Hydro-meteo risks in Socio-Ecological Systems: part-two - Modelling risk with future hazards

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OPERANDUM
OPEn-air laboRAtories for Nature baseD solUtions to Manage hydro-meteo risks

Summer School on Nature-based Solutions for hydro-meteo hazards and climate change adaptation
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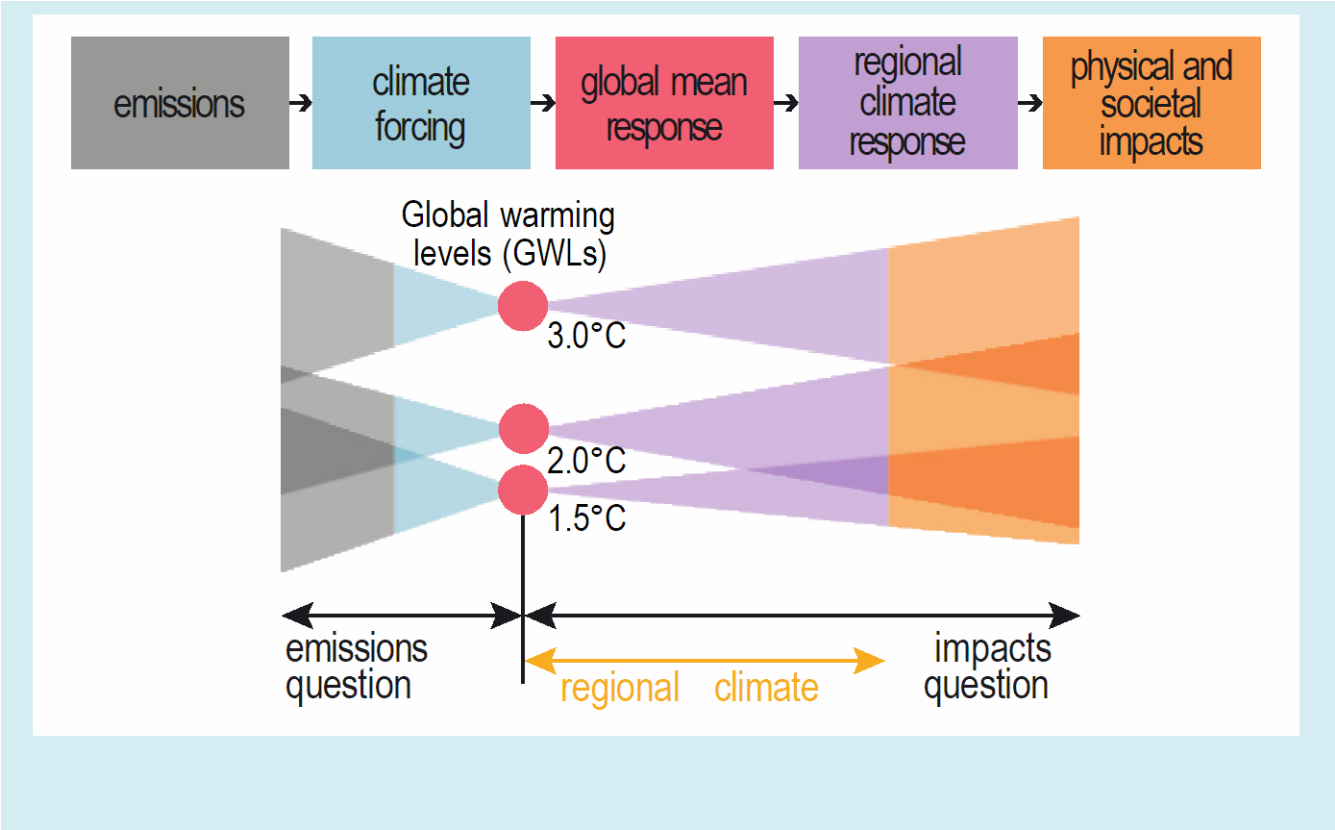
Global warming level



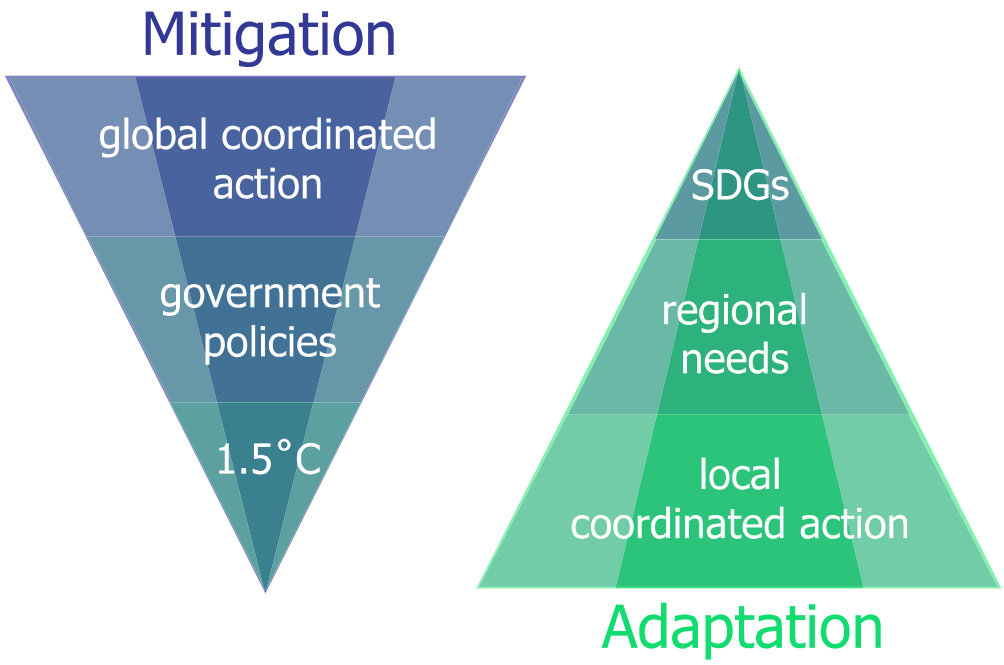
Split response of weather extremes into:
-the transient global warming response to scenarios
- the regional response as function of a given GWL, (regional climate sensitivity)

EU funded project
GA no. 776848

Coordinated climate research

The objective of the My Climate Risk Lighthouse Activity is to develop and mainstream a ‘bottom-up’ approach to regional climate risk, which starts from the decision context (and the decision scale) and enables relevant climate information to be brought into that context.

‘Lab’ approach to adaptation



‘The Activity will primarily use a case-study approach, in the form of labs […], where labs are understood to be dynamic, exploratory, transdisciplinary environments, and not physical infrastructure’

Fig. 1. Contrast between the ‘‘top-down’’ approach in climate-change science, which is needed for mitigation action, and the ‘‘bottom-up’’ approach needed for adaptation action.

Small is beautiful: climate-change science as if people mattered

Regina R. Rodrigues [a] and Theodore G. Shepherd[b]

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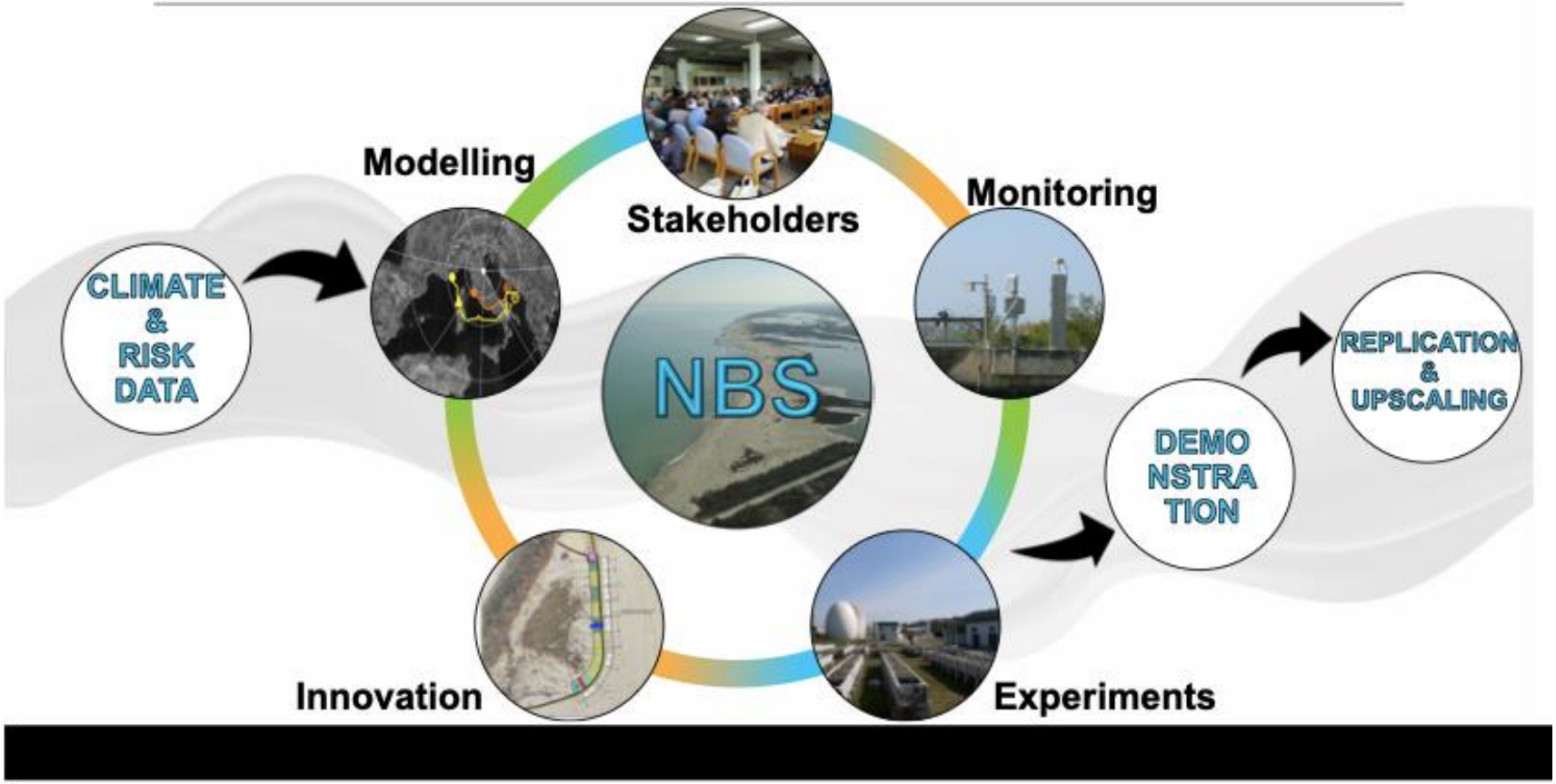
OPEN-AIR LABORATORY



The Open-Air Laboratories (OALs) are 'living labs' where Nature-Based Solutions are **co-developed** and **demonstrated** with local stakeholders.
The OALs constitute an innovative approach to adaptation to climate change.

The Open-Air Laboratory Italy

The 3 sites of the OAL-Italy

OAL-ITALY IN NUMBERS

6 international partners

3 operational sites in real life environment

4 Nature-Based Solutions implemented, modeled and tested

10 monitoring, modelling and experimental initiatives

more than **40** among scientists and stakeholders involved

The operational sites

The Panaro Site

Target Hazards: River Flooding

NBS: Plantation of deep-rooted plants on the riverbank

The Po di Goro Site

Target Hazards: Salt wedge intrusion, drought

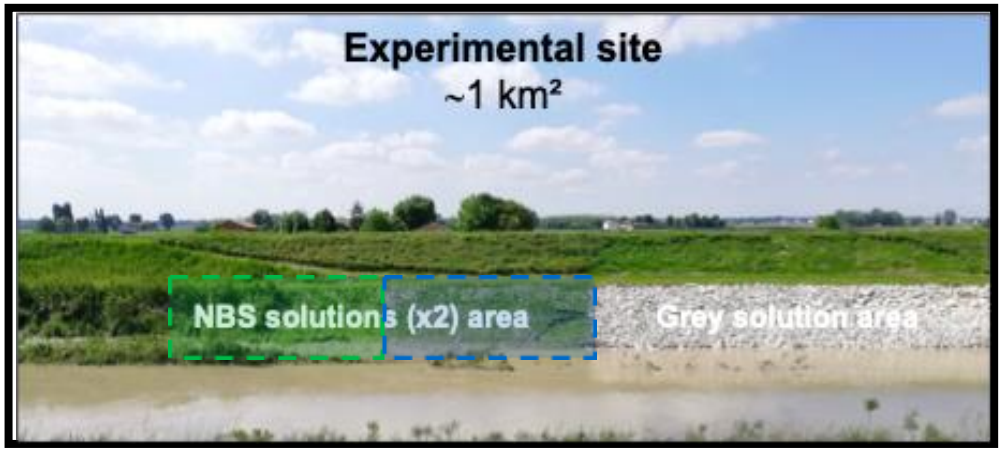
NBS: Plantation of halophytes plants

The Bellocchio/Volano Site

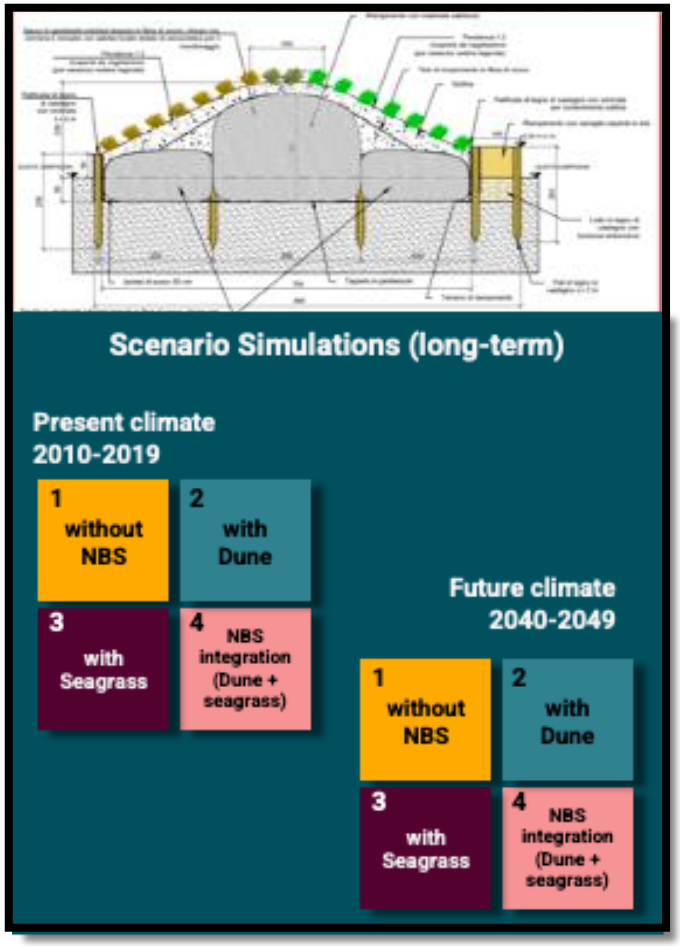
Target Hazards: Storm Surge and Costal Erosion

NBS: Artificial dune with natural material & seagrass

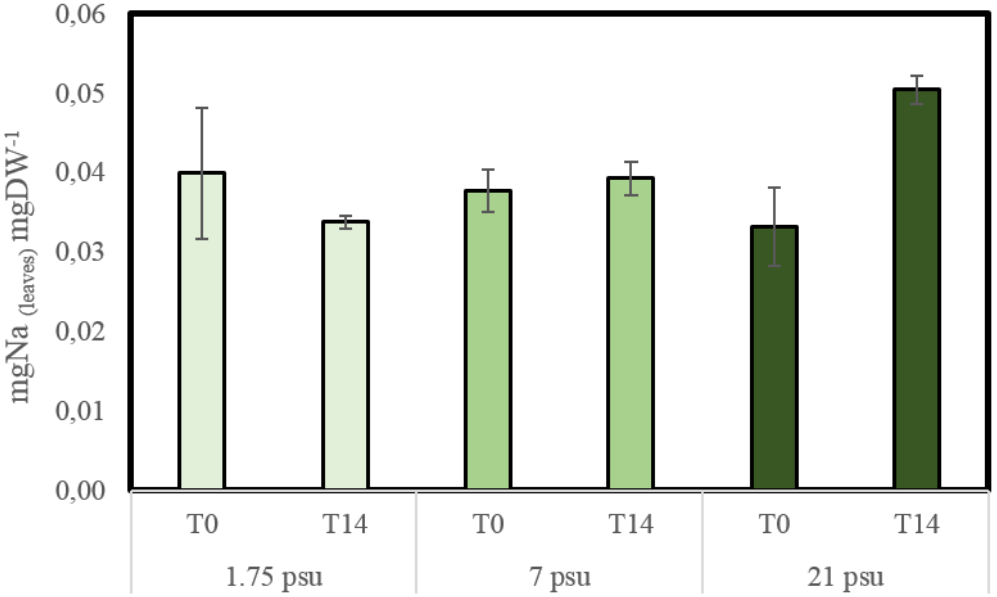
Highlights of the 4 NBS in OAL-Italy

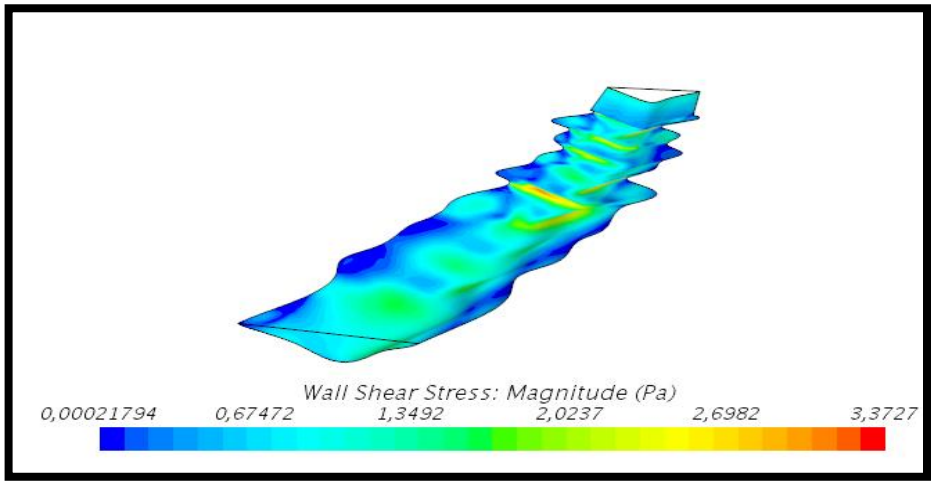


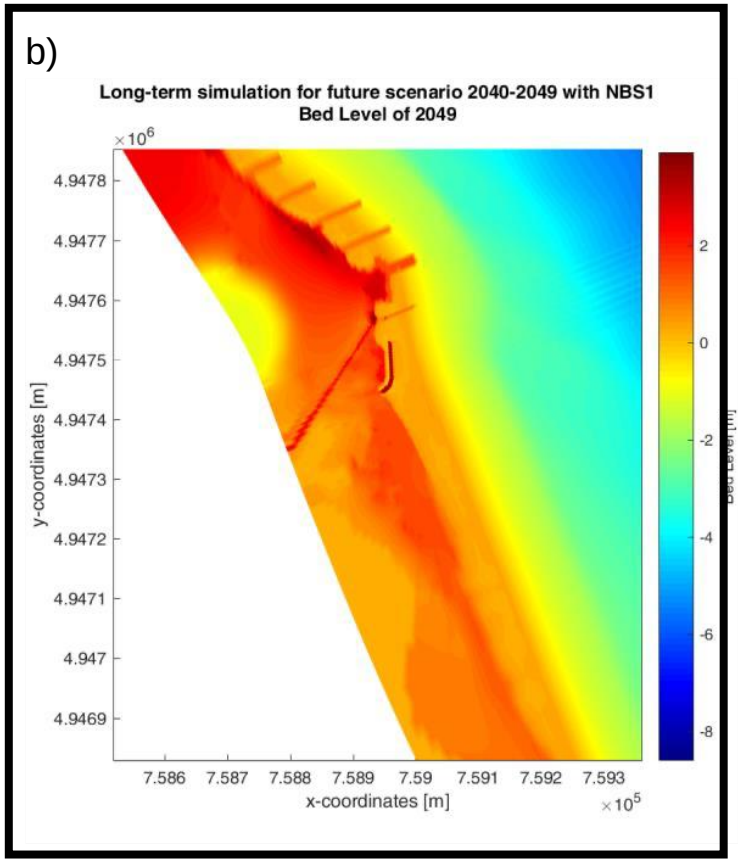
Urban River Lab (URL). Source: Naturalea



Monitoring and modelling results







NBS expected damage reduction

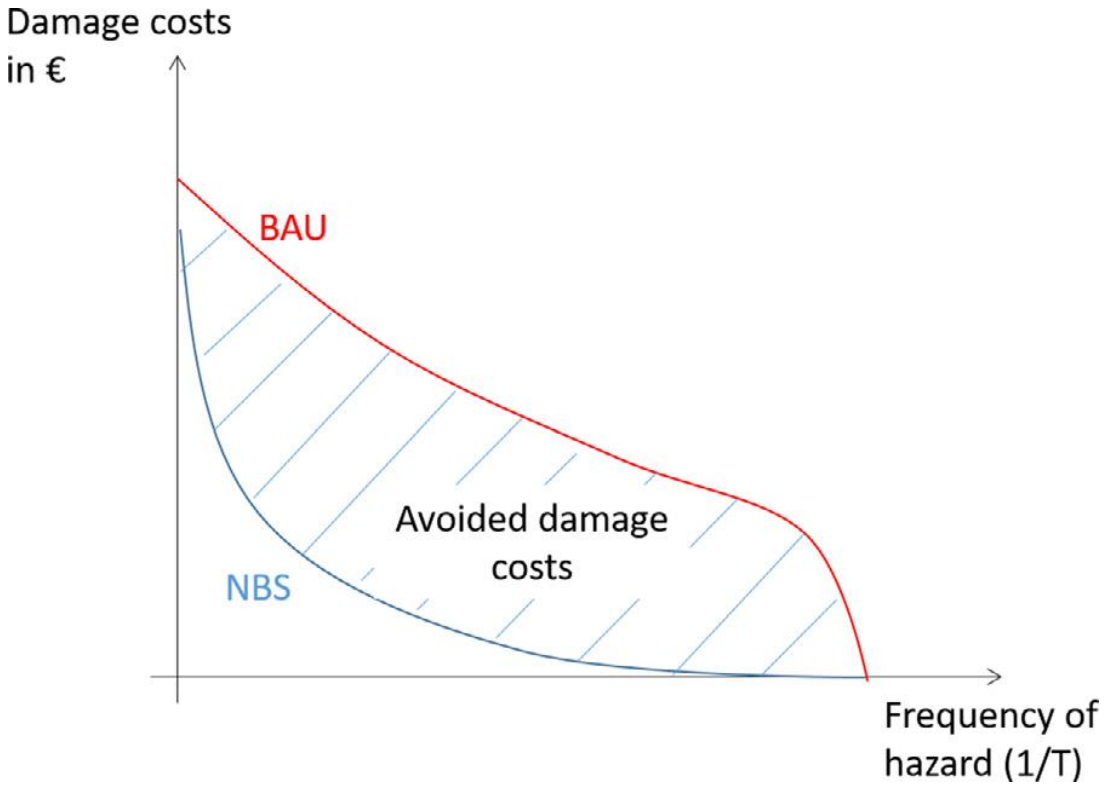
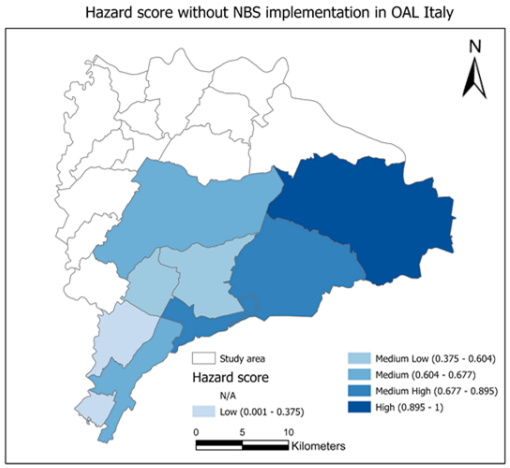
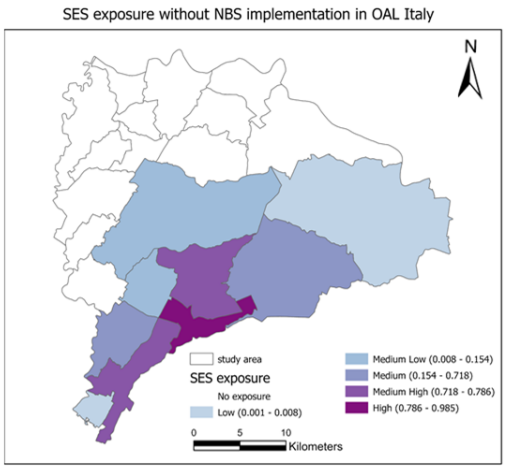


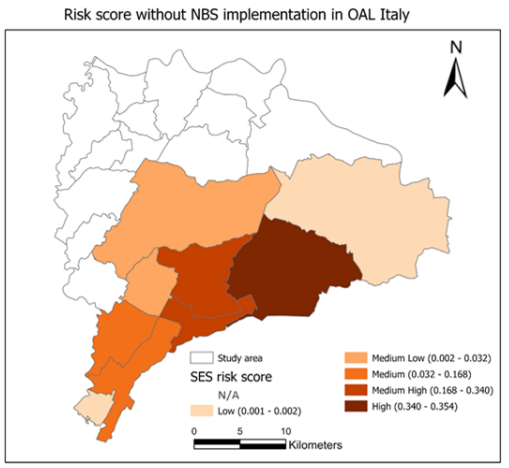
Fig. 2. The principle for assessing avoided damage costs.

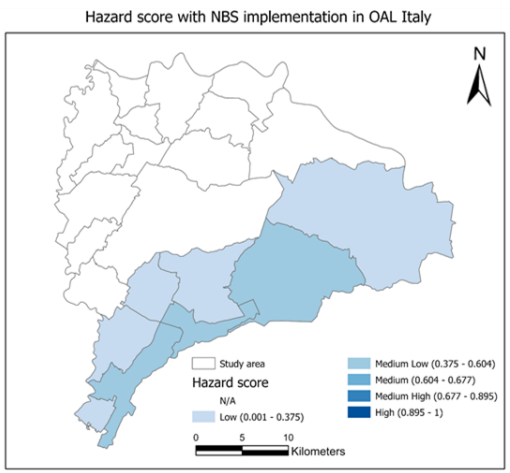
Le Coent, Philippe, et al. "Is-it worth investing in NBS aiming at reducing water risks? Insights from the economic assessment of three European case studies." *Nature-Based Solutions*

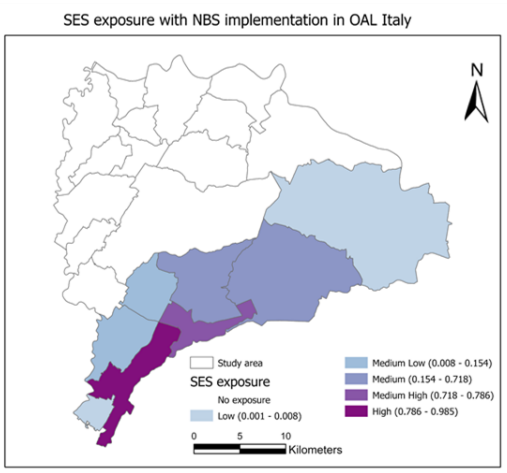
Flood risk reduction with NbS - Panaro River, Italy, indicator-based approach

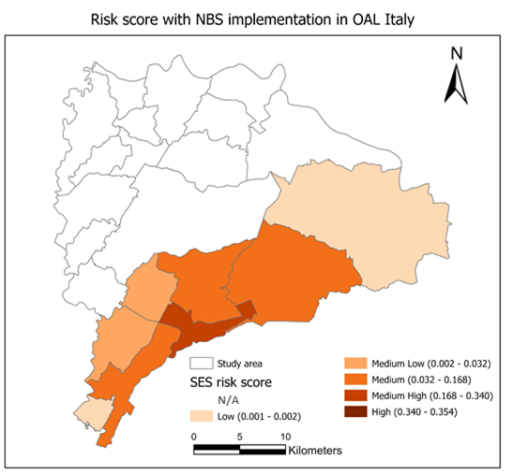












Draft results: SES hazard, exposure, and risk scores for a 200-year flood event in OAL Italy for with and without NBS scenarios

Risk model with future hazard

A) Estimation of future frequency of hazard –
Ensemble climate impact modelling

Cremen, Gemma, Carmine Galasso, and John McCloskey. "Modelling and quantifying tomorrow's risks from natural hazards." *Science of The Total Environment* (2021):

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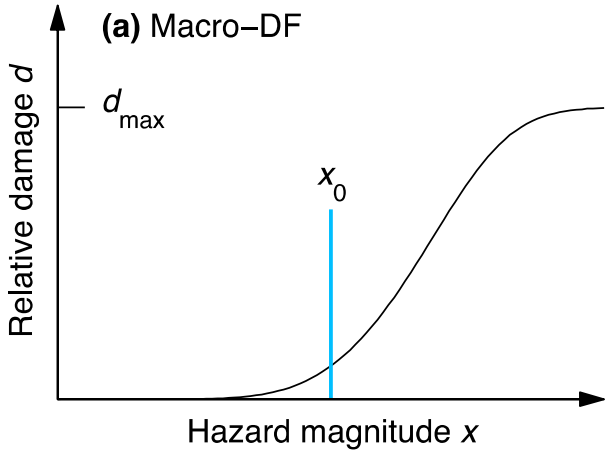
B) Estimation of hazard-impact relationship – CAT model

- Mapping of event's hazard intensity (e.g. flood map)
- Assessment of the exposure of the assets/elements at risk (e.g. land cover)
- Damage functions/models.
- Modelling of protection measures

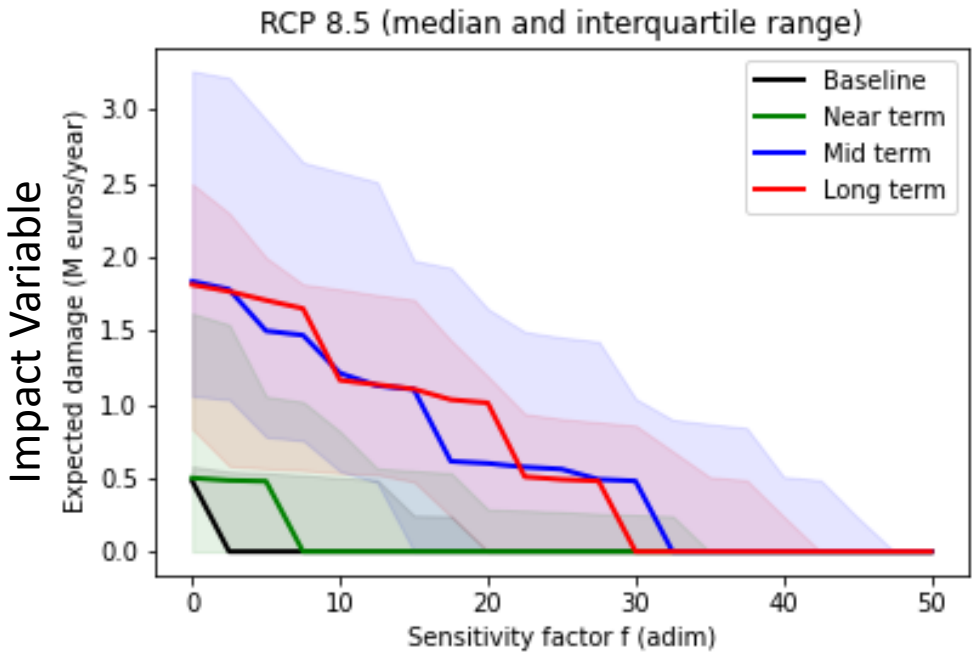


Prahl, Boris F., et al. "Damage functions for climate-related hazards: Unification and uncertainty analysis." *Natural Hazards and Earth System Sciences* (2016)

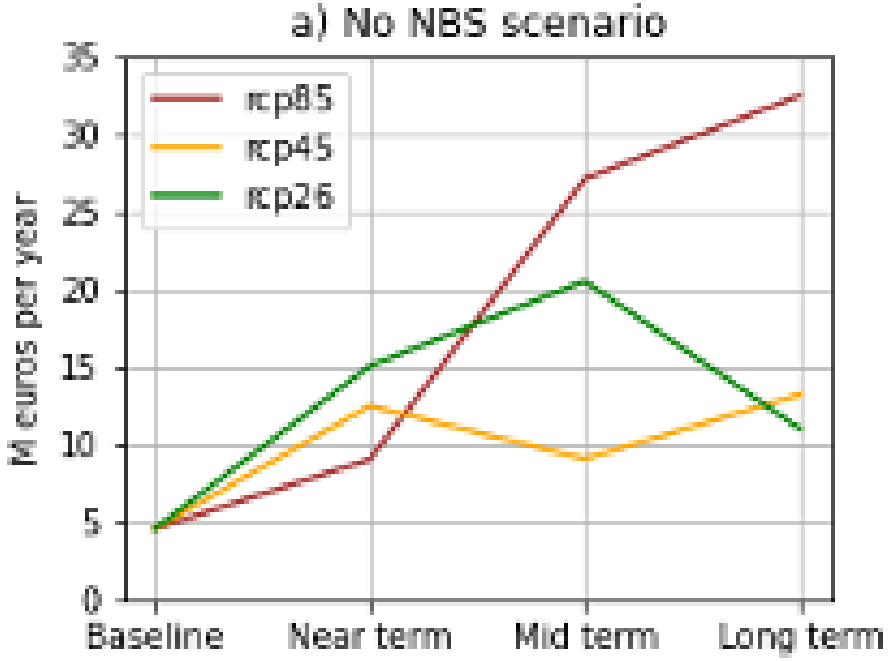
Risk model with future hazard

c) Expected damage reduction by adaptation action

By ‘parametrizing’ the effect of the NBS in this framework we can estimate costs and expected damage reduction
At the catchment scale



NBS and risk reduction

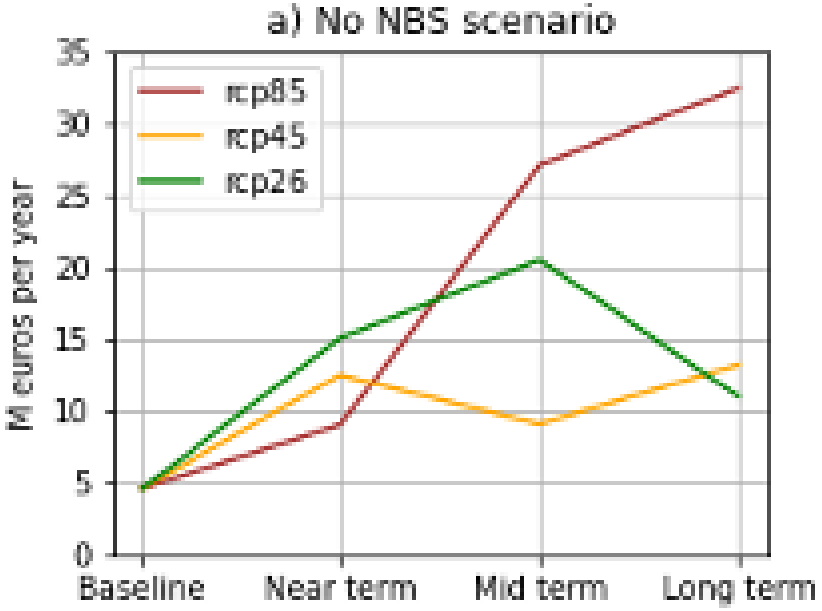


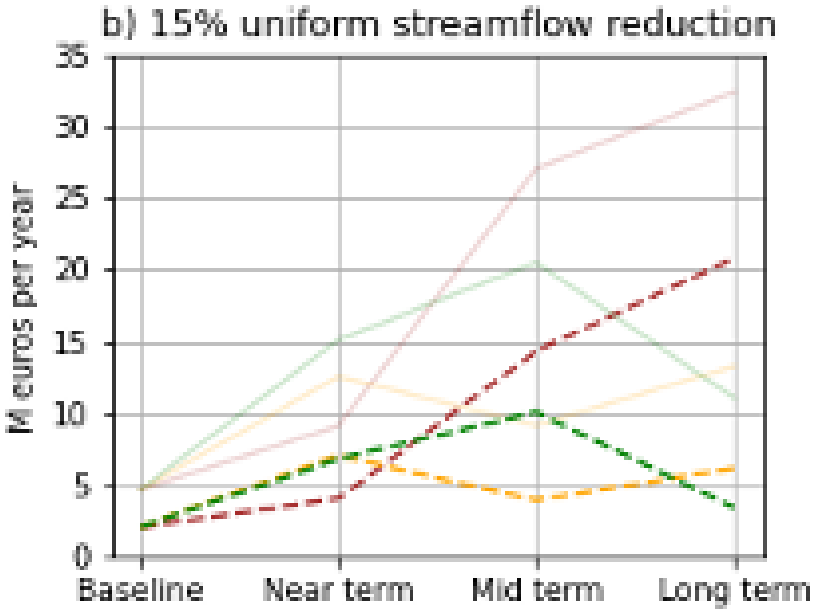
Example in the Panaro basin

Expected damage about 4 times larger in the long term (substantially depending on the scenario)

Near term is referred to the next twenty years.
Long term is end of the century.

NBS and risk reduction





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Effectiveness of NBS in adapting to future risk

Decision Framework

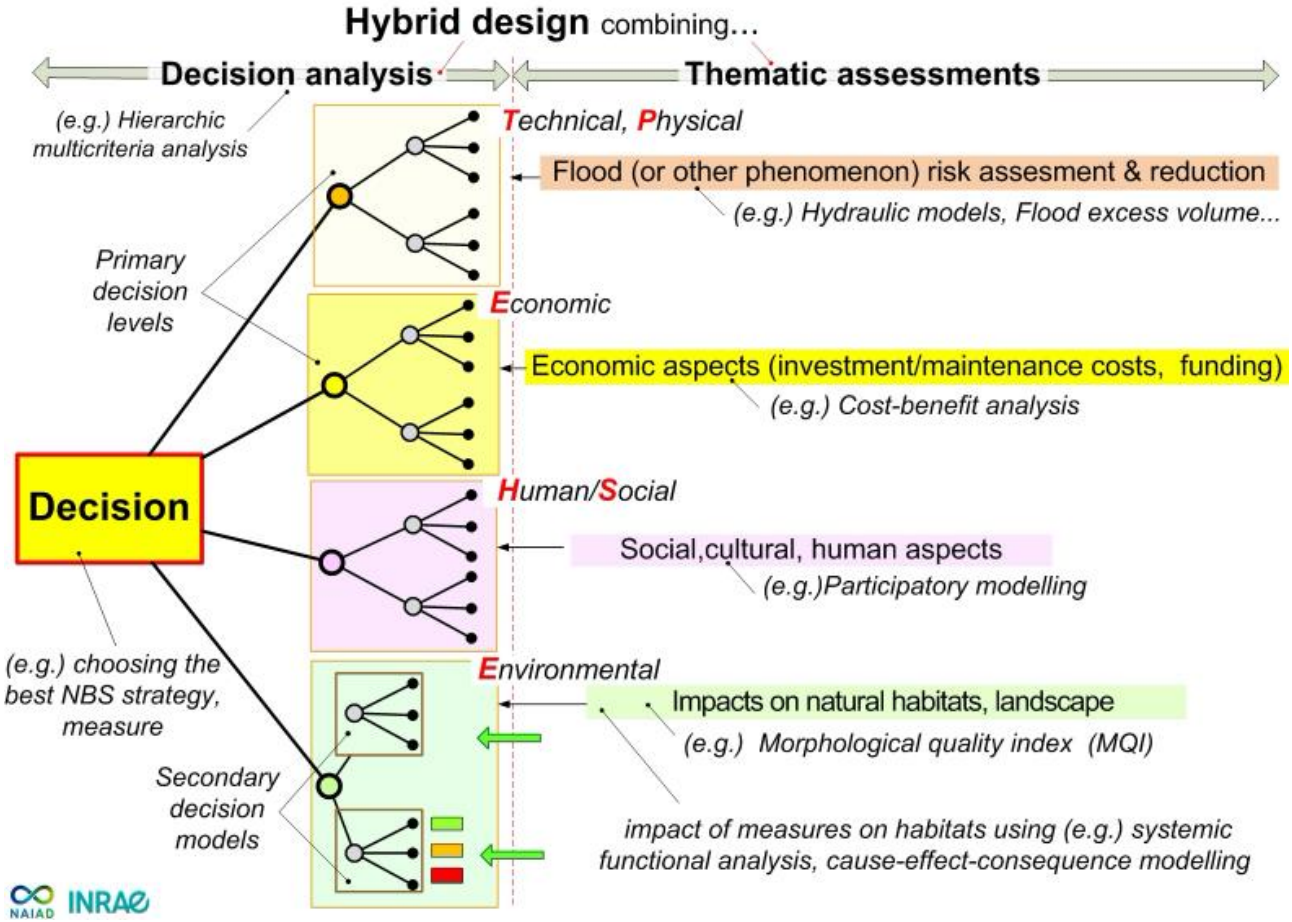

Figure 6-7. A multicriteria decision-making framework allows to integrate and combine technical, physical, environmental and economic indicators. Decision makers express their preferences on high-level criteria (protection level, economy of projects, social/cultural and environmental impacts). Experts provide and assess indicators for those categories (adapted from Tacnet et al., 2018).