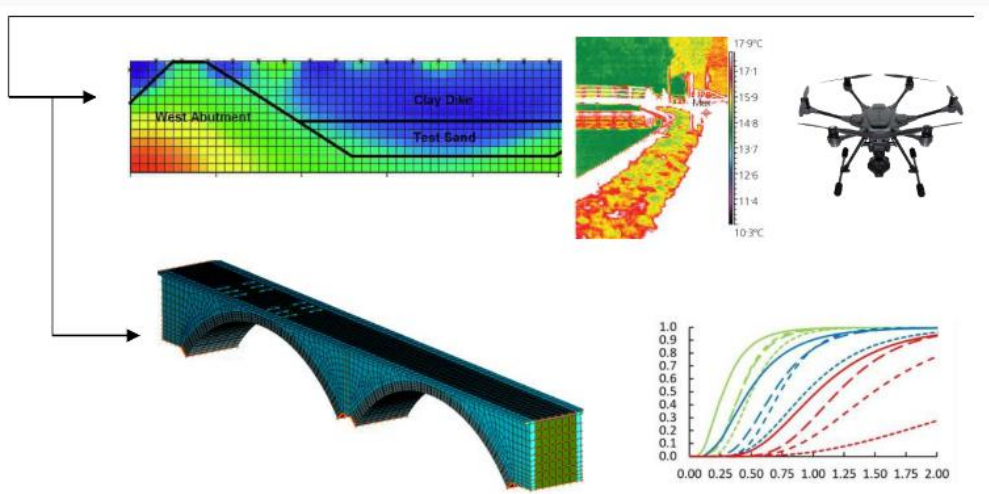
The structural condition assessment of the bridges is performed on the basis of in-situ investigation works including detailed visual expert assessment and application of non-destructive investigation techniques on bridge deck, columns and foundations. The scouring potential due to flood events is investigated by underwater bridge inspection, bathymetric survey of riverbed.

Based on methodology developed on the trial sections, a condition assessment of embankments and bridges in case study areas is conducted.

WP4 Vulnerability assessment methodology

WP4 provides the vulnerability assessment methodology using numerical models, with determination of embankments and bridges failure triggering values based on their condition and loading / hazard scenarios. The protocols for data fusion through integration of multiple data sources (investigation works, monitoring, historical data, downscaled scenarios) in order to produce more consistent input information for vulnerability assessment of embankments and bridges are established. Development of fragility curves represens the probability of exceeding an ultimate limit states (or serviceability limit states) for the given asset condition and triggering values.

Based on developed flooding scenarios, sets of relevant loads on embankments and bridges is determined, covering wide range of possible actions for both ultimate and serviceability limit state. A sophisticated finite element analysis will be conducted with overall aim of obtaining the fragility curves for both types of structures, where activity will include various spatial and temporal analysis based on data



From data analysis to vulnerability assessment

Inventory of critical infrastructure assets is established in case study locations to validate the methodology.

2 Project brochures

oVERFLOw - VulnERability assessment of embankments and bridges exposed to FLOoding hazards

Funded by European Union Civil Protection
Grant Agreement Number 874421

Call: UCPM-2019-PP-AG

(Prevention and preparedness in civil protection and marine pollution)

Topic: UCPM-2019-PP-PREV-AG

Type of action: UCPM-INT-AG

Grant Agreement Number: 874421

Project acronym: oVERFLOw

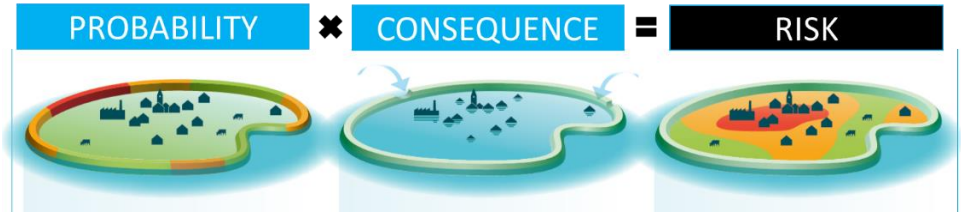
Project title: VulnERability assessment of embankments and bridges exposed to FLOoding hazards

#	Participants in the project	Country
1	University of Zagreb Faculty of civil engineering (FCEZG)	CRO
2	Infra Plan konzalting jdoo (IPK)	CRO
3	GEKOM – geophysical and ecological modelling (GEKOM)	CRO
4	VEILIGHEIDSREGIO ZUID-HOLLAND ZUID (VRZHZ)	NL
5	INGEO – BV	NL
6	Slovenian national building and civil engineering institute (ZAG)	SL
7	Administration of the RS for civil protection and disaster relief (URSZR)	SL

Project website: **www.projectoverflow.eu**

Project background

In recent years Europe has experienced some of the largest flood events in its history. The resilience of a flood defence system is controlled by the weakest link. Whilst the risk based method for assessing flood defences VNK2 developed in the Netherlands is the state of the art, the determination of the probability of failure is critically dependent on a number of highly uncertain parameters. A number of recent collapses of major bridges due to scour shortly after inspection highlight the limitation of risk assessments based on periodic inspection. During flood induced failures the condition of a bridge or levee changes in a matter of minutes. The oVERFLOw project implements a number of technologies to reduce these uncertainties and move to real-time risk assessment.



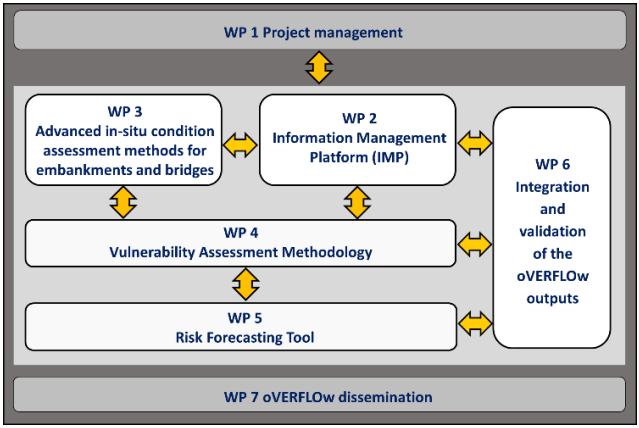
VNK2 Risk approach (Rijkswaterstaat VNK Project Office, The National Flood Risk Analysis for the Netherlands, 2014)

The overall objective of the oVERFLOw project is ***strengthening resilience to climate change impacts*** with the specific objective being the development of ***climate-resilient infrastructure***. This will be achieved by:

1. Reducing the known uncertainties in the VNK2 approach using techniques and procedures, e.g. non-intrusive geophysical techniques to quantify length effects, image processing using drone data to identify piping and additional sensors to provide real-time response of a critical infrastructure object (levee of bridge) during a flood event.

The technology is deployed and demonstrated at two pilot sites, at flood prone areas in the Netherlands and Croatia in order to (i) validate the new technologies and increase the TRL levels, (ii) transfer the state of the art risk based approach from the Netherlands to Slovenia/Croatia and (iii) to provide validation and buy-in from a range of stakeholders including CPAs, infrastructure owners, regional authorities and responsible bodies for cultural heritage and the general public.

The oVERFLOw project delivers results using the interactive structure shown in the project structure figure. The consortium consists of a multidisciplinary team, namely two civil protection agencies (SI and NI), research and educational institutions (University of Zagreb Faculty of Civil Engineering, Slovenian National Building and Civil Engineering Institute), and three research driven SMEs (Infra Plan consulting, GEKOM and InGEO).



oVERFLOw project structure

Four technical Work Packages consist of the following work streams

WP2 Information Management Platform – GIS web based platform, implementation of historical data, climate change and flooding scenarios.

WP3 Advanced in-situ condition assessment methods for embankments and bridges – combines several rapid and reliable non-destructive methods of GPR, MASW and seismic refraction for assessing the condition of levees. For bridges the focus is on foundation scouring potential due to flood events with the vulnerability assessed through vibration based methods and drones.

WP4 Vulnerability assessment methodology –vulnerability assessment methodology using numerical models, with determination of levees and bridges failure triggering values based on their condition and loading / hazard scenarios.

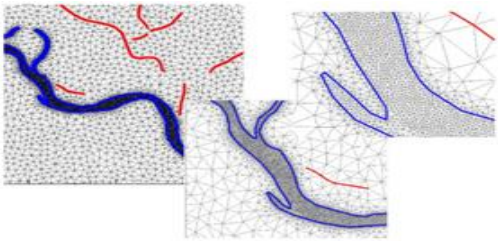
WP5 Risk forecasting tool – develops a framework based on the VNK2 approach for the quantification of direct and indirect impacts of the hazard on the wider case studies area considering impacts to natural and cultural heritage assets. Integration into multi attribute utility theory based risk forecasting tool which will take into account multiple socio-economic objectives and assess the cascading effects of critical assets' failures.

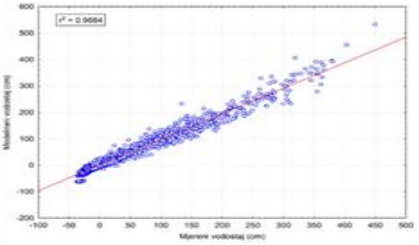
The last Work Package **WP6** is aimed as validation of new methods.

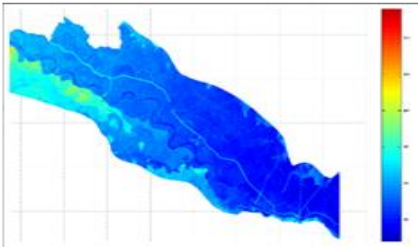
WP2 Information Management Platform (IMP)

Photo archive URSZR

GIS web based platform, that implements historical data, climate change and flooding scenarios for selected areas is established in WP2. In this WP downscaled climate change and flooding scenarios to define attributes for GIS web-based platform, are developed. An information management platform will be established to store all baseline attributes of embankments and bridges (e.g. age, geometry, materials, maintenance history, flood history related data, etc.), as well as the developed climate change and flooding scenarios. Also, protocols for data collection, storage and provision of information to different parties are being developed.





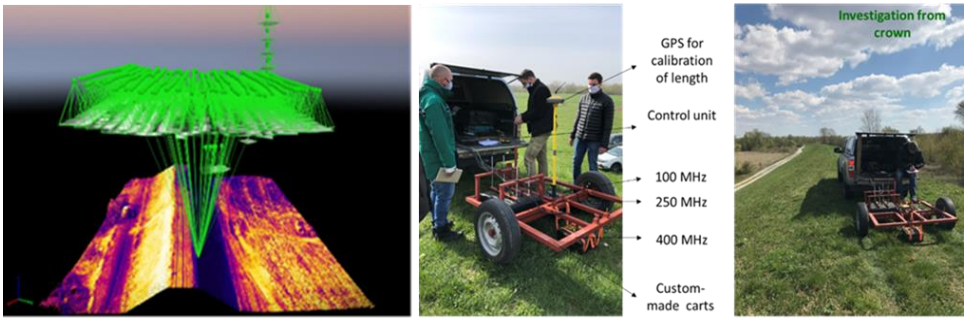


Hydrological analysis (hydrological models, water levels modelling and data, topography)

A separate operational layer within GIS platforms of CPAs and authorities from city of Karlovac and Rhine-Maas delta region is developed. It contains all relevant baseline data for embankments and bridges for the case study locations.

WP3 Advanced in-situ condition assessment methods for embankments and bridges

In order to collect data on condition of embankments in-situ investigation activities include several methods, and the focus is on rapid and reliable methods. Multi-geophysical approach is accompanied with static penetration test in order to define local mechanical and physical characteristics of embankments. Also, detailed visual expert assessment is conducted and a monitoring system is implemented. Unmanned aerial vehicle for both photogrammetry purposes and visual inspection of embankments is used. Additionally, UAV is equipped with thermal camera in order to determine moisture level in embankments. Further, remote monitoring protocols are developed to obtain key input data for a probabilistic based vulnerability analysis.



Point cloud of the embankment (left) investigation works on crown of the embankment (right)

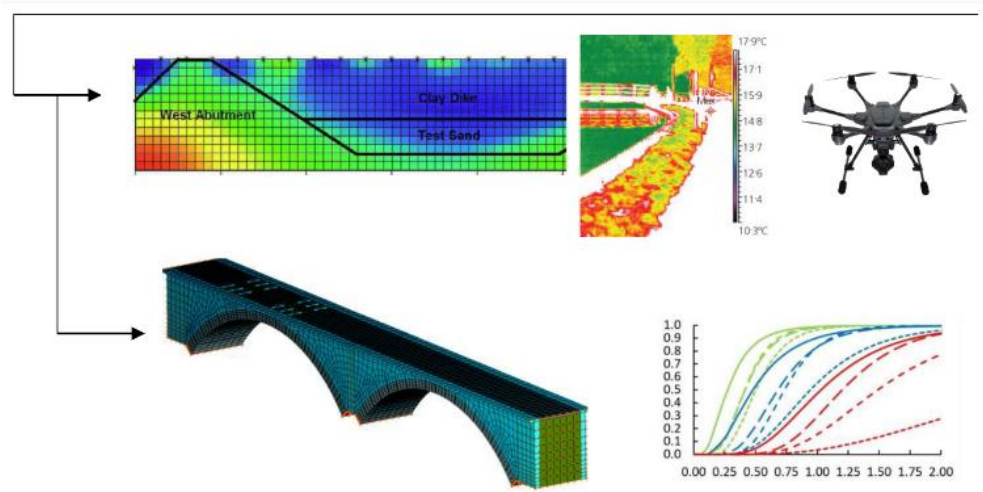
The structural condition assessment of the bridges is performed on the basis of in-situ investigation works including detailed visual expert assessment and application of non-destructive investigation techniques on bridge deck, columns and foundations. The scouring potential due to flood events is investigated by underwater bridge inspection, bathymetric survey of riverbed.

Based on methodology developed on the trial sections, a condition assessment of embankments and bridges in case study areas is conducted.

WP4 Vulnerability assessment methodology

WP4 provides the vulnerability assessment methodology using numerical models, with determination of embankments and bridges failure triggering values based on their condition and loading / hazard scenarios. The protocols for data fusion through integration of multiple data sources (investigation works, monitoring, historical data, downscaled scenarios) in order to produce more consistent input information for vulnerability assessment of embankments and bridges are established. Development of fragility curves represens the probability of exceeding an ultimate limit states (or serviceability limit states) for the given asset condition and triggering values.

Based on developed flooding scenarios, sets of relevant loads on embankments and bridges is determined, covering wide range of possible actions for both ultimate and serviceability limit state. A sophisticated finite element analysis will be conducted with overall aim of obtaining the fragility curves for both types of structures, where activity will include various spatial and temporal analysis based on data



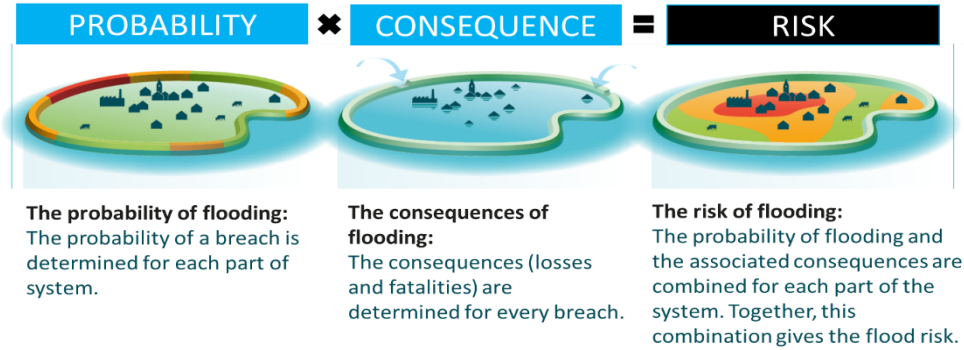
From data analysis to vulnerability assessment

Inventory of critical infrastructure assets is established in case study locations to validate the methodology.

WP5 Risk forecasting tool

In order to develop basis for the development of a tool for rapid risk forecast, this activity includes quantification of all direct and indirect impacts of flooding hazards, as well as a scenario of their cascading effects. The quantified impacts serve as the key performance indicators for multi-attribute utility theory. The impact assessment is done in accordance with relevant EU documents, i.e. European Directive 2014/52/CE which deals with impacts on environment and cultural heritage.

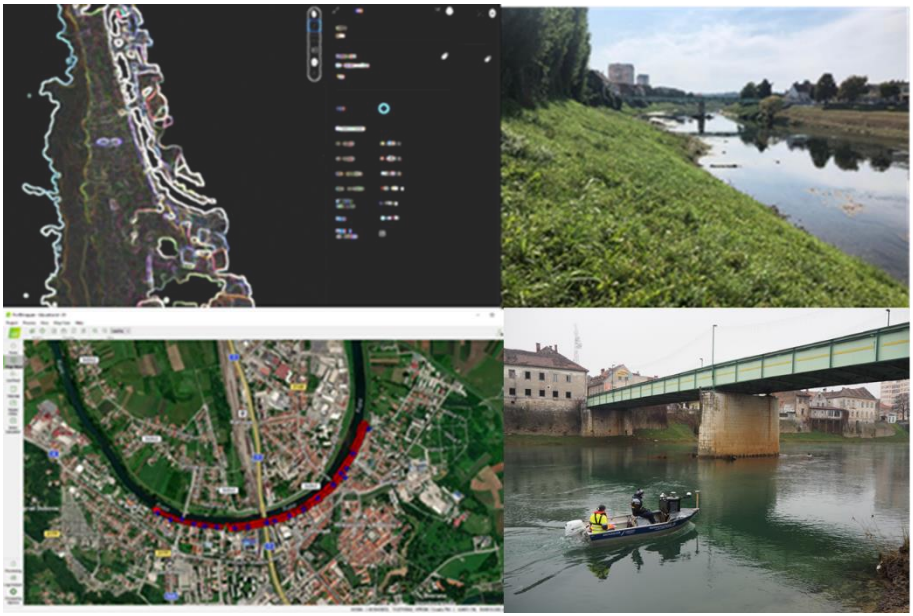
Floods in Slovenia, November 2012



VNK2 Risk approach (Rijkswaterstaat VNK Project Office, The National Flood Risk Analysis for the NI, 2014)

Development of the risk forecasting tool implies intersection of vulnerability assessment, i.e. developed fragility curves, for embankments and bridges with impact, information to provide a rapid and uniform risk forecast for selected areas. A multi-attribute utility theory serves as basis for risk forecasting tool. The developed risk forecasting tool is applied on the selected case study areas (city of Karlovac wider area and Rhine-Maas delta.

WP6 Integration and validation



PILOT SITE 1 - Croatian case study – The city of Karlovac

Integration and validation of the established inventory of critical infrastructure and the developed risk forecasting tool into existing GIS mapping of CPAs and authorities as separate operational layer. Set of guidelines is produced on how to integrate developed risk forecasting tool into existing emergency management plans for high-impact flooding events, adapted to needs of European CPAs. Climate change adaptation measures for prevention of flooding are proposed.

PILOT SITE 2 - Netherlands case study - Rhine-Maas delta region

Funded by European Union Civil Protection
Grant Agreement Number 874421

Programme:

UCPM 2019 PP AG , EU Civil Protection Mechanism

Project duration: 01-12-2019 – 30-11-2021

Total Cost : EUR 586 192

EU Contribution : EUR 498 260

Coordinator: University of Zagreb Faculty of Civil Engineering

www.projectoverflow.eu

CONSORTIUM

1 University ¤ 3 SMEs ¤ 1 Institute ¤ 2 CPAs

CROATIA ¤ NETHERLANDS ¤ SLOVENIA