Asita Academy 2023

Towards a spatial decision support system for hydrogeological risk mitigation in railway sector

Giada Varra[1], Luca Cozzolino[1], Renata Della Morte[1],
Mario Tartaglia[2], Andrea Fiduccia[2], Ivan Agostino[3], Alessandra Zammuto[3]

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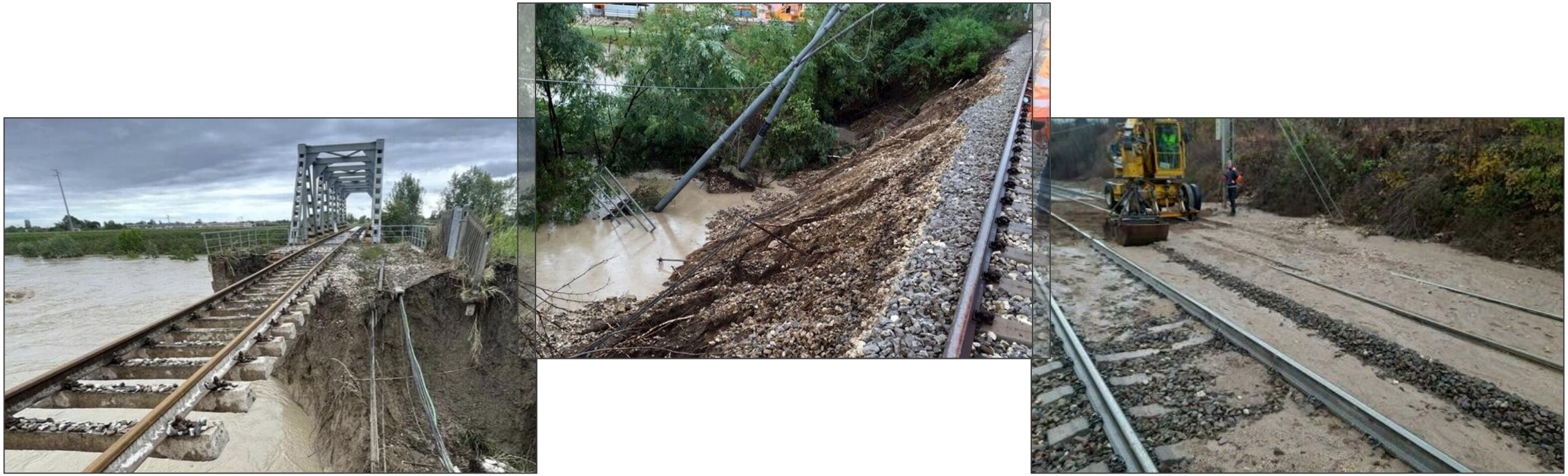
01| Introduction

- Railways are exposed to the impacts of hydro-meteorological hazards (landslides and flooding due to intense rainfall)
  - The magnitude and frequency of extreme weather events is expected to increase due to climate change
- Systematic adaptation is required for enhancing railway resilience against extreme hydro-meteorological events



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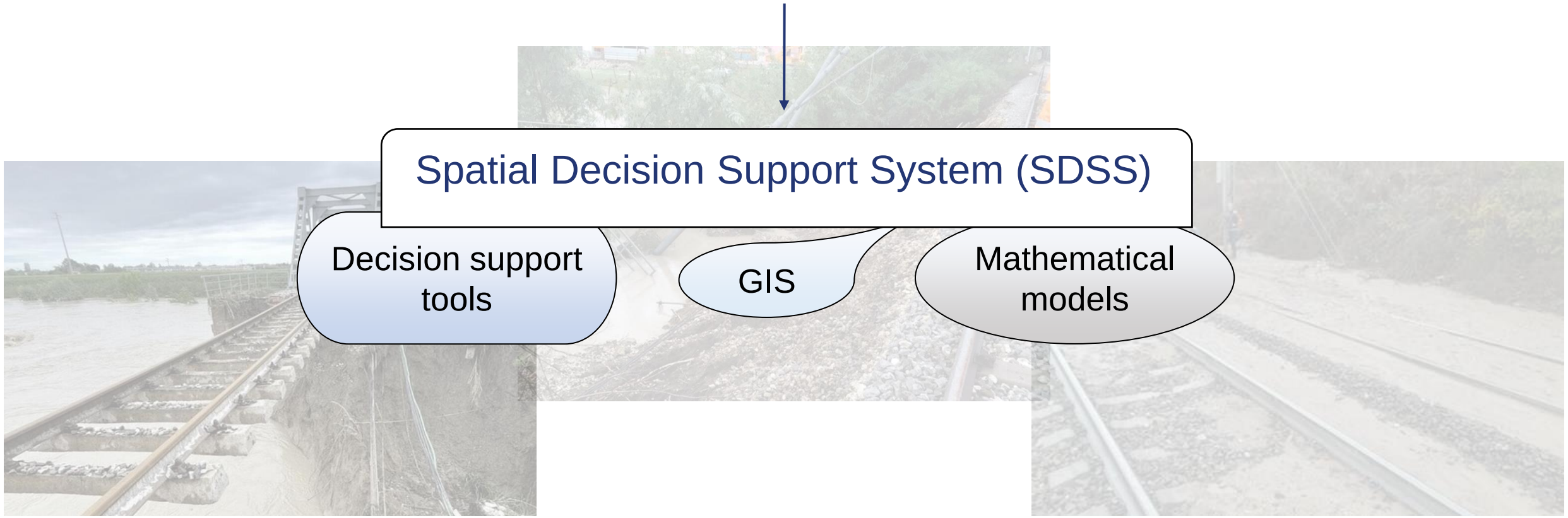


01| Introduction

UNIONE EUROPEA
Fondo Sociale Europeo

Ministero dell'Università e della Ricerca

PON RICERCA E INNOVAZIONE 2014 - 2020

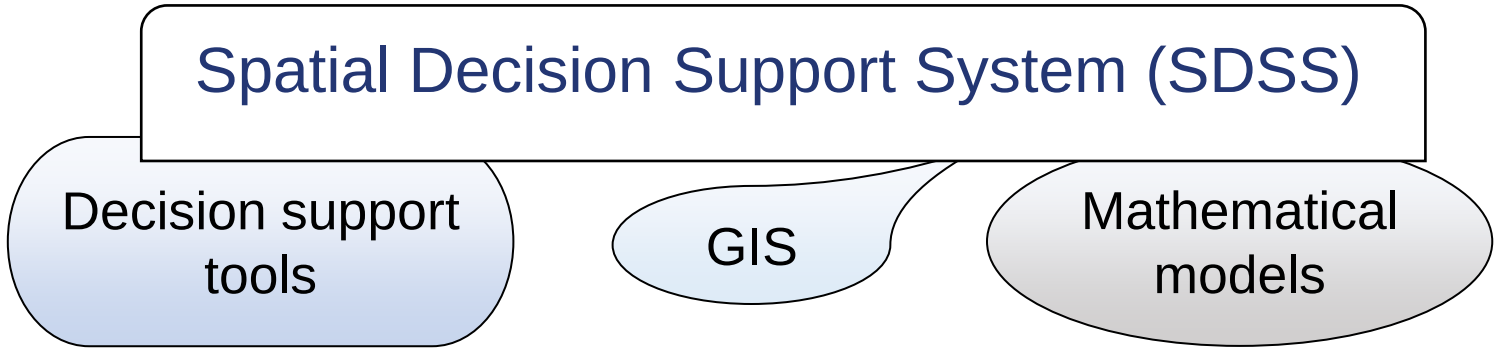
UNIVERSITÀ DEGLI STUDI DI NAPOLI PARTHENOPE

FERROVIE DELLO STATO ITALIANE

UWE Bristol University of the West of England

ARFEC project

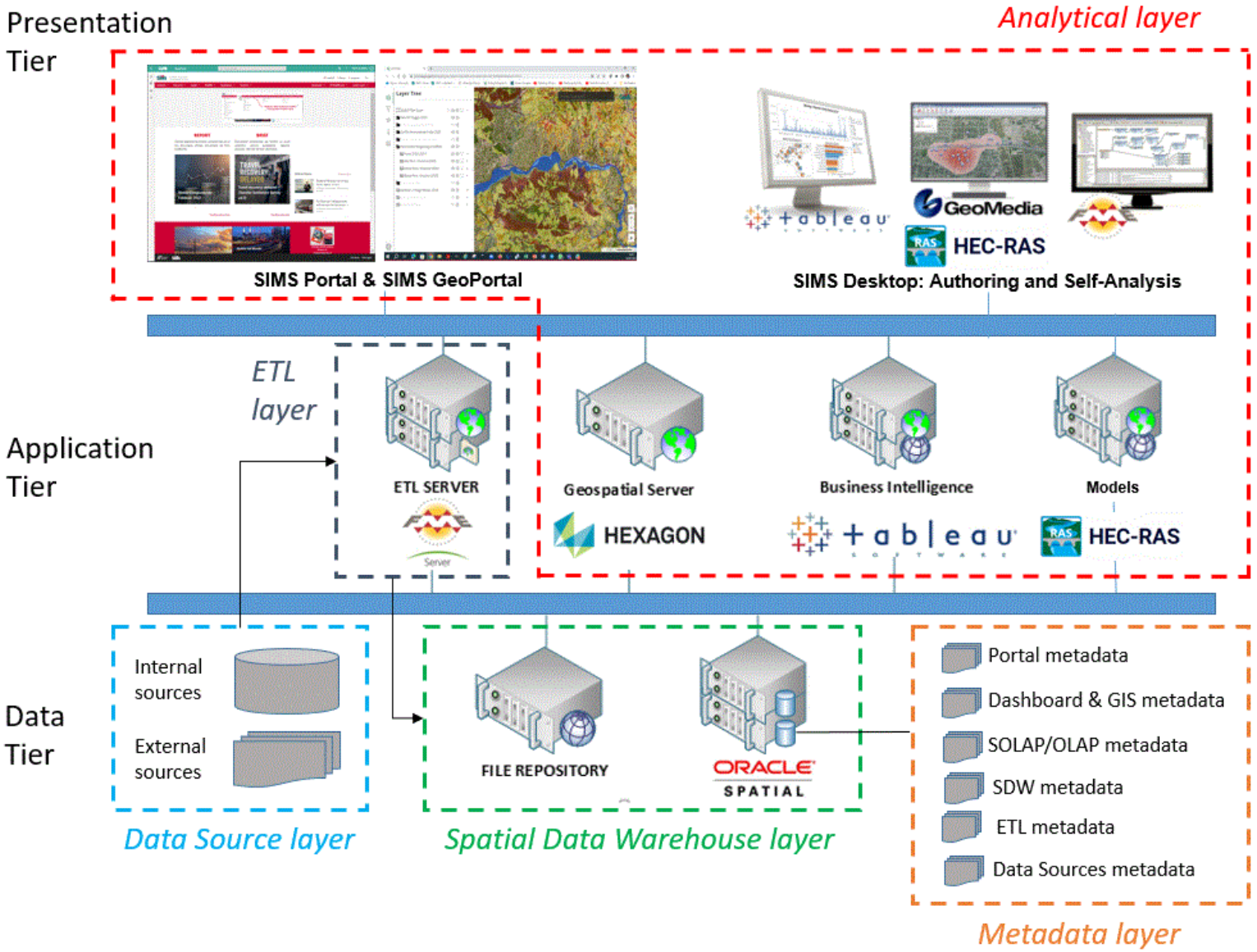
(Aumento della Resilienza delle reti FErroviarie nel contesto dei cambiamenti Climatici)

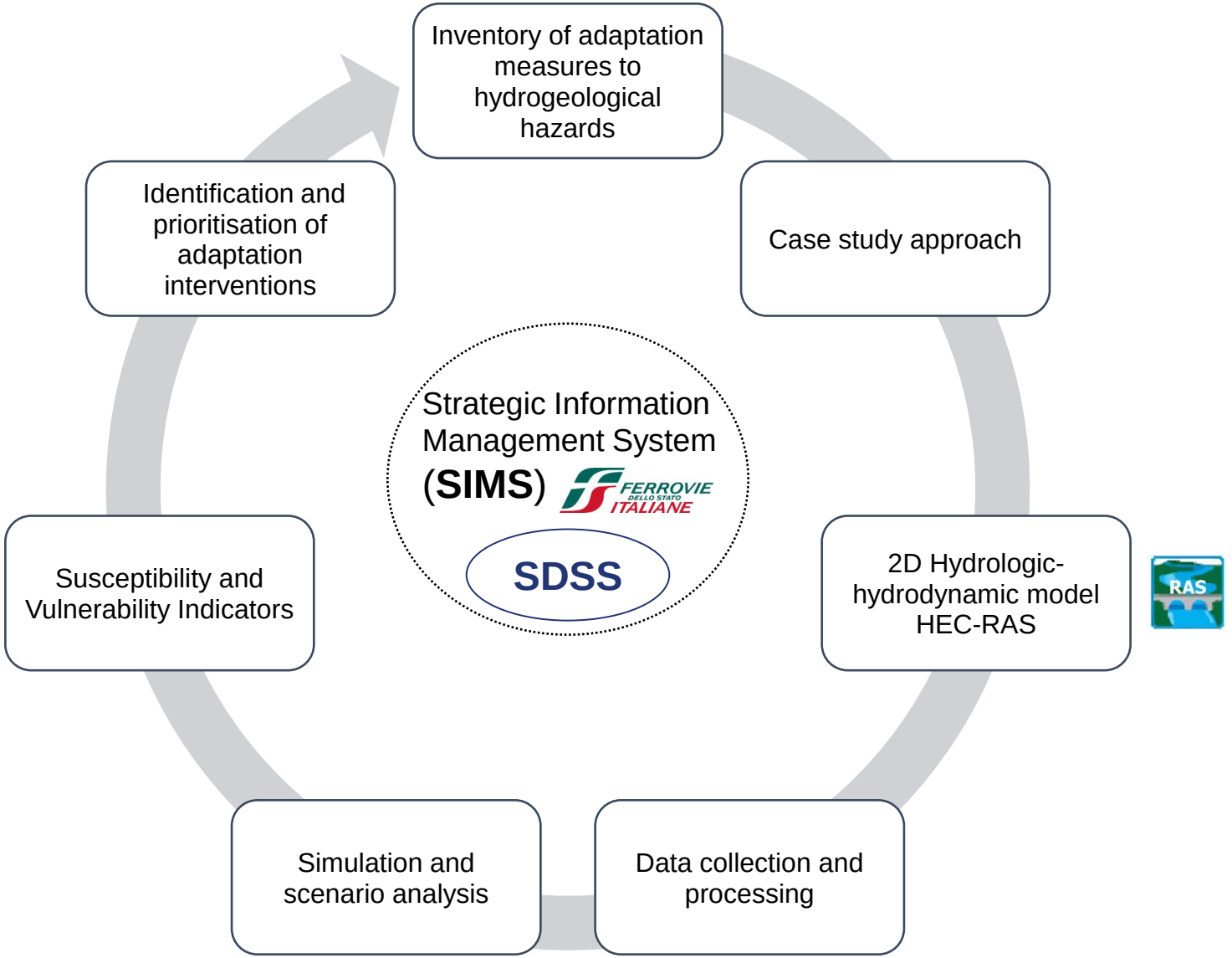


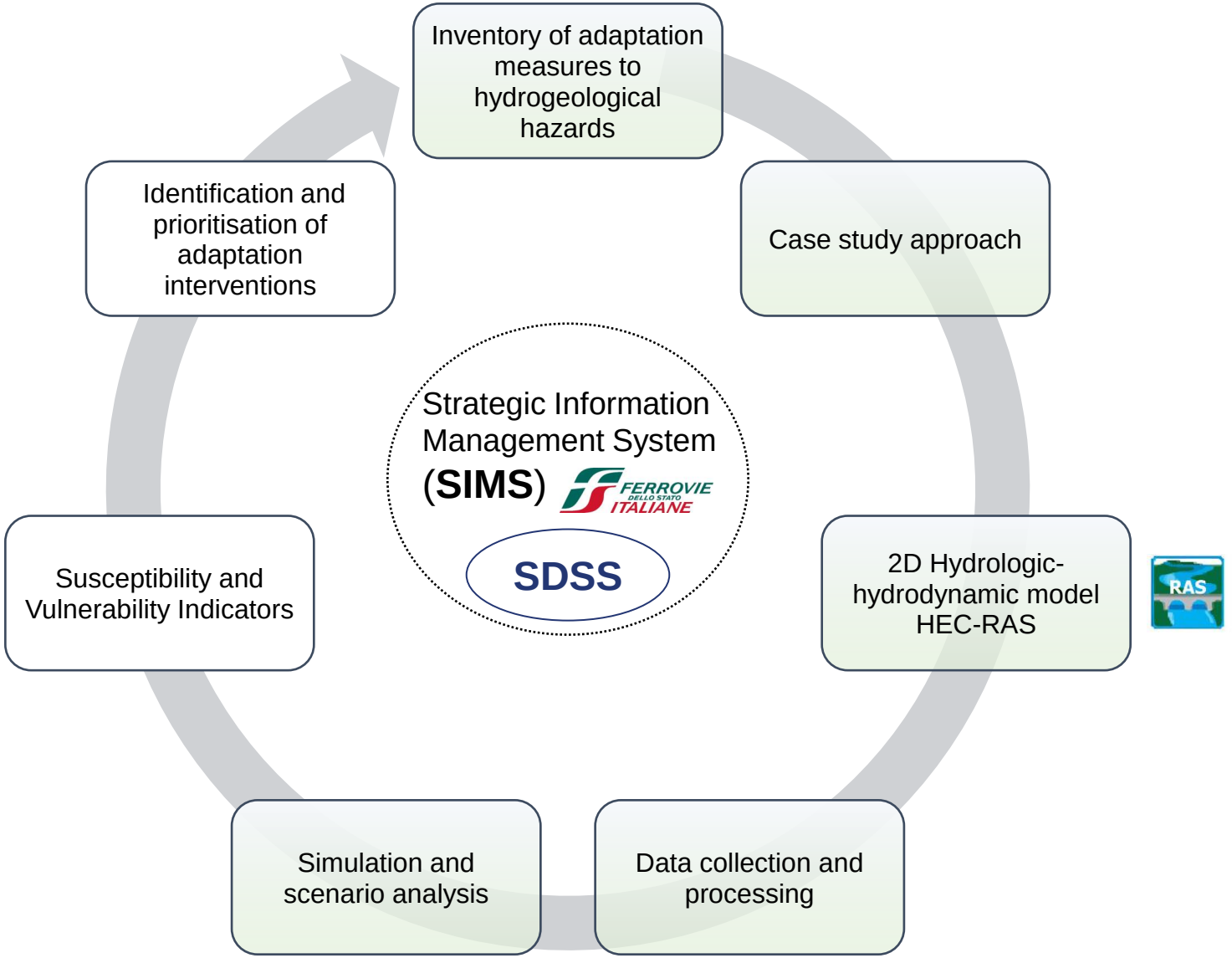
SDSS *conceptual framework* supporting railways to identify effective adaptation measures to hydrogeological hazards in a context of high uncertainty

Strategic Information Management System (**SIMS**)

FERROVIE DELLO STATO ITALIANE




Inventory of adaptation measures to hydrogeological hazards
Case study approach
2D Hydrologic-hydrodynamic model HEC-RAS
Data collection and processing
Simulation and scenario analysis
Susceptibility and Vulnerability Indicators
Identification and prioritisation of adaptation interventions
Strategic Information Management System (SIMS)
SDSS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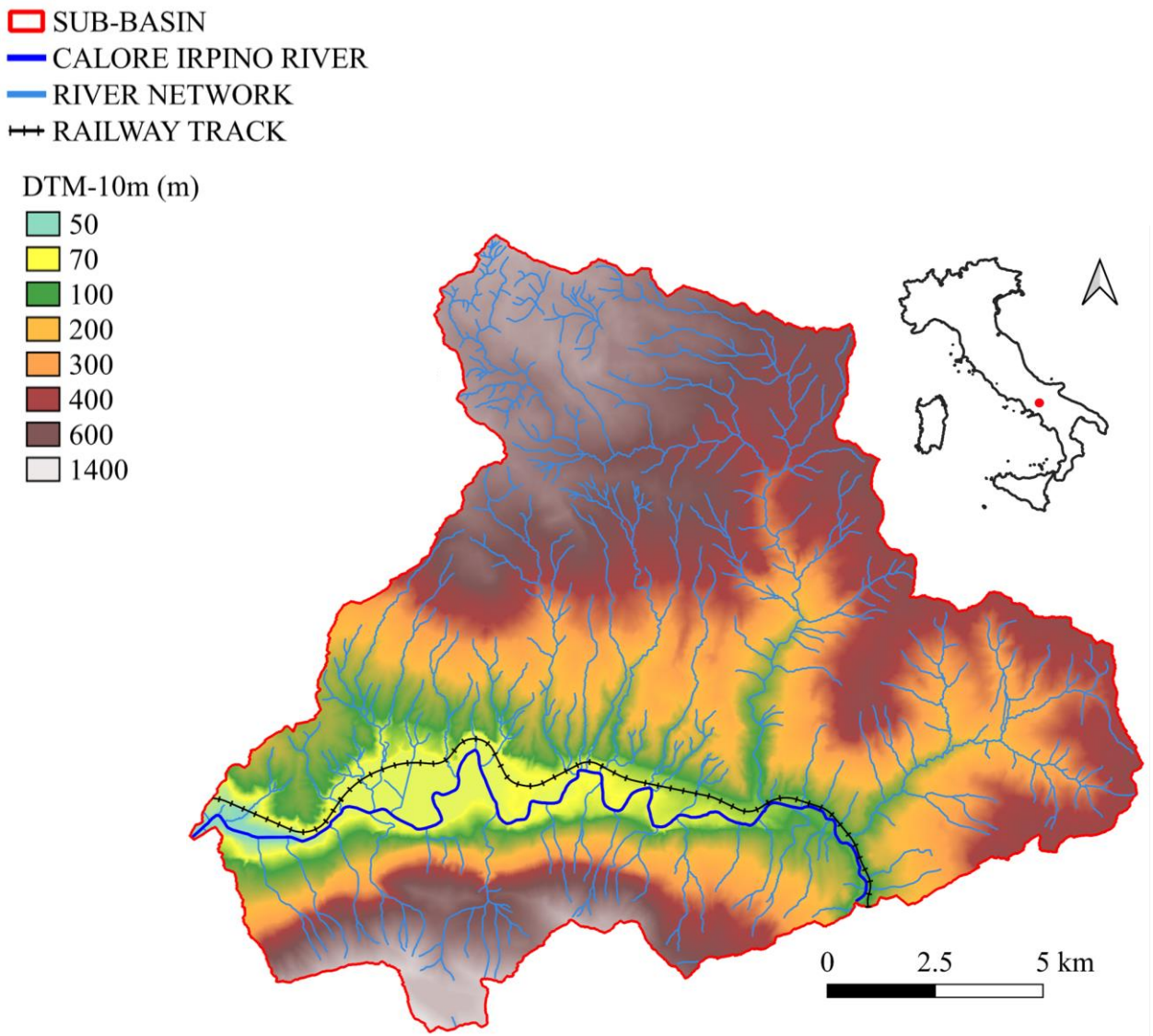
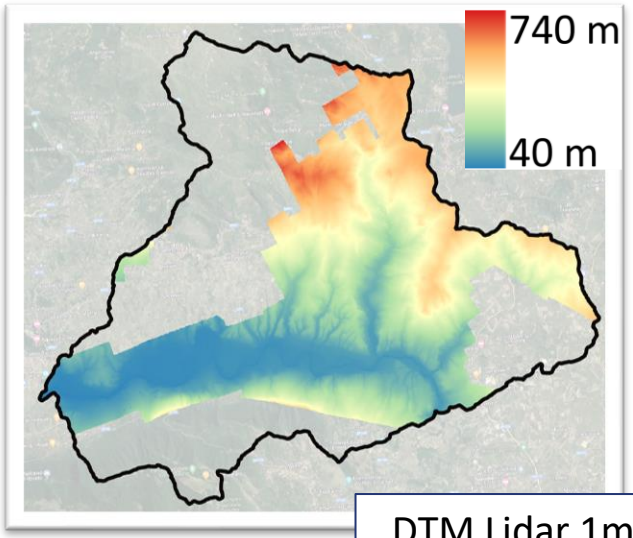
The study area, in the Benevento province of Campania region, Southern Italy, was affected by a destructive flood induced by an extreme rainfall event (**14th-15th October 2015**) that caused severe economic damages and impacts to the railway line, also leading to a six-day service disruption.

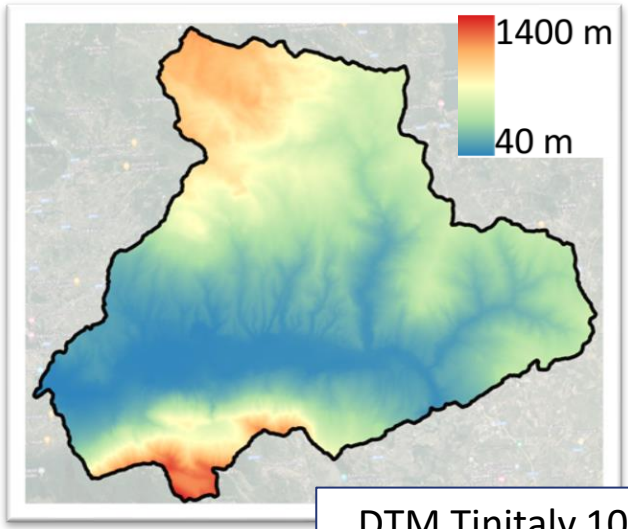
Railway damages resulted from a combination of an overflowing main river and overland flow phenomena triggered by heavy rainfall, which appear to be occurring more frequently due to anthropogenic climate change in combination with uncontrolled urban growth and land development.



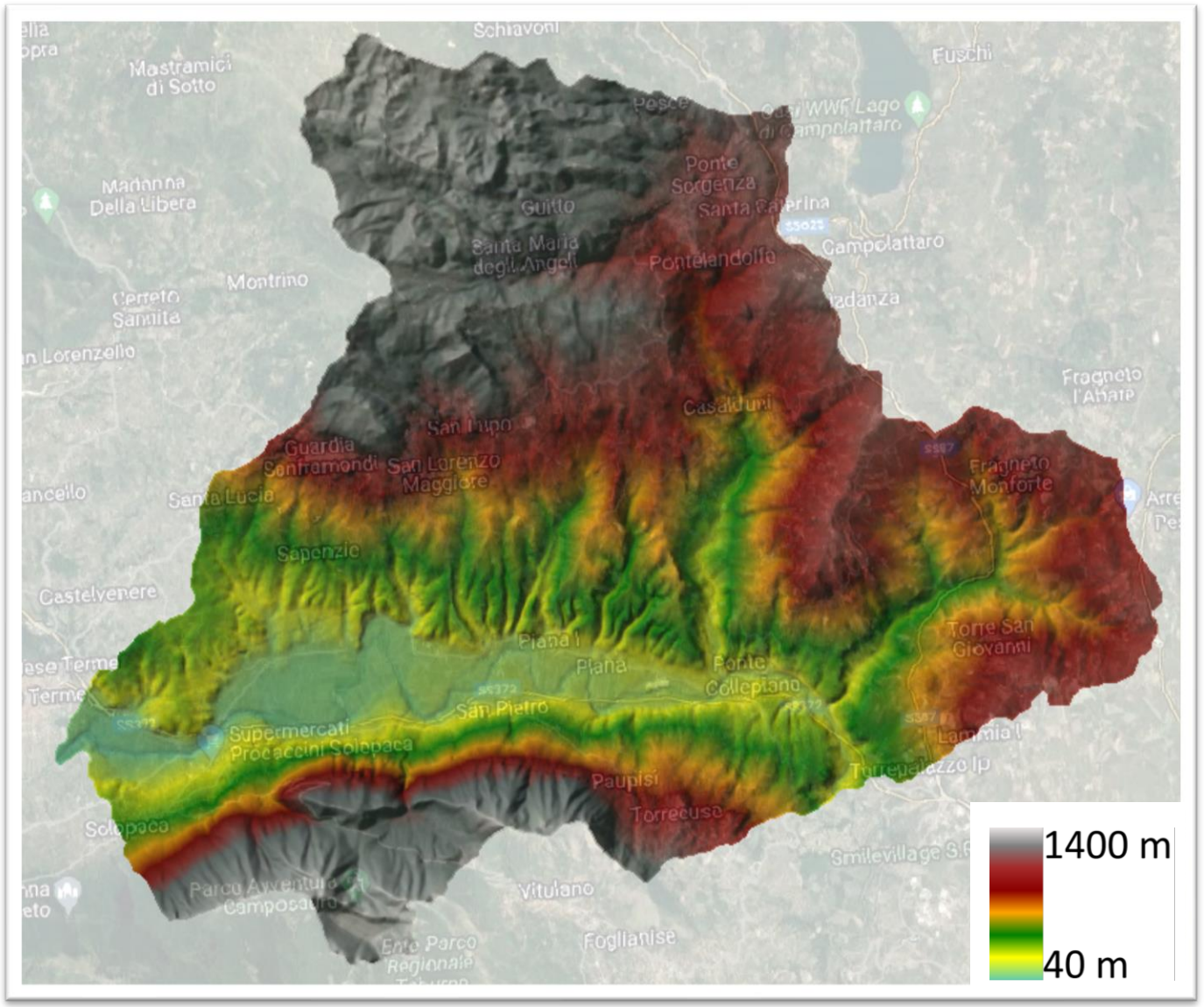
04| Data collection and processing

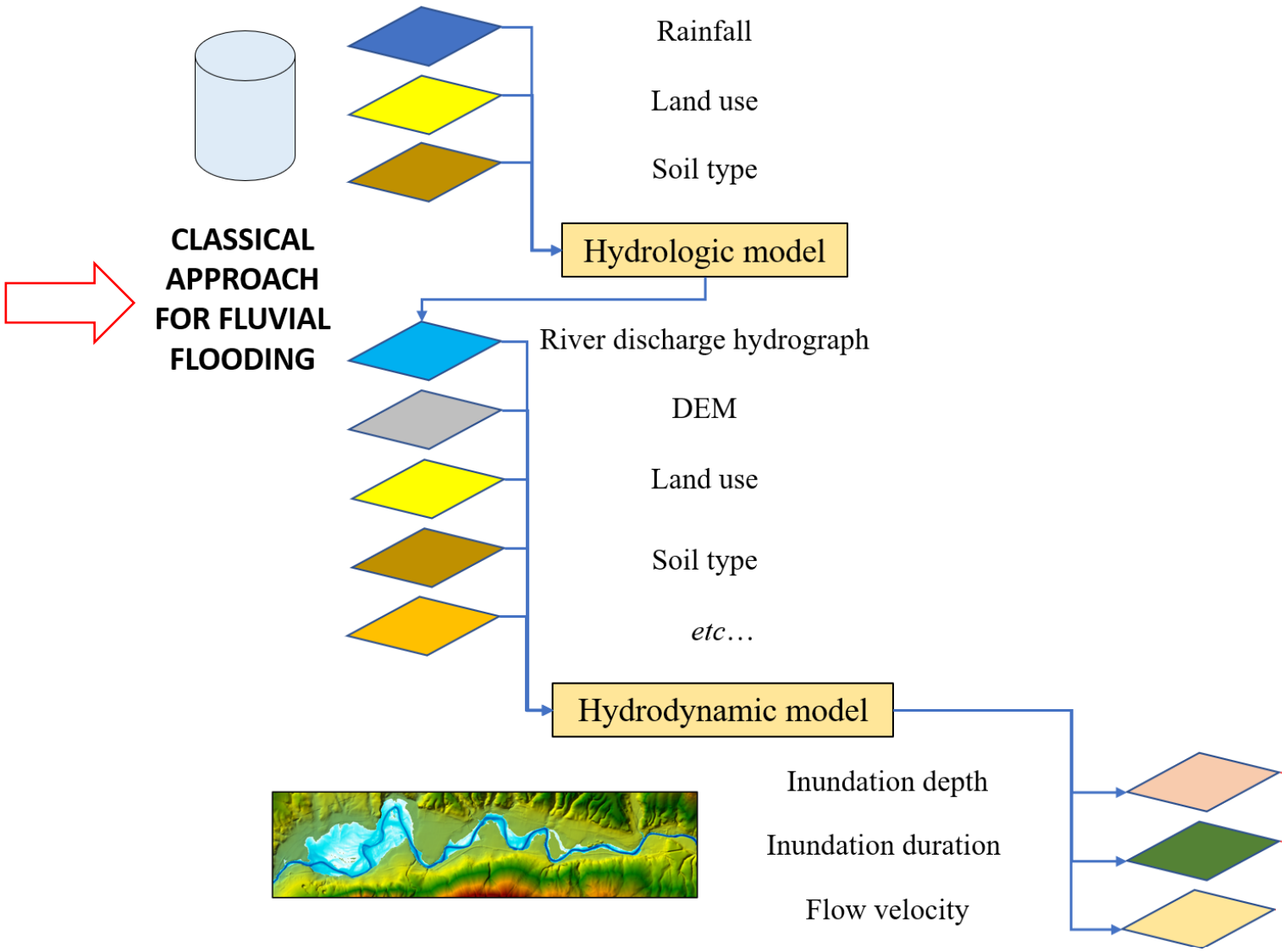


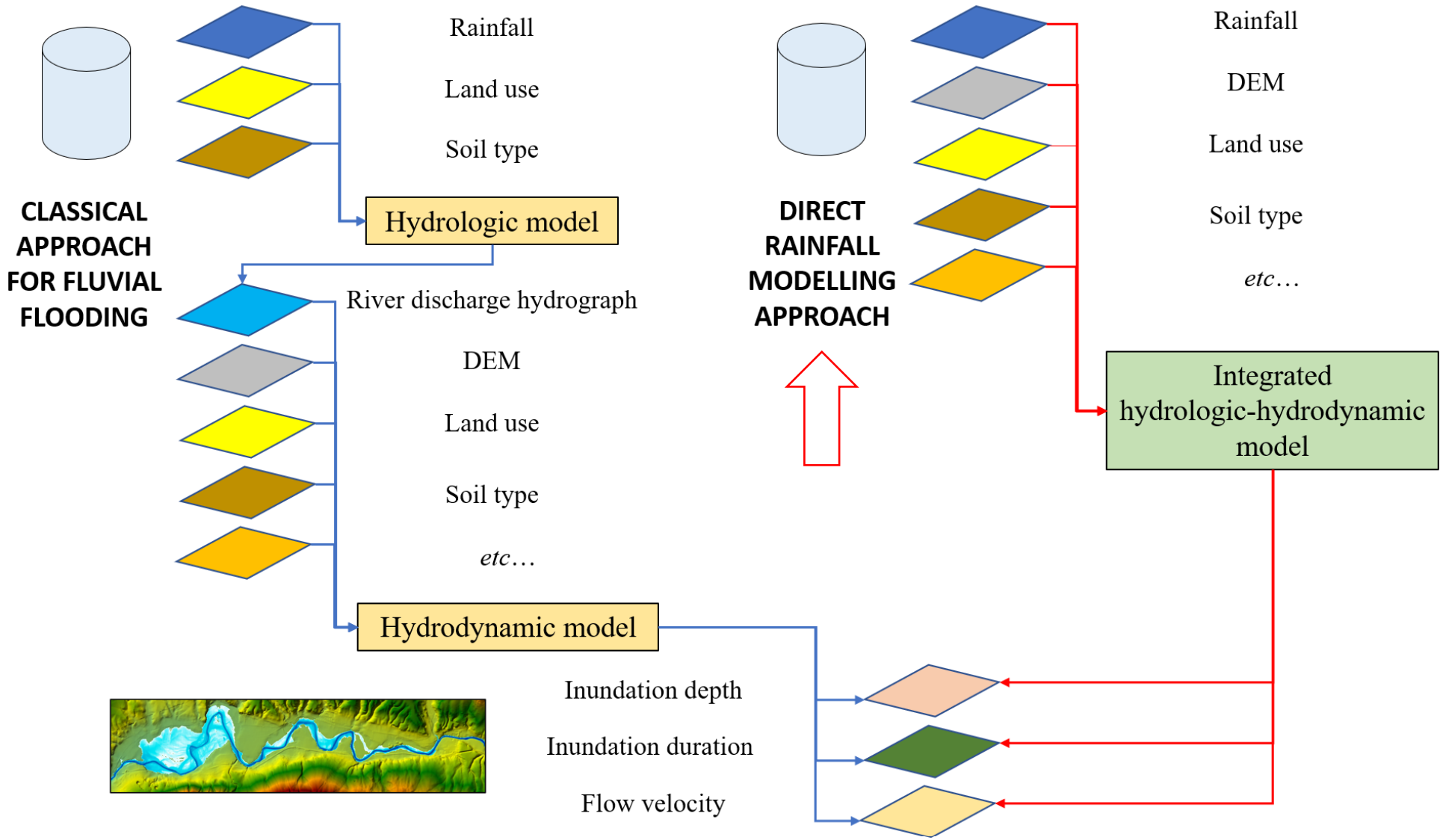
DTM Lidar 1m



DTM Tinitaly 10m




Rainfall
Land use
Soil type
CLASSICAL APPROACH FOR FLUVIAL FLOODING
Hydrologic model
River discharge hydrograph
DEM
Land use
Soil type
etc…
Hydrodynamic model
Inundation depth
Inundation duration
Flow velocity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DIRECT RAINFALL MODELLING APPROACH
Rainfall
DEM
Land use
Soil type
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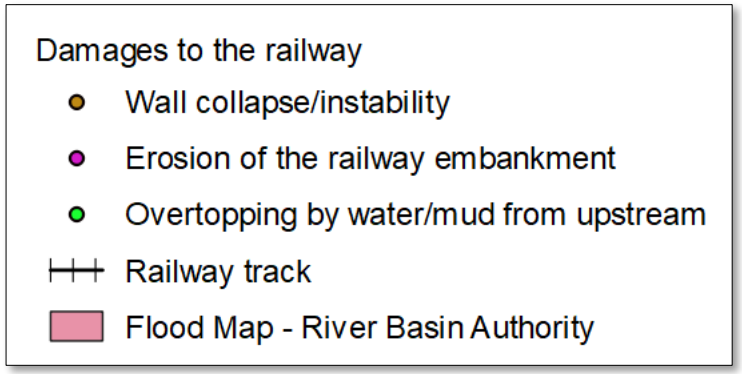
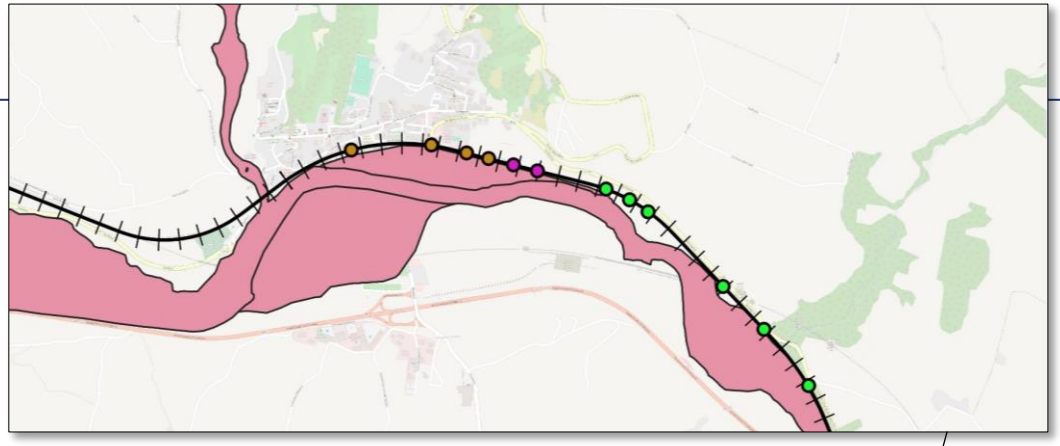
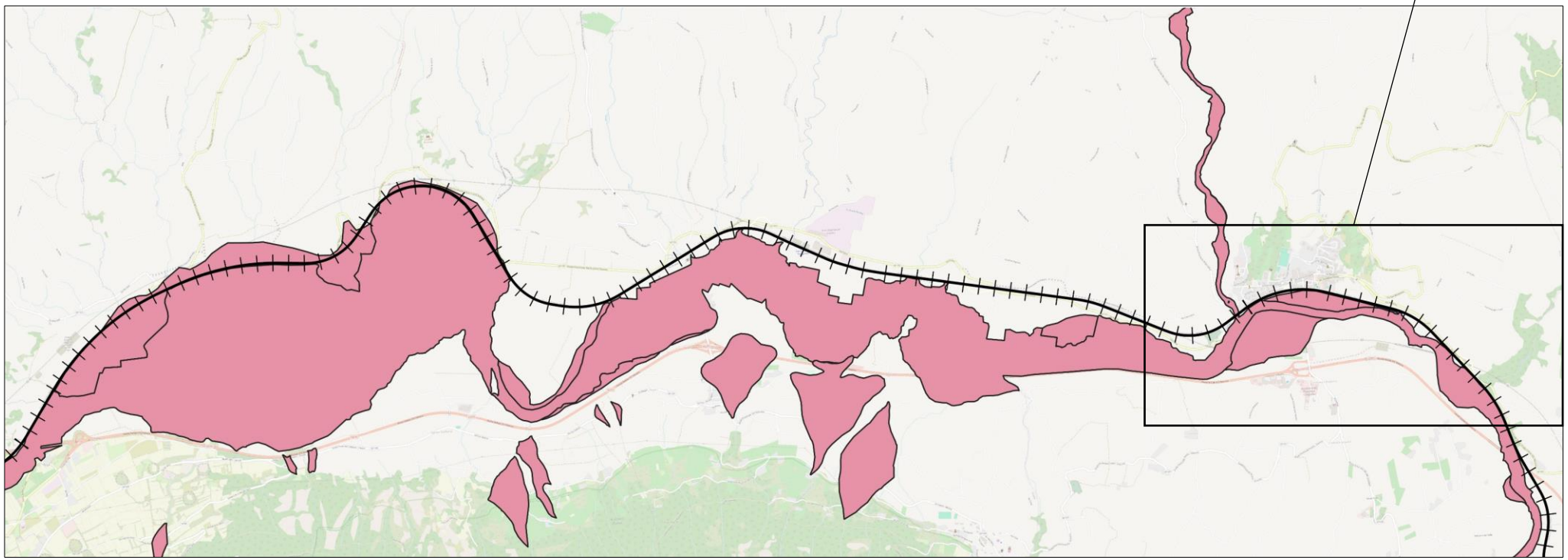
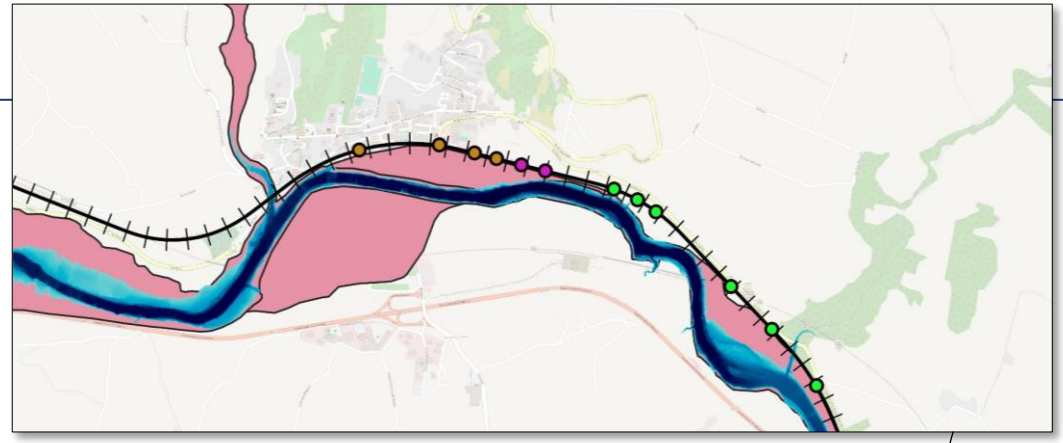
Integrated hydrologic-hydrodynamic model


Damages to the railway
Wall collapse/instability
Erosion of the railway embankment
Overtopping by water/mud from upstream
Railway track
Flood Map - River Basin Authority







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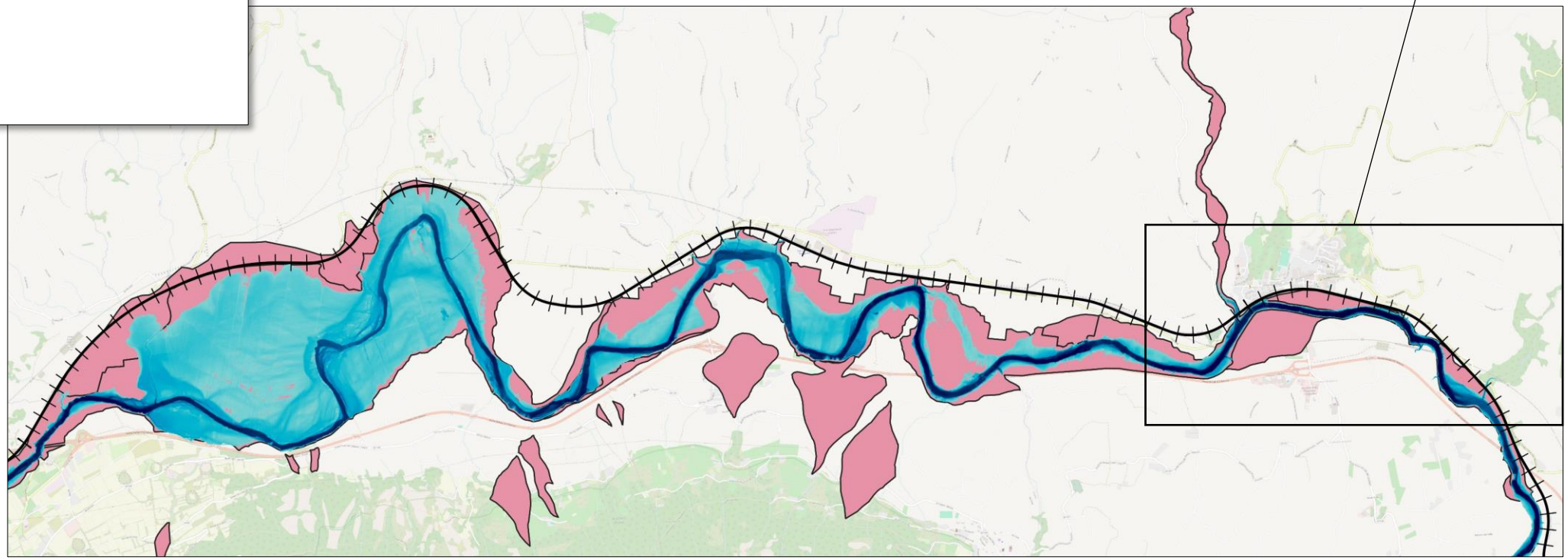
Flood Map - River Basin Authority

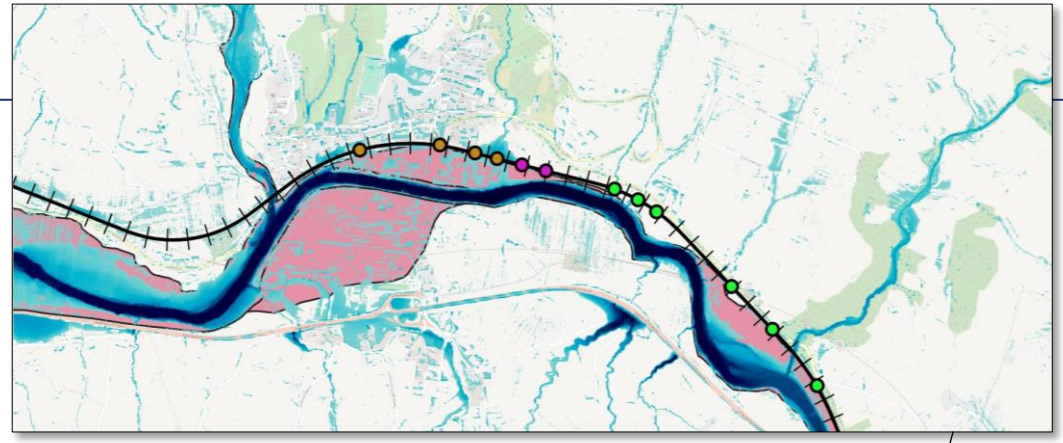
Water depth (m) - Simulation

13.5

0.001



Classic Modelling approach



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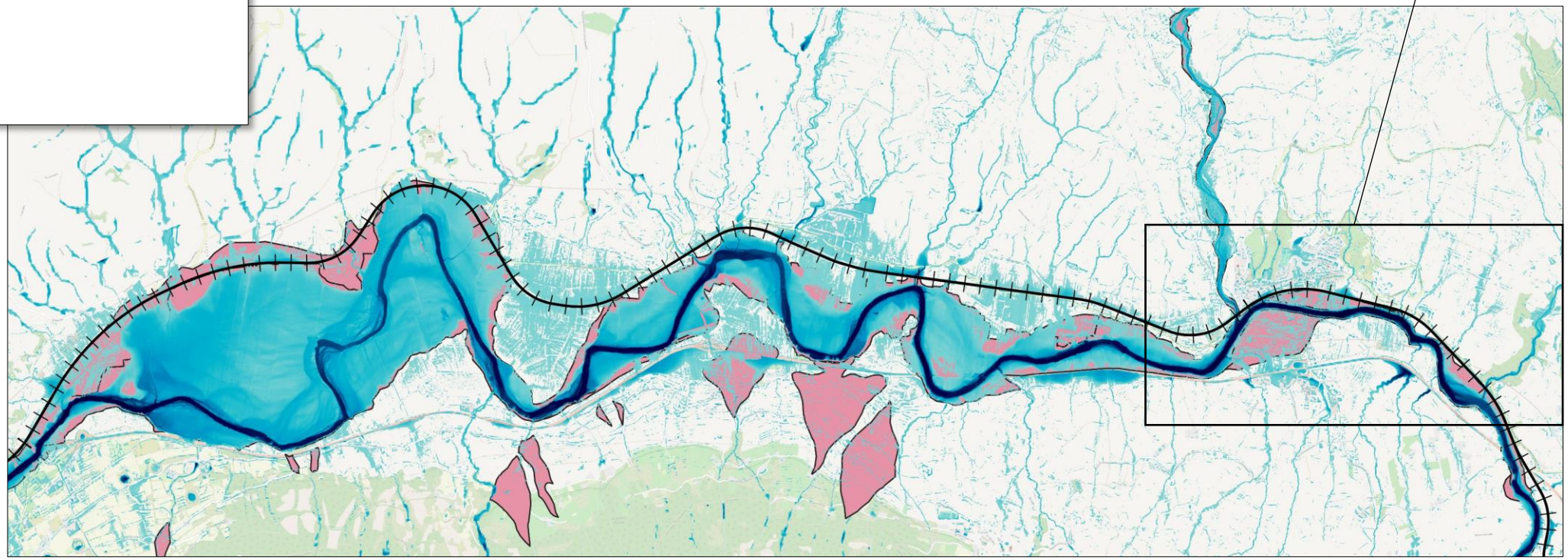
Direct Rainfall Modelling approach



- Methodology for a Spatial Decision Support System (**SDSS**) integrating **GIS** functionalities and predictive models to facilitate strategic decision-making for railway adaptation to hydrogeological hazards.

- The applicability of the methodology at the local scale was tested through a case study involving a main railway track in Southern Italy that recently experienced damages and disruption due to an extreme storm event.

- In the case study, we distinguish between flood events (i) related to river overflow, and (ii) directly linked to heavy rainfall (that generate hydraulic instability effects on slopes).

- With the **direct rainfall modelling approach** in 2D HEC-RAS, we identify not only the railway sections intersecting with flooded areas, but also potential damage sources caused by direct rainfall, which are not currently incorporated into official hazard maps.

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THANKS