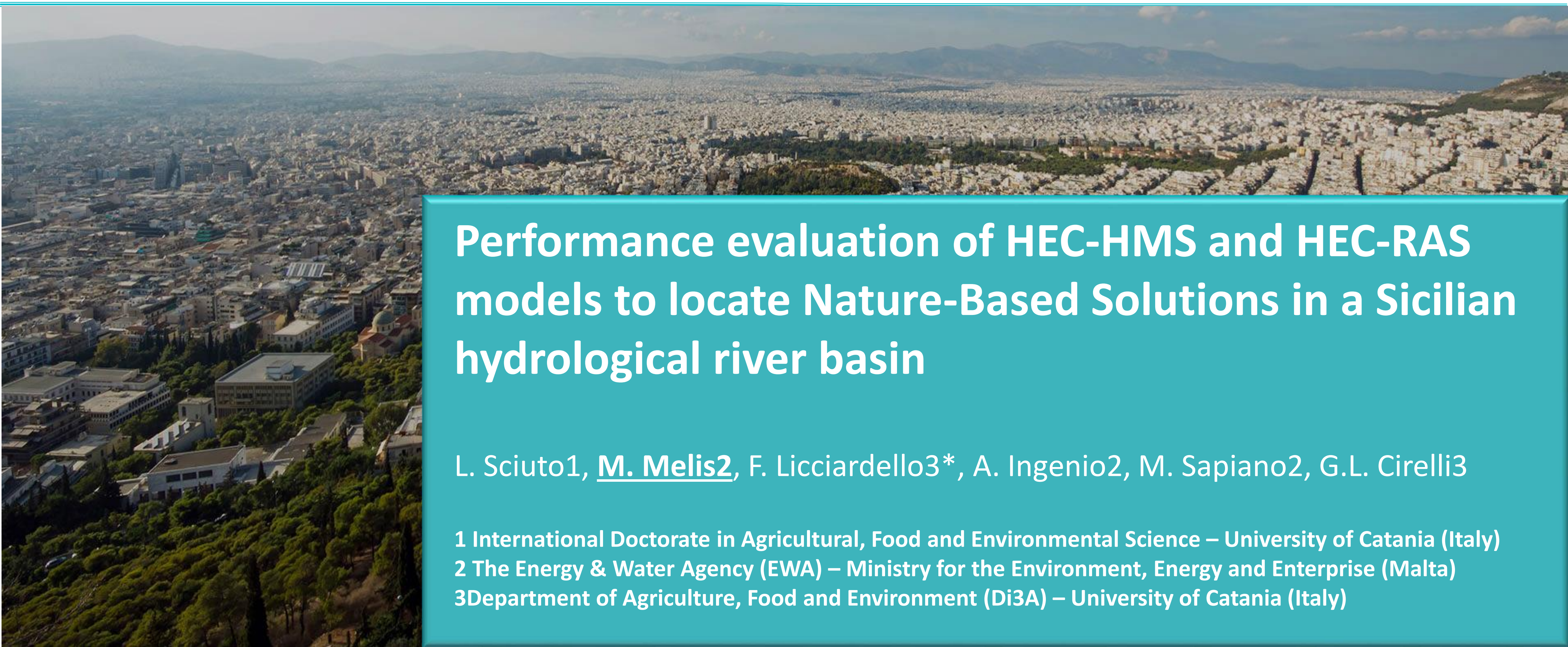
WATER Innovation & Circularity CONFERENCE (WICC)

7th -9th JUNE

ATHENS

GREECE



Performance evaluation of HEC-HMS and HEC-RAS models to locate Nature-Based Solutions in a Sicilian hydrological river basin

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GIFLUID project

Green **I**nfrastructures to mitigate **f**lood risks in **U**rban and sub-urban areas and to **i**mprove the quality of rainwater **d**ischarges - **GIFLUID**

The project aims to develop and promote practical tools which integrate the planning and design of **Green Urban Infrastructures** (GUIs) in critical urban areas of Malta and Sicily in order to mitigate floods effects, to increase the infiltration of rainwater also improving its quality.

Green Roofs

Porous Pavements

Rain Gardens

Introduction

AGRICOLTURA, ALIMENTAZIONE E AMBIENTE

THE ENERGY & WATER AGENCY

Frequently, traditional drainage networks, known as "***GRAY INFRASTRUCTURE***," demonstrate their inadequacy in managing stormwater, and it would be necessary to adapt them to new flow rates and volumes of runoff.

The main causes of the significant ***increase in flow rates and volumes of runoff*** in urban and suburban areas are due to:

•The increase in rainfall intensity, primarily due to climate change phenomena.

•The increase in ***soil sealing*** caused by urbanization and large infrastructures.

In the last 20 years, the extent of urbanized areas in Europe has increased by an average of 20% - (ISPRA, 2020).

"STREAMS as ROADS"

Lavinaio Stream (Aci Catena)

Forcile Stream (Catania)

"ROADS as RIVERS"

Catania – 25 Oct 2021

Catania – 26 Oct 2021

Land use consumption in Italy (2006-2021)

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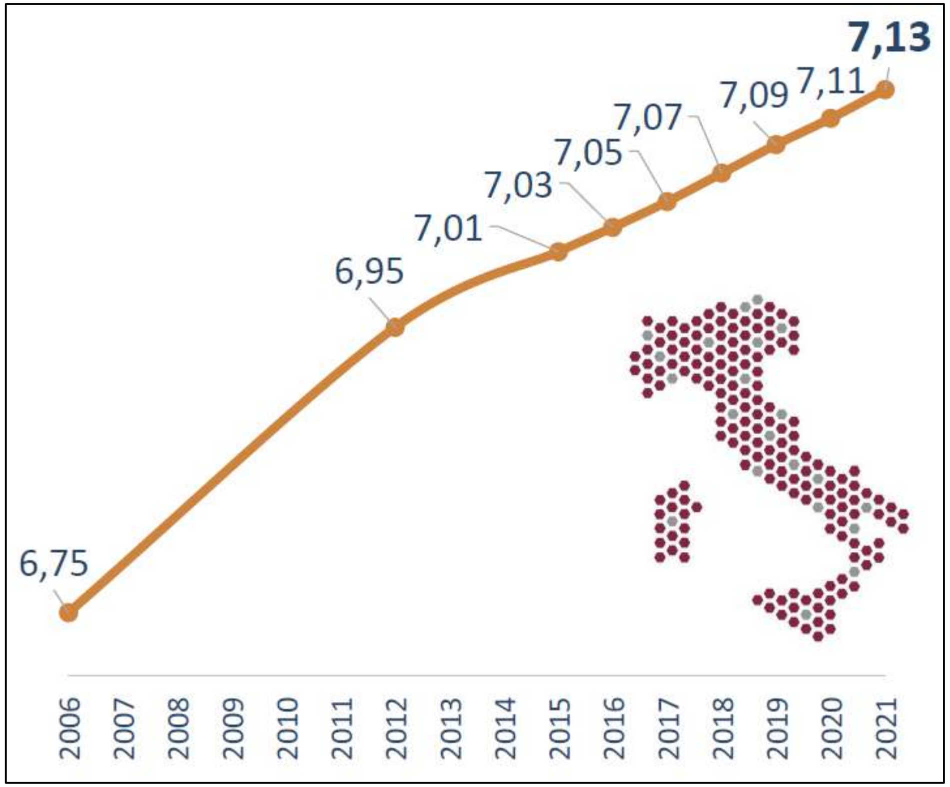
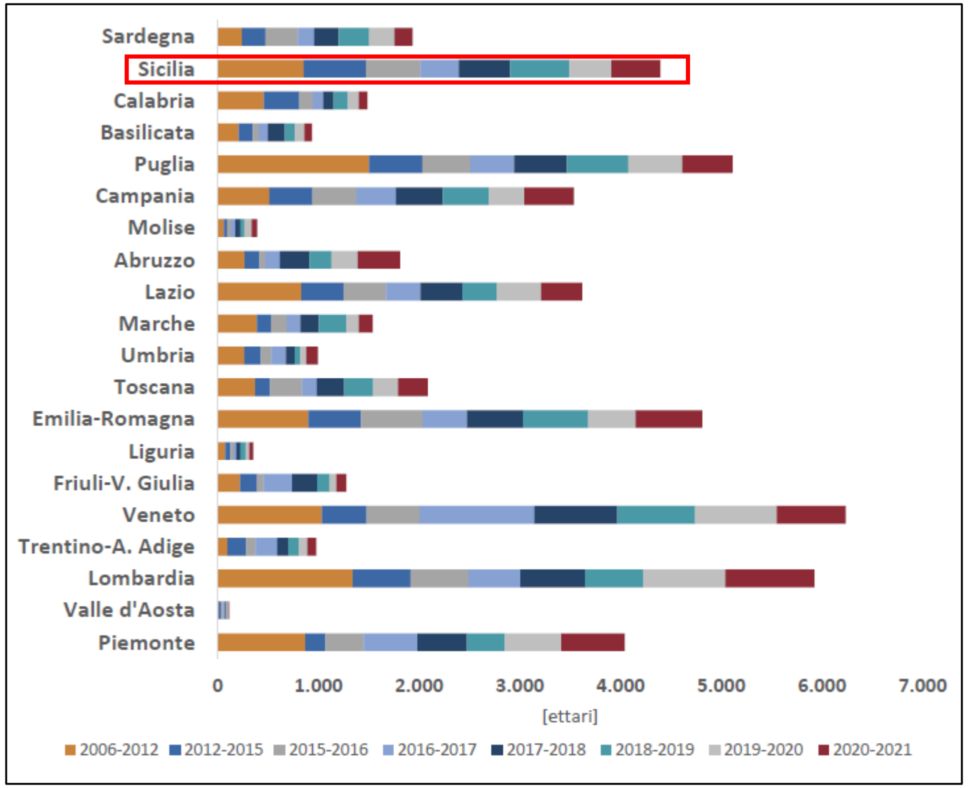
THE ENERGY & WATER AGENCY

Percentage of the total annual land use consumption at ***National*** level



Total annual land use consumption at ***Regional*** level



Total annual land use consumption (**2021**): **69.1 km²** → **19** hectares per day
2 square meters per second

ISPRA (Italian Institute for Environmental Protection and Research)

Flood events in Sicily

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THE ENERGY & WATER AGENCY

NEED FOR A CHANGE OF CURRENT WATER MANAGEMENT MODELS TO CONTROL FLOODING AREAS

Palermo, 5-6 October 2013

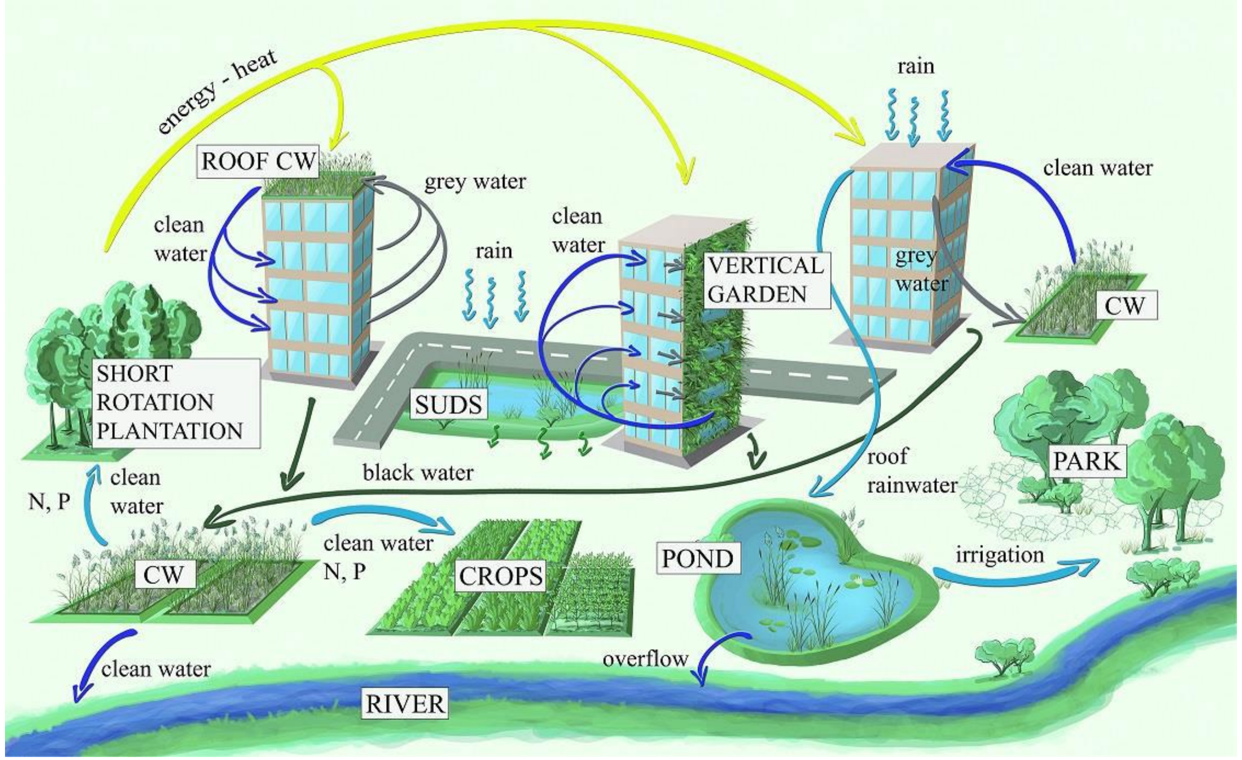
Siracusa, 22 October 2021

Licata, 19 November 2016

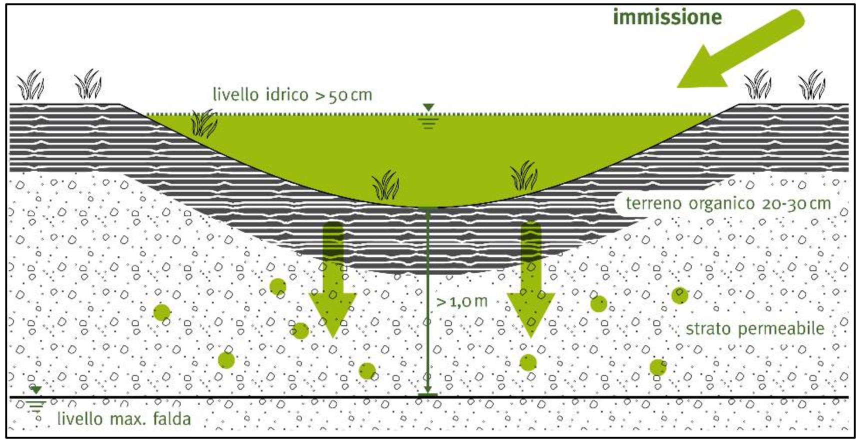
Catania, 26 October 2021

The "Sponge City" concept

Compared to other urban stormwater management systems, the ***"SPONGE CITY"*** or ***"PERMEABLE CITY"*** covers a broader range of objectives, including reducing runoff and water stagnation, preventing floods, improving water quality, restoring natural ecosystems, and mitigating the impacts of heat islands.

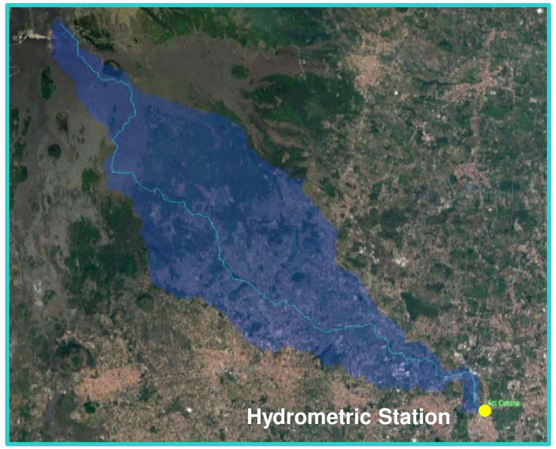


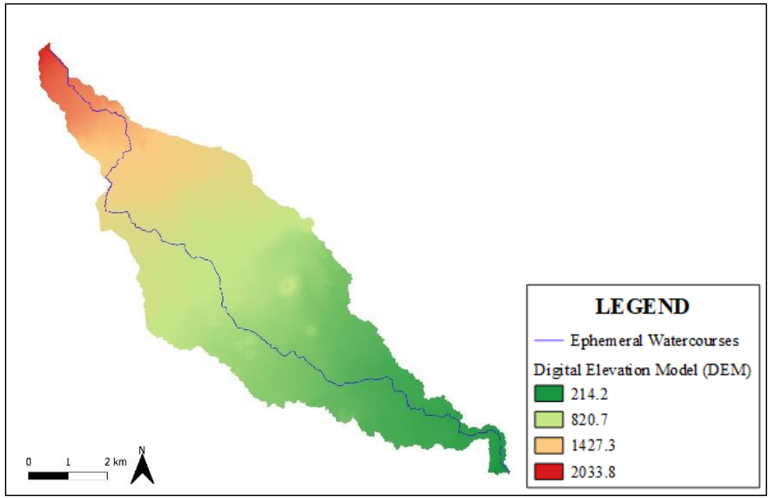
Infiltration Basin



Construction detail design of an Infiltration basin

Lavinaio’s stream location and hydrological characteristic

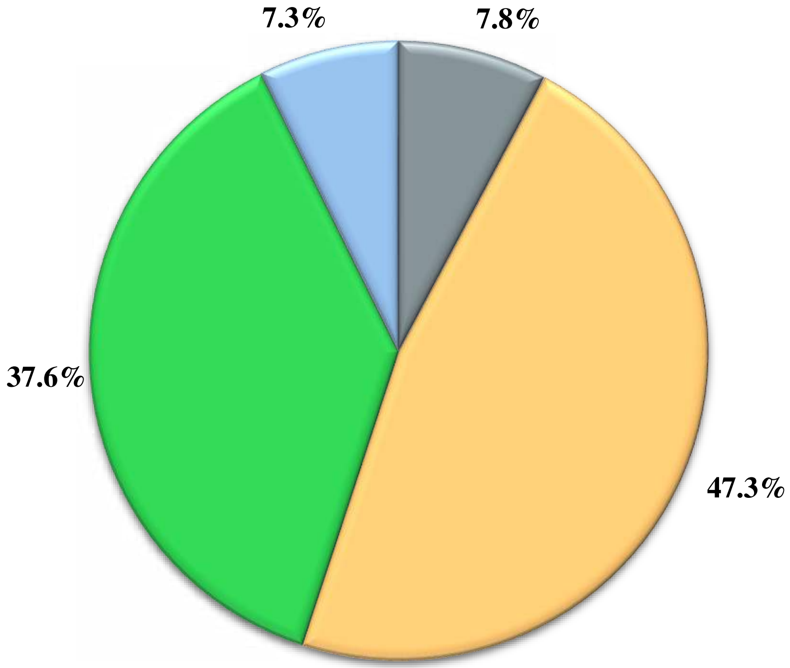


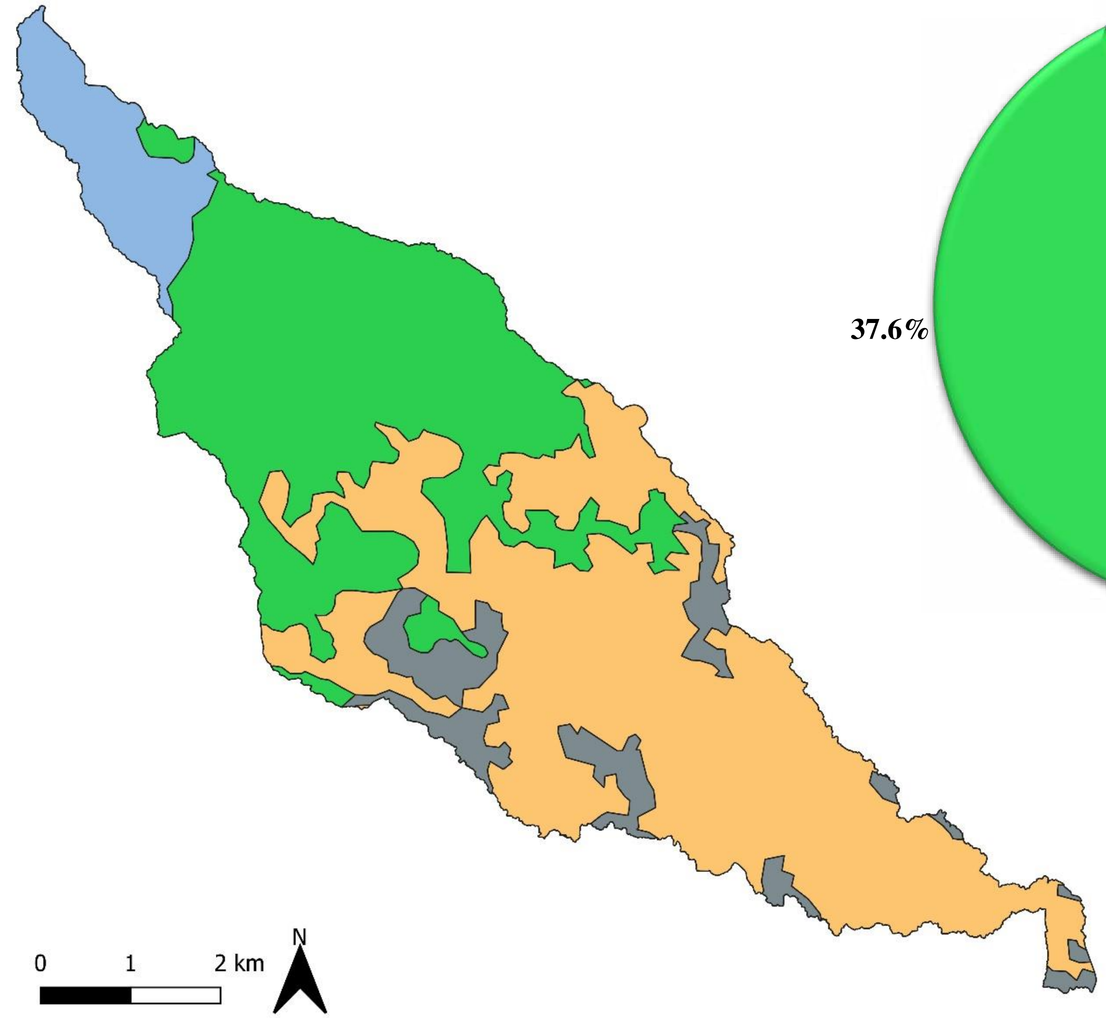


Morphological and Orographical Parameters

- Area (A) = 38.50 km^2
- Perimeter (P) = 47.3 km
- Main stream Length (L) = 22.78 km
- Max Height (Q_M) = 2048.61 m.a.s.l.
- Min Height (Q_m) = 195.37 m.a.s.l.
- Average Height (H_m) = 854.97 m.a.s.l.
- Gradient (ΔQ) = 1852 m
- Main stream slope (i) = 8.13 %

Land use (CLC 2018)



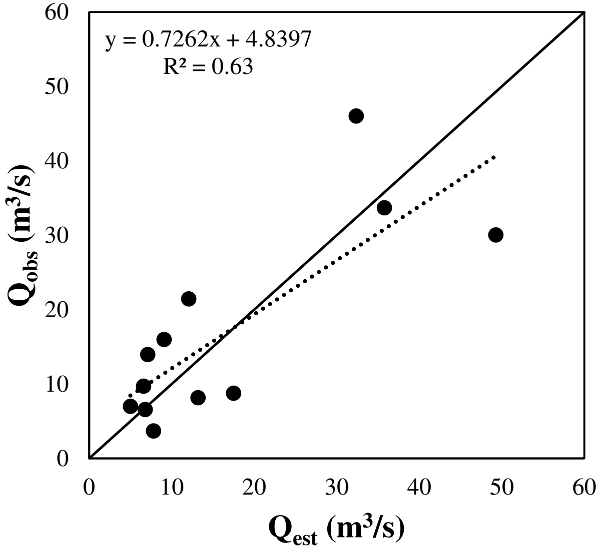


Hydrometric Station of Aci Catena

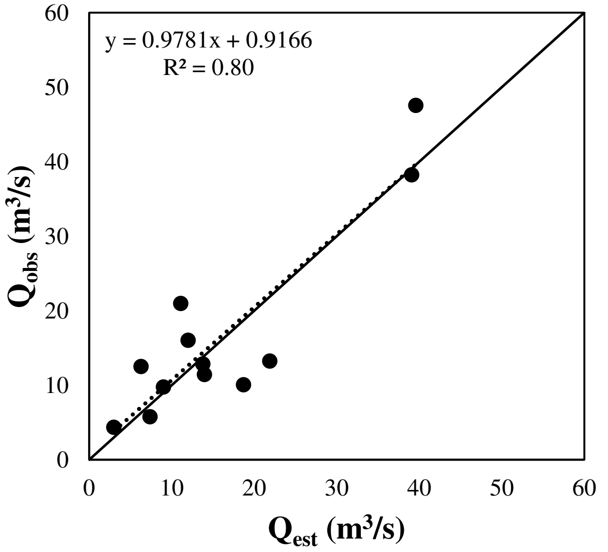
- Historical recordings: **2016 – 2022**
- Data recording time interval: **10 minutes**

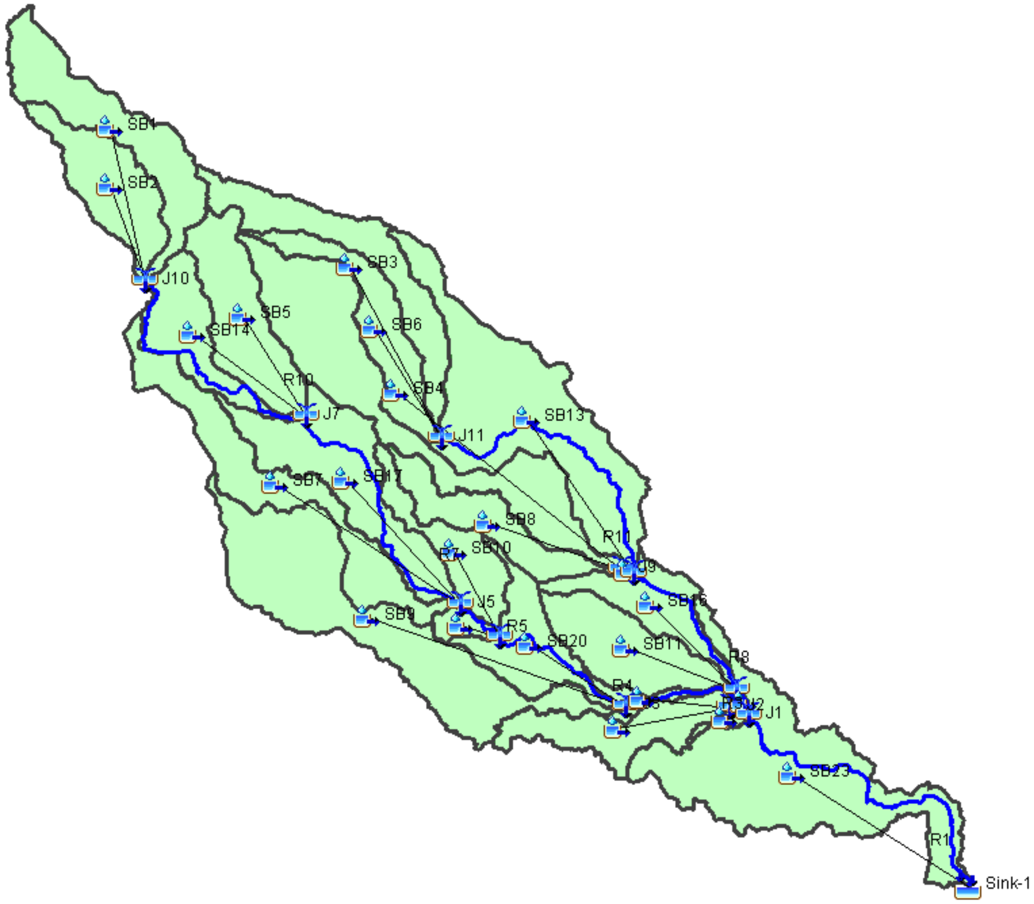
Hydrological modelling – Hec HMS

C A L I B R A T I O N



V A L I D A T I O N





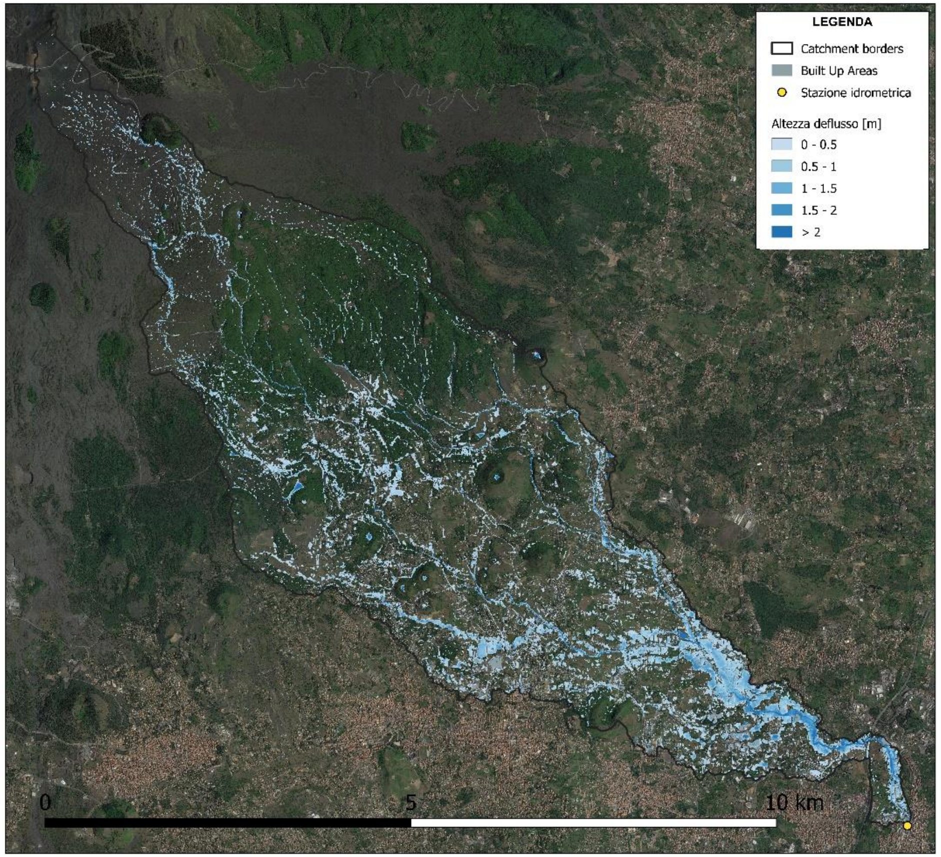
CALIBRATION			
NSE	PBIAS	RMSE	R^2
0.54	1%	8.54	0.63

Variation	NSE	PBIAS	RMSE	R^2
0 %	0.35	29.71%	10.16	0.57
25 %	0.48	15.68%	9.07	0.60
50 %	0.54	1.26%	8.54	0.63
75 %	0.51	-13.36%	8.85	0.65
100 %	0.38	-28.31%	9.93	0.67

12 X 5 = 60 simulations

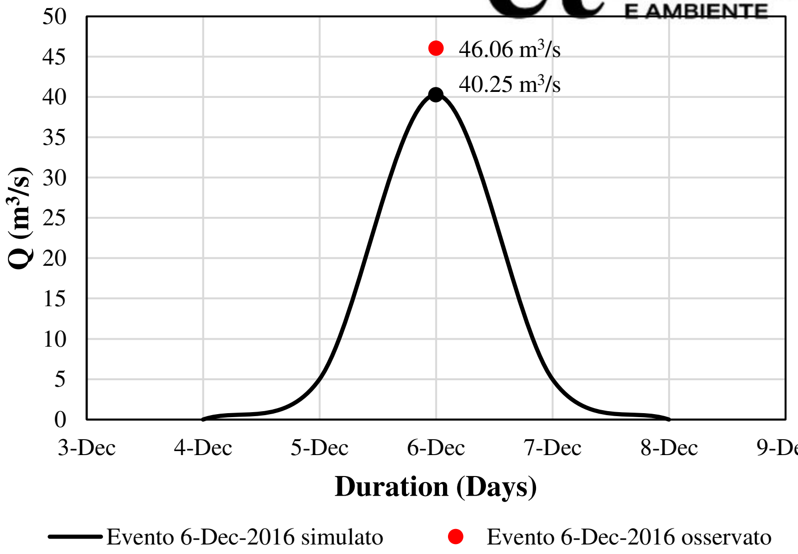
VALIDATION			
NSE	PBIAS	RMSE	R^2
0.80	3%	5.61	0.80

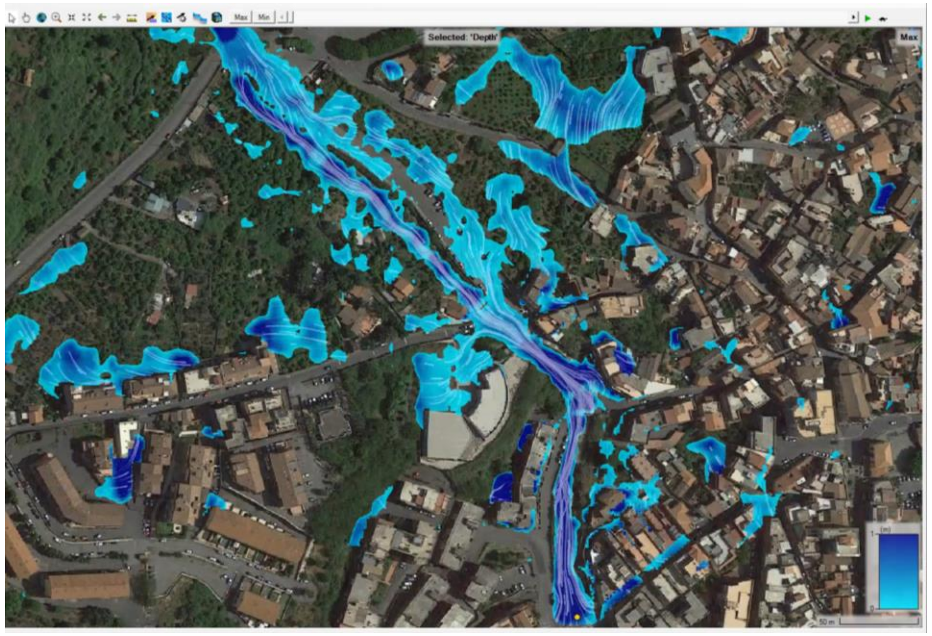
Hydraulic modelling – Hec RAS



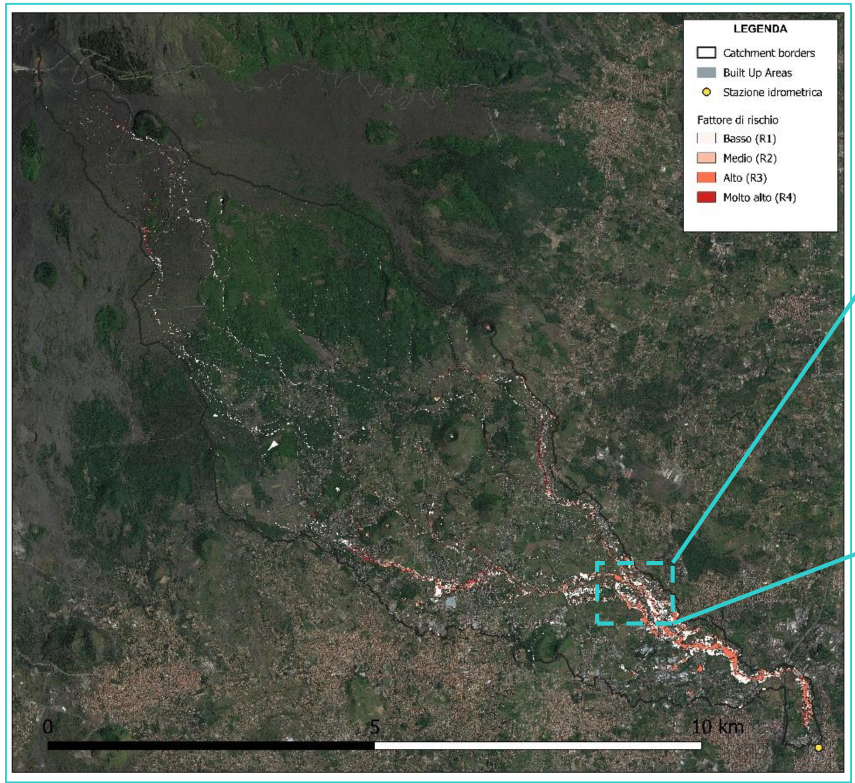
Runoff Depth – T200 years

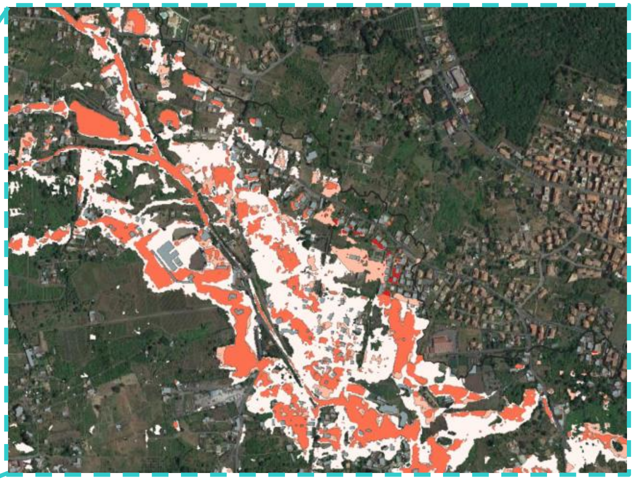
Peak Flow Discharge at outlet		
T10 years	T50 years	T200 years
123.6 m³/s	295.4 m³/s	478.1 m³/s

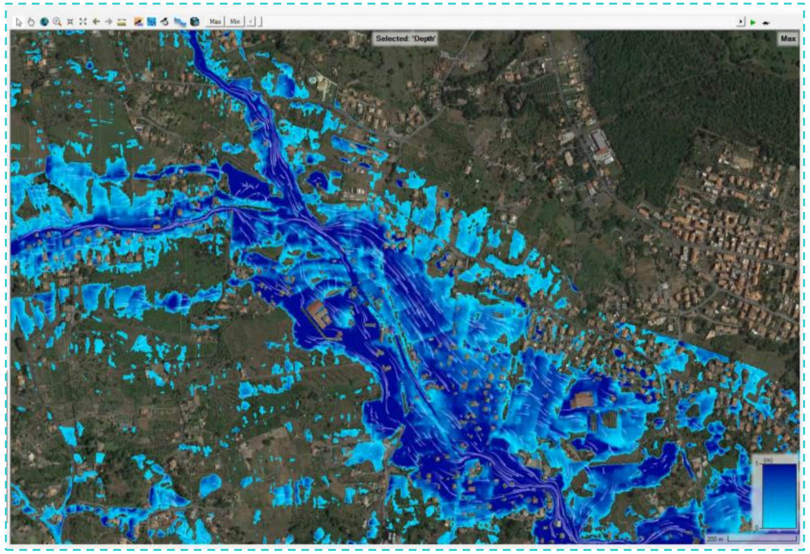




Nature Based Solution for Flood Risk Mitigation

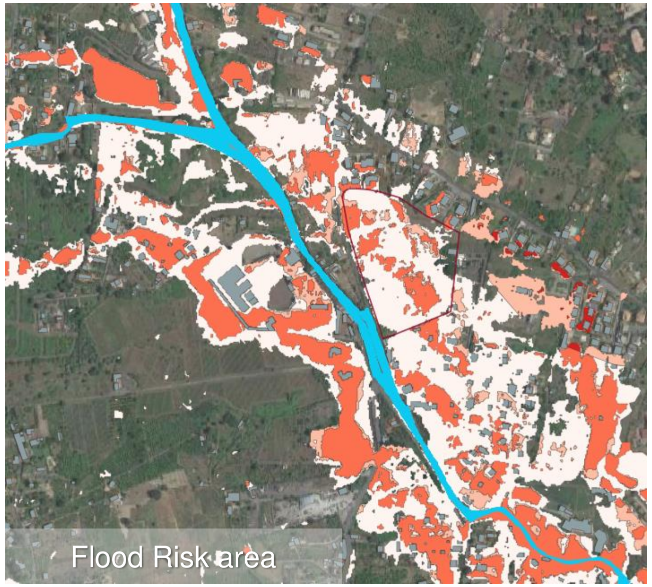


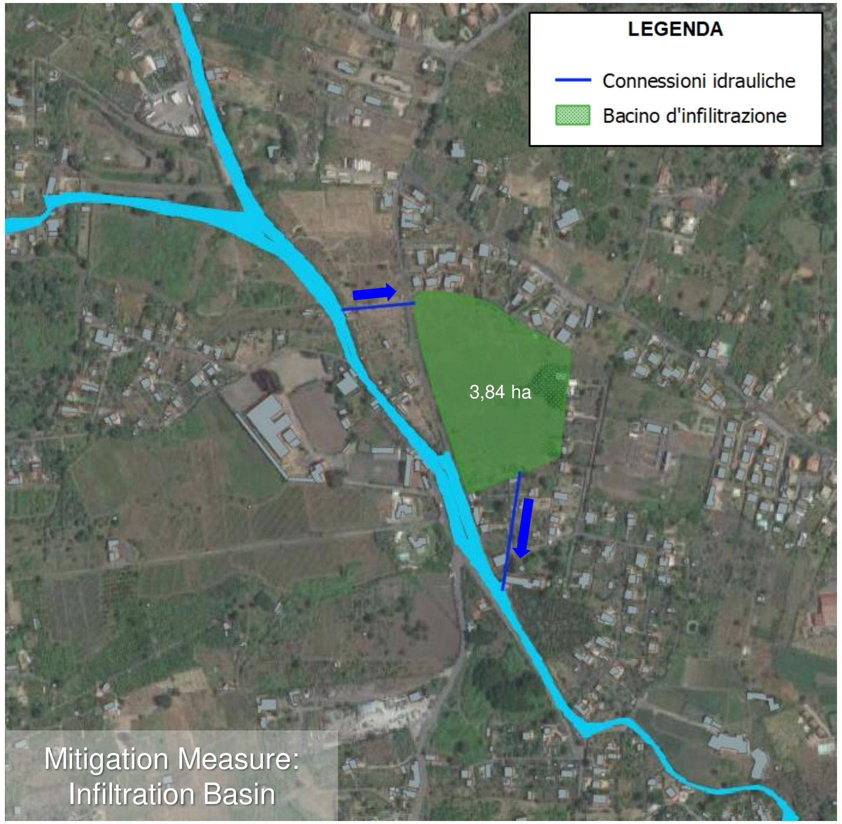




Considering the high percentage of permeable areas (e.g., rural areas, areas with spontaneous vegetation) covering approximately ***85%*** of the ***Lavinaio Stream basin***, it is necessary to implement large-scale nature-based solutions (NBS) in order to mitigate hydraulic risk, such as infiltration basins, rather than relying solely on local or urban small-scale NBS, such as green roofs, rain gardens, or porous pavements.

Nature Based Solution for Flood Risk Mitigation cont'd





Benefits:

1. Reduction of hydraulic risk in the surrounding urbanized area.
2. Control of flow rates in the watercourse aiming at improve consistency of downstream discharges both in terms of flow and event duration.
3. Enhancement of the area by increasing its usability for recreational purposes during dry periods, thus creating additional benefits for the locals.

Infiltration Basin effects – EPA SWMM

Infiltration basin effects			
	10 Years	50 Years	200 Years
	Peak flow at the outlet (m^3/s)	Peak flow at the outlet (m^3/s)	Peak flow at the outlet (m^3/s)
Current Scenario	141.0	269.2	410.2
With Nature Based Solution (NBS)	134.4	259.8	399.9
Peak flow reduction (%)	4.7	3.5	2.5

Conclusions

- Preliminary calibration and validation processes of HEC-HMS and HEC-RAS models showed satisfactory results.
- The proposed approach has high replication capacity and is able to perform consistently well on different datasets and in different environments.
- It can provide a tool to guide the climate change green adaptation strategies of the Mediterranean Countries by enabling both the better management of storm runoff and the transformation a potential hazard into a resource through the use of NBS.
- A Masterplan will be created using the methodology and modelling framework proposed. Its purpose is to guide decision-makers in determining the economically optimal level of applying NBS for flood risk mitigation.
- Investing in NBS can transform cities into more resilient, livable, and sustainable destinations for residents, employees, and visitors alike.

Thank you for your attention

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Soil sealing and climate change effects

\+ SOIL SEALING

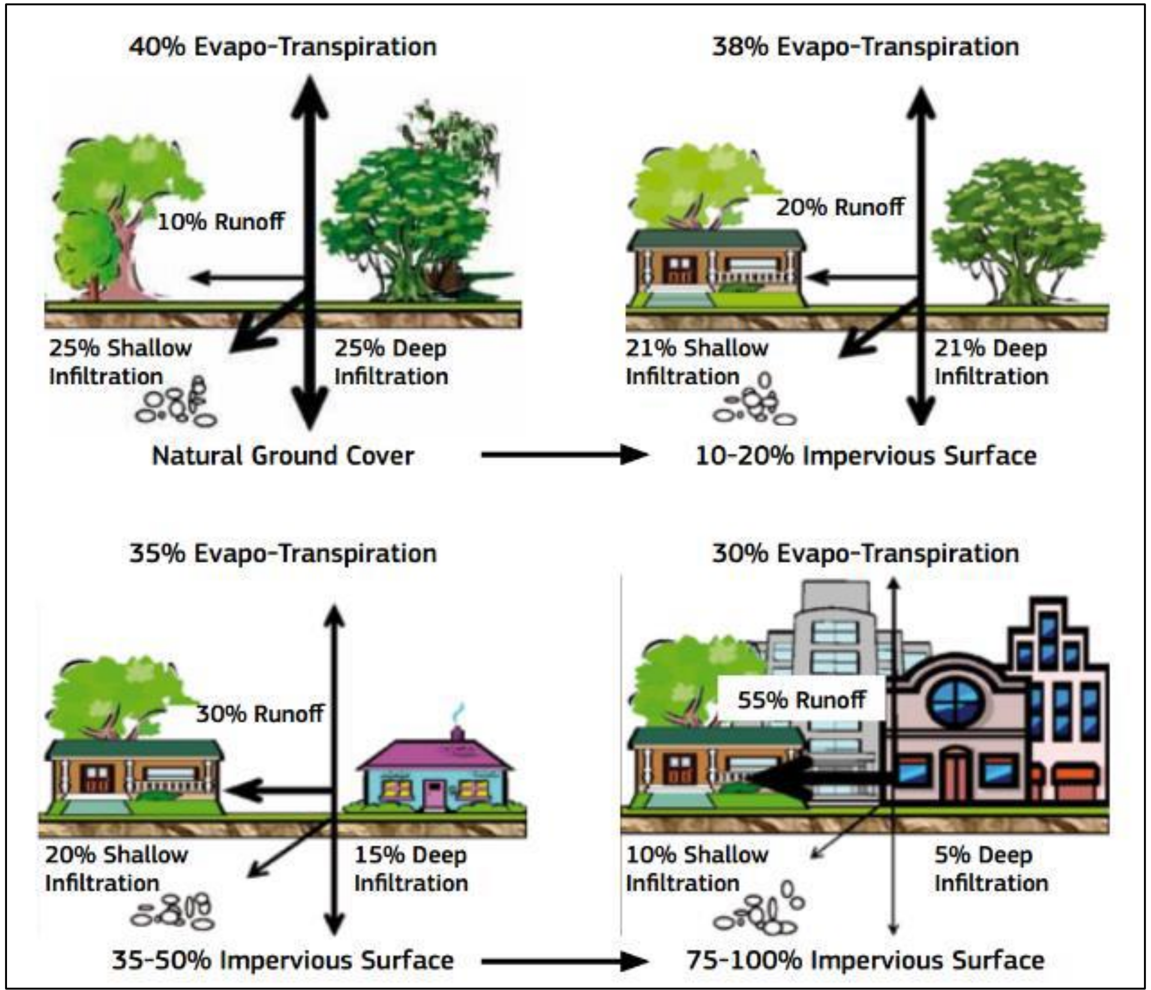
↓

\+ DISCHARGE VOLUMES

↓

− INFILTRATION CAPACITY

= INCREASED SURFACE RUNOFF



ISPRA (Italian Institute for Environmental Protection and Research)