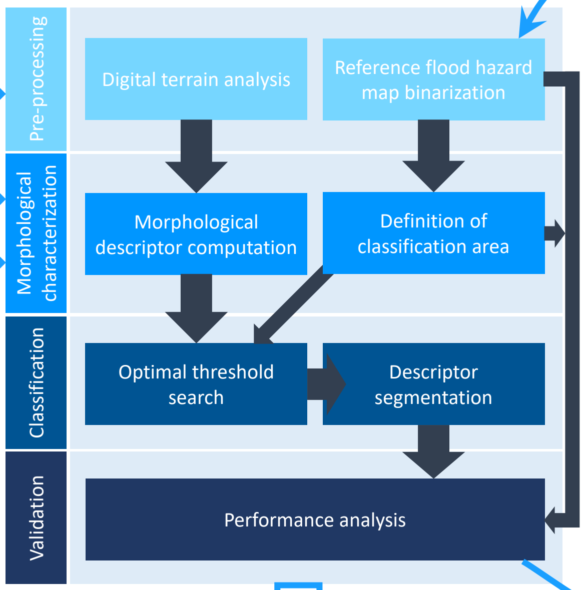
Estimation of flood-prone areas for preliminary large-scale flood risk assessment using hydro-geomorphic mapping approaches [hands-on workshop]

Ricardo Tavares da Costa
17.09.2019

HYDRO-GEOMORPHIC METHOD
An Overview

Digital Elevation Model ⇨
Channel initiation ⇨
hydraulic scaling ⇨

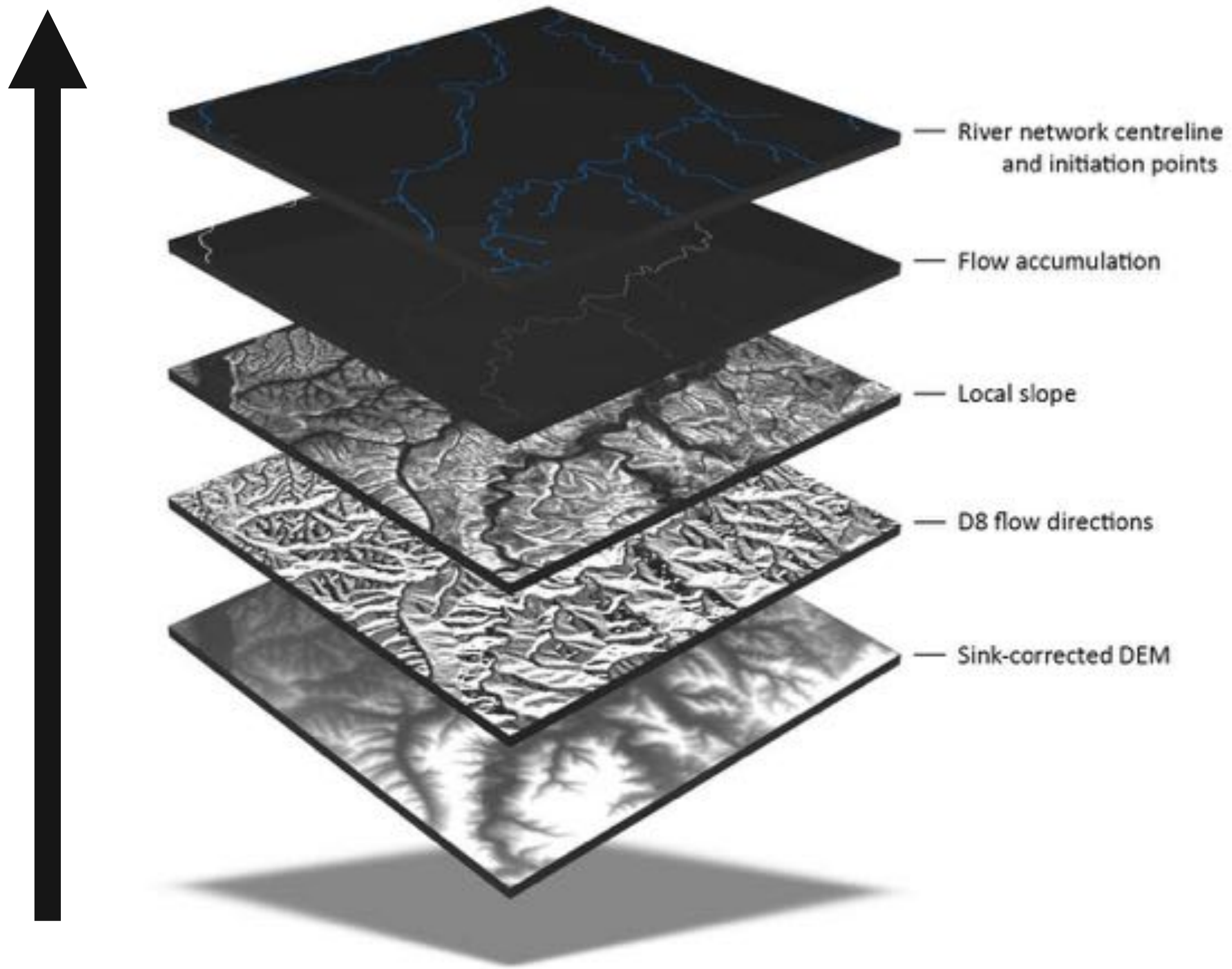


downscaling & extrapolation

- flood extent from modelling results
- flood extent from remote sensing
- flood extent from field surveys

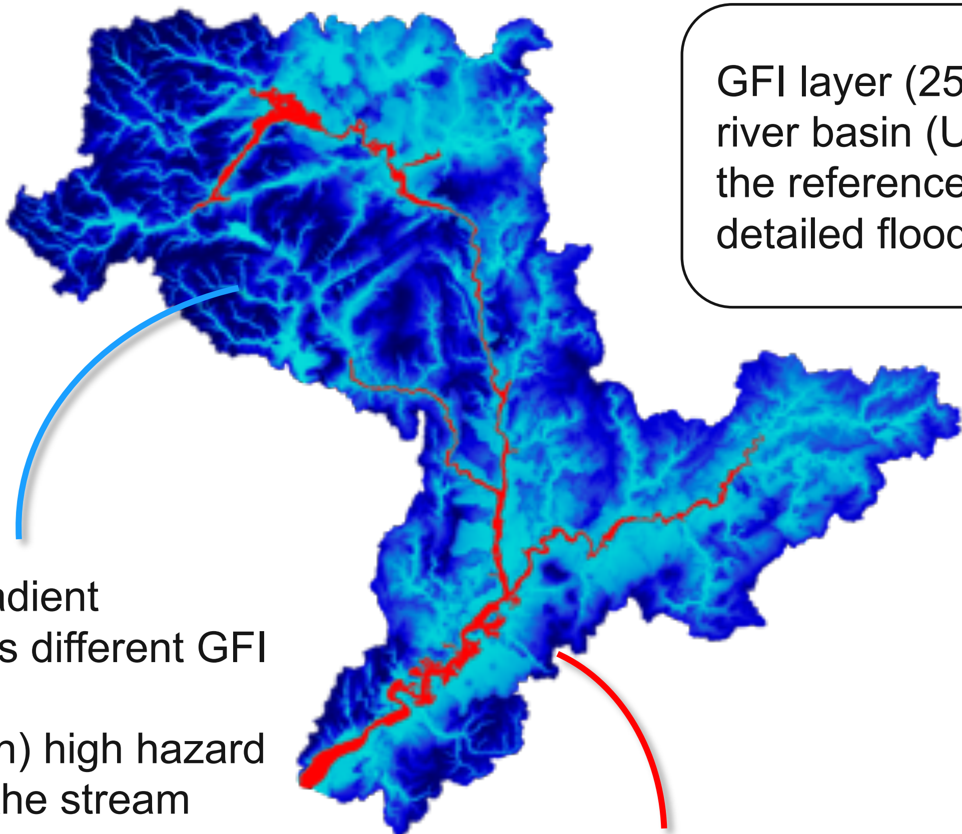
hydrogeomorphic flood extents

HYDRO-GEOMORPHIC METHOD
Terrain Analysis



HYDRO-GEOMORPHIC METHOD

GFI Threshold Binary Classification



GFI layer (25 m) for the Severn river basin (UK) ready to reproduce the reference flood extents from a detailed flood study

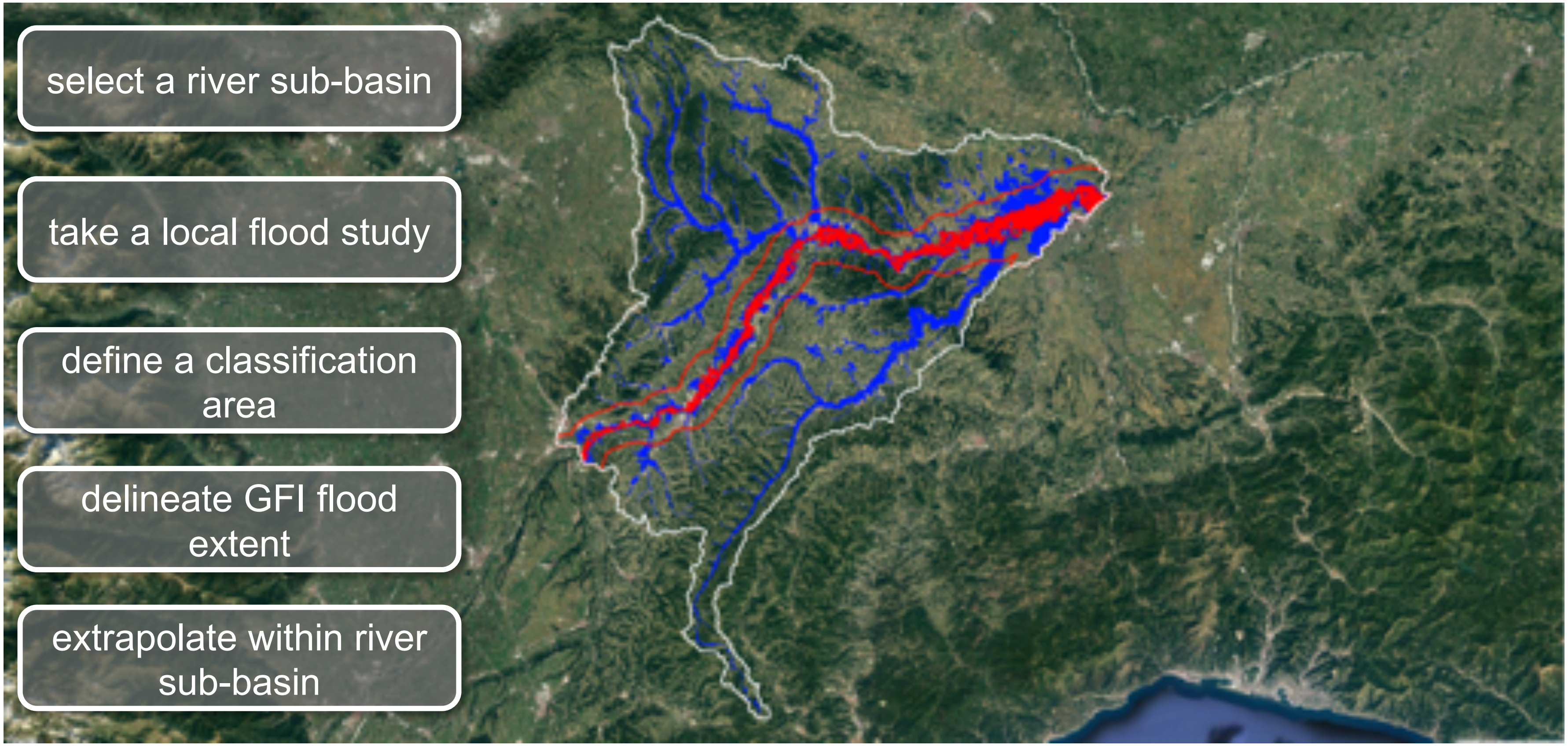
Objective Function
True Skill Score,
TSS=(tp*tn-fp*fn)/(tp+fn)*(fp+tn)

colour gradient represents different GFI values:

- 1 (cyan) high hazard (near the stream channel)
- 0 (dark blue) low hazard (away from the stream channel)

Benchmark flood hazard map

HYDRO-GEOMORPHIC METHOD
Extrapolation and Downscaling



HANDS-ON EXERCISE
Before We Start

What you will need:

1. Internet connection
2. Google account
3. Link to access the notebook (provided by me)
4. Credentials to access the case study data (provided by me)

HANDS-ON EXERCISE

Hydrogeomorphic Mapping of Flood-Prone Areas

Objective of this workshop:

1. understand how to perform a hydrogeomorphic mapping of flood-prone areas by estimating the envelope of major floods based on a benchmark flood extent
2. understand how the methodology works in practice by following a step-by-step procedure implemented as a Google Colab notebook and applying it to a test case
3. compare the mapping outcomes obtained in the test case with the benchmark flood hazard maps and discuss the findings in the context of hypothetical assets

How many persons and assets do you think will be prone to flooding?

This workshop covers all steps to arrive to a final map of flood-prone areas — from pre-processing the digital elevation model (DEM) and reference flood extent, to computing the morphological descriptor, classification, mapping the flood-prone areas in the region of interest and downscaling and extrapolating the results beyond this region

HANDS-ON EXERCISE
Overview of Google Colab Notebook

SYSTEM RISK ETN

Starting Up

- **CELL 1** installs all necessary python modules for this exercise
- **CELL 2** imports all modules
- **CELL 3** authenticates to Google Drive and loads the case study folder to the notebook environment, creating links to each file
- **CELL 4** defines a simple python function to plot images

Pre-Processing

- **CELL 5** loads and pre-processes input raster layers to start terrain analysis, namely:

1. D8 flow direction model
2. Flow accumulation layer
3. Local slope
4. Benchmark flood hazard map
5. Assets layer for overlaying at the end

- **CELL 6** computation of river network initiation points (channel initiation) by thresholding with 10^5 the product of contributing area A with the local slope S to the power of k = 1.7

$$AS^k < 10^5$$

HANDS-ON EXERCISE
Overview of Google Colab Notebook

Morphological Characterization

- **CELL 7** defines a python function necessary for flow routing in the computation of the GFI components, i.e. the empirical stage, h, and the elevation difference, H
- **CELL 8** computation of river network centerline from initiation points
- **CELL 9** computation of the H
- **CELL 10** flood frequency analysis to determine bankfull depth scaling relation
- **CELL 11** computation of the h
- **CELL 12** computation of the GFI

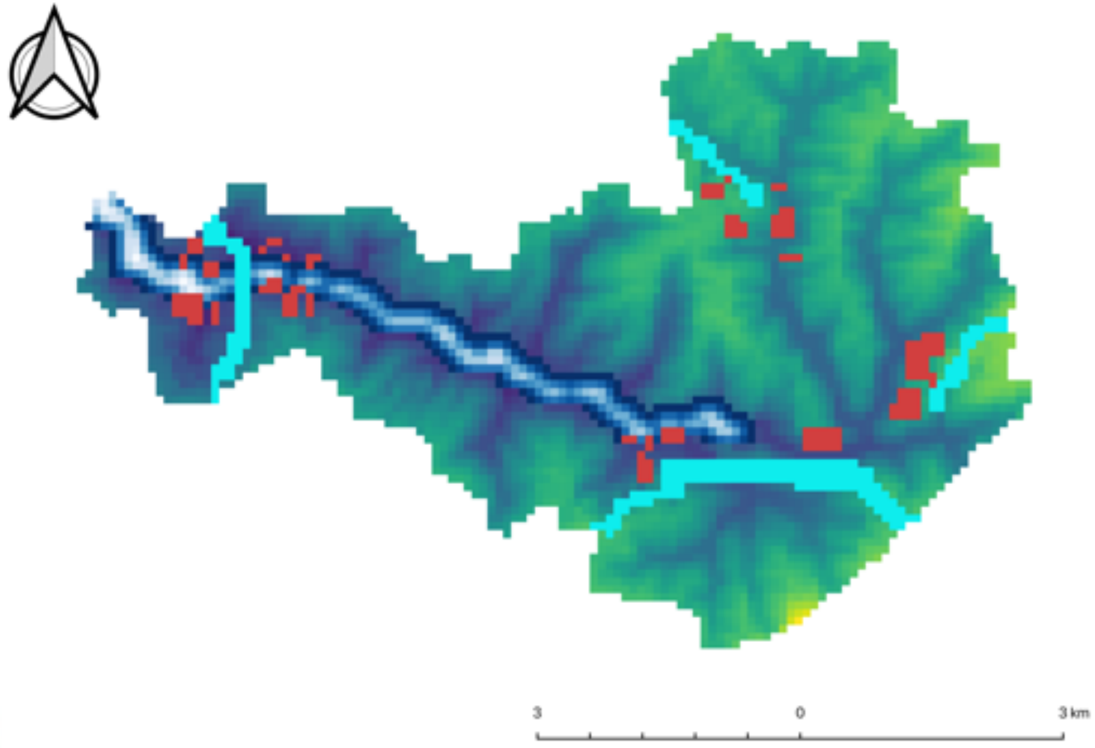
Classification

- **CELL 13** binarize benchmark flood hazard map
- **CELL 14** classification of flood-prone areas

- **CELL 15** overlay of resulting map of flood-prone areas and the assets layer

HANDS-ON EXERCISE
Case Study

- The chosen case study is a very small catchment within the Ohio river basin, US
- The benchmark flood hazard layer is obtained from the US Federal Emergency Management Agency (FEMA)
- The assets layer is completely hypothetical, all footprints of infrastructure (roads in cyan and buildings in red) represented in this layer are not real



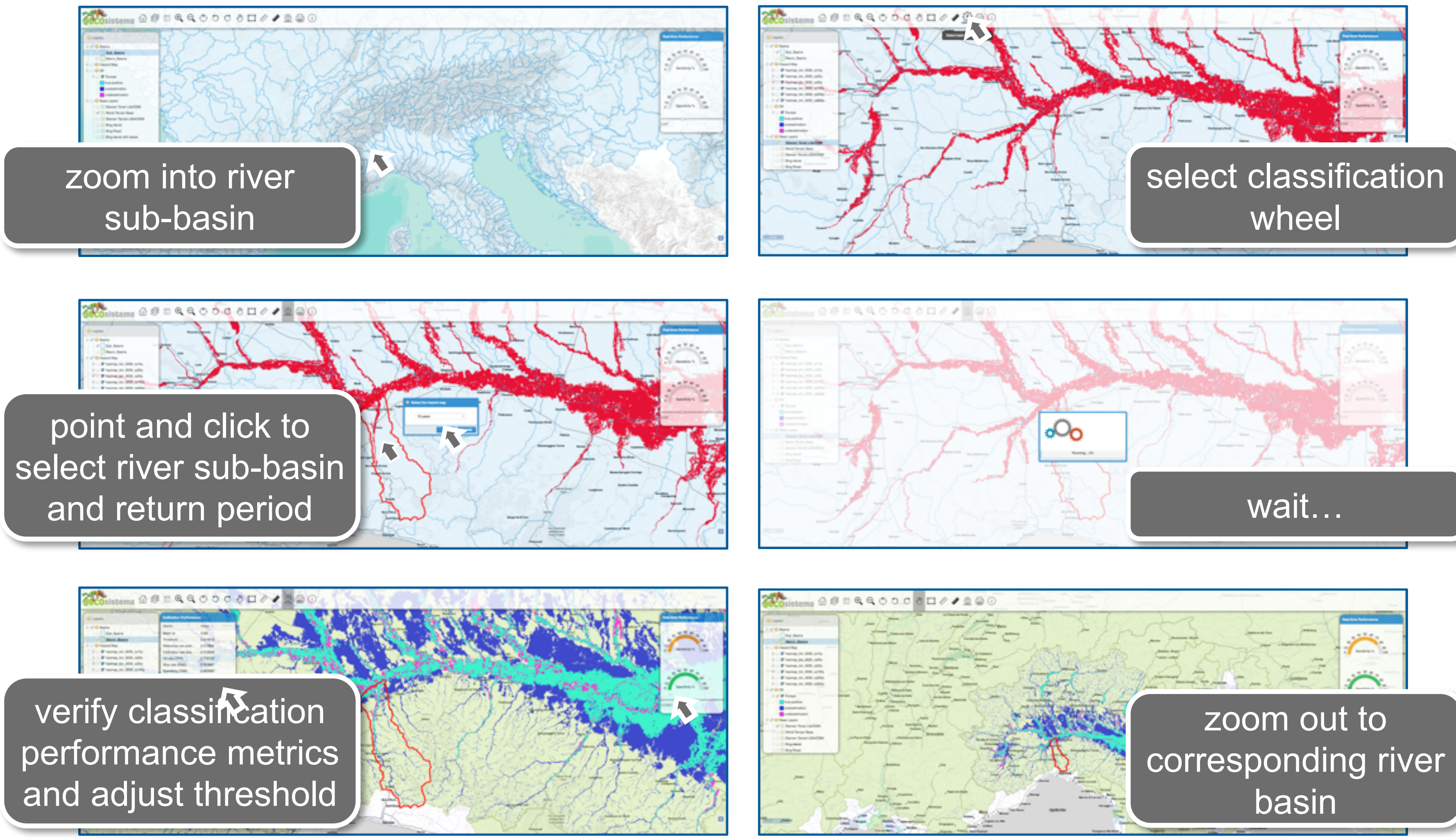
ONLINE TOOL
SmartFLOOD Platform

gecosistema.com/smartflood

SmartFLOOD

digital platform for large-scale flood research

ONLINE TOOL
SmartFLOOD Platform



THANK YOU

Feel free to drop me a line anytime

Ricardo Tavares da Costa
ricardotavarescosta@gmail.com

SYSTEM RISK ETN

FULL PARTNERS ARE:

GFZ Helmholtz Centre Potsdam

HR Wallingford — Working with water

adelphi

Middlesex University London

University of BRISTOL

TU WIEN

Deltares — Enabling Delta Life

Umwelt Bundesamt — KomPass

gecosistema

FutureWater

PARTNER ORGANISATIONS:

Risk Management Solutions Ltd. (RMS)
USA

Ministry of Infrastructure and the Environment (RWS)
Netherlands

Royal Netherlands Meteorological Institute (KNMI)
Netherlands

Autorità di Bacino del Fiume Po – Po Basin Authority (AdB-Po)
Italy

Guy Carpenter
USA

Deutsche Rückversicherung AG
Germany

Landesamt für Umwelt (LfU)
State Office for Environment of the Federal State of Brandenburg
Germany

This project has received funding from the European Union‘s EU Framework Programme for Research and Innovation Horizon 2020 under Grant Agreement No. 676027

www.system-risk.eu