

Future proofing strategies FOr RESilient transport networks against Extreme Events H2020-MG-7-1-2017: Resilience to extreme (natural and man made events)

Validation of the FORESEE methodology in road and railways

Final Conference 22.02.2022

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Overview on the approach

The main objective was to validate and demonstrate, in some EU representative case studies, the FORESEE outcomes developed in the project.

The test cases to be carried out covered:

- Different risk scenarios
- Different transport sectors
- Different scales
- Different geographical locations







Case Study Overview - Assets



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 769373"

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Case Study #1 Overview - Assets

A24 Highway (from 52 km to 73 km) is a strategic and barycentric road system that connects Rome to the Adriatic Sea. The motorway plays a vital role in supporting the mobility of production activities, communications, commerce, tourism and social and economic development throughout the country.







Case Study #1 Overview - Assets

The A24, especially its montaneous section in winter, is particularly prone to bad weather with sudden snowstorms, strong winds, fog and ice.



#1 - CARSOLI-TORANO A24 HIGHWAY.

PILOT RESPONSIBLE: AIS

HAZARD	The motorway has been selected as the focus of the first FORESEE case study due to the frequent earthquakes , extreme weather condition
TOOLS	 TRAFFIC MODULE FRAGILITY FUNCTIONS, VULNERABILITY FUNCTIONS AND DECISION SUPPORT INTERPRETER MODULE



- Connection of the structural vulnerability against disruptive events and correspondent transport flows modifications.
- Assessment of the Level-of-Service distribution over the transport infrastructure before and after the event.
- Losses and Resilience Assessment (Risk Quantification, Direct Losses, Vulnerability Curves, Loss Curves).

- Allow the integration of resilience analysis scenarios of structures in traffic models.
- Simulate scenarios considering variables with uncertainty (Annual Probability for Capacity Loss).
- Provide a prioritization indicators to increase the resilience of the infrastructure

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Case Study #2 Overview - Assets

The A16 highway ("Motorway of the Two Seas") runs from Naples to Bari along the TEN-T Corridor 5.



It plays a crucial role in the mobility of production and commercial activities across southern Italy, thus contributing to the social and economic development of the country.



Case Study #2 Overview - Assets









#2 - NAPLES TO BARI A16 HIGHWAY (TEN-T CORRIDOR #5)

PILOT RESPONSIBLE: ASPI

Focus on the section between km. 97-99, where 3 bridges were considered.

HAZARD Specific hazard: landslides Other hazards in the area: high seismic zone and extreme weather conditions (i.e. snow).

Virtual Modelling platform and asset failure prediction SHM BIM based alerting SAS





TOOLS

Case Study #2 Overview - Results

- 1. Virtual Modelling platform
- 2. S-SHM BIM based alerting SAS platform



#2 - NAPLES TO BARI A16 HIGHWAY (TEN-T CORRIDOR #5)

PILOT RESPONSIBLE: ASPI

- Improved landslide forecasting and hazard management.
- Identification of failure potentials, their mechanisms and reliable correlations between movement events and their triggering factors.
- Timely warning of potential events with a positive impact on mobility and safety.
- Integration of different data sources.
- BIM model of the infrastructure and components to be kept under control.
- More reliable identification of warning thresholds, based on the displacements that
- the infrastructure is able to undergo, in the absence of damage or with acceptable
 damage, thus increasing resilience of the infrastructure.
- Used to program and design interventions.
- Timely warning of potential events with a positive impact on mobility and safety.





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Case Study #3 Overview - Assets

This case study (CS) focuses on the risks of strong winds and snowfall on a section of the A-67 motorway (Reinosa - Los Corrales de Buelna) including the Montabliz Viaduct, to evaluate, through the FORESEE Tools



#3 - MONTABLIZ VIADUCT

PILOT RESPONSIBLE: UC







Case Study #3 Overview - Assets

The case study of Montabliz Viaduct has been studied in two different scenarios, corresponding to two phases of the life cycle.

- **Design & Construction**, **D phase**, definition of the design resilient to the specific hazards, wind and snowfall.
- **Operation & Maintenance**, **M phase**, definition of flood zones on the A-67 motorway, for avenues with different return periods.



#3 - MONTABLIZ VIADUCT

PILOT RESPONSIBLE: UC



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Case Study #3 Overview - Results

- **Risk Mapping Tool** 1.
- **Governance Module** 2.

- Processing and classification of large amounts of data •
 - 80% labor savings, at early phases of design •

- Control of strategical resilience objectives.
- Objective and Transparent decision-making processing •
- 90% labor savings •

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1.000.000 100.000 10.000 1.000 100 Traffic Hazards goods traffic

76.777

26.667

50.110

Total benefit

Total costs Next benefit



PILOT RESPONSIBLE: UC

281.623

4.000





Case Study#4 Overview - Assets

This case study (CS) focusses on flooding hazards on railway tracks on the German railway track no. 6185 between Oebisfelde and Berlin-Spandau, which is part of the high-speed railway (HSR) Hannover – Berlin (HB).



#4 - RAILWAY TRACK 6185 (OEBISFELDE-BERLIN SPANDAU)

PILOT RESPONSIBLE: IVE



The approx. 150 kilometres long track section between Oebisfelde (km 267,9) and Berlin-Spandau (km 112,7) is built as ballastless track with a maximum speed up to 250 km/h.

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Case Study#4 Overview - Hazards

Due to former flooding events (especially the Elbe Flood in June 2013), there are data available regarding risks and damages caused by flooding. As a result of the Elbe flood in June 2013, the Haemerten bridge and an approximately 5 km long track section near Schoenhausen were closed due to flooding.



#4 - RAILWAY TRACK 6185 (OEBISFELDE-BERLIN SPANDAU)

PILOT RESPONSIBLE: IVE

HAZARD	Severe flooding events in that zone	
TOOLS	 Bridge Flooding Model Command and Control Center 	





Case Study#4 Overview - Results

- 1. Bridge Flooding Model
- 2. Command and Control Center



#4 - RAILWAY TRACK 6185 (OEBISFELDE-BERLIN SPANDAU)

PILOT RESPONSIBLE: IVE

- It provides information on the possible serviceability or damage of individual railway track components depending on different water levels in the form of a small-scale simulation.
- Big Data analysis of historical flooding events and the derivation of automatic real-time warnings for future hazards



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Case Study#5 Overview- Assets

This case study (CS) will test and validate the FORESEE toolkit (in the Madrid Calle 30 Ring Road, Spain) in order to select and design the best technical solutions for preventive maintenance, future maintenance, continency and emergency interventions and to set up of procedures for events management.



#5 - M30 RING ROAD MADRID

PILOT RESPONSIBLE: FERR



Madrid Calle 30 Ring Road is the most important and the busiest road infrastructure in Spain. 1.5 million vehicles per day use (part of) the Calle 30, of which 200,000 vehicles per day make a "full" journey that covers the use of all tunnels (48 km in total).



Case Study#5 Overview - Hazards

Three different scenarios for three different hazards have been studied specifically in the section of the tunnels that are located in the southwest part of the M30 ring road.

- 1. Man-made events including cyberattack
- 2. Flooding and other extreme events derived from raining in the valley
- 3. Fire inside the tunnels

HAZARD Flooding, fire and cyberattack

TOOLS

- Cyberattack assessment
- Flooding methodology
 - Traffic module

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#5 - M30 RING ROAD MADRID

PILOT RESPONSIBLE: FERR

Case Study#5 Overview - Results

- 1. Cyberattack assessment
- 2. Flooding methodology
- 3. Traffic module
- Preventive measures aimed at facing a cyber-attack.
- Analysis of the resilience capacity of the facilities and equipment managed by the Main Control Centre.
- A new methodology based on design storm can provide an accurate and detailed flood study
- to simulate traffic scenarios considering variables with uncertainty and specific hazards: the aim was to generate statistical results related to uncertainty input parameters by applying stochastic methods.



#5 - M30 RING ROAD MADRID

PILOT RESPONSIBLE: FERR



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Case Study#6 Overview – Assets

The 25th April suspension bridge is a multimodal rail and road megastructure that connects the city of Lisbon to the municipality of Almada. The bridge has been selected as the sixth case study for the FORESEE project due to its location in a region of significant seismic activity.



#6 - 25TH April Suspended Bridge - Lisbon Pilot Responsible: IP



The upper deck carries six car lanes while the lower deck carries an electrified double track railway.

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Case Study#6 Overview – Hazards

This case study focusses on earthquake hazards on the 25th April suspension bridge to evaluate, test and validate, through the FORESEE Tools, the project outcomes regarding risk assessment.

#6 - 25TH April Suspended Bridge - Lisbon Pilot Responsible: IP







TOOLS

Case Study#6 Overview – Results

1. Design, Construction and Remediation Plans

 a design resilient aware approach based on performance criteria, which will allow evaluating the functionality of a transport infrastructure under different risk scenarios, to set different performance objectives during and after an extreme event



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#6 - 25TH APRIL SUSPENDED BRIDGE - LISBON PILOT RESPONSIBLE: IP



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