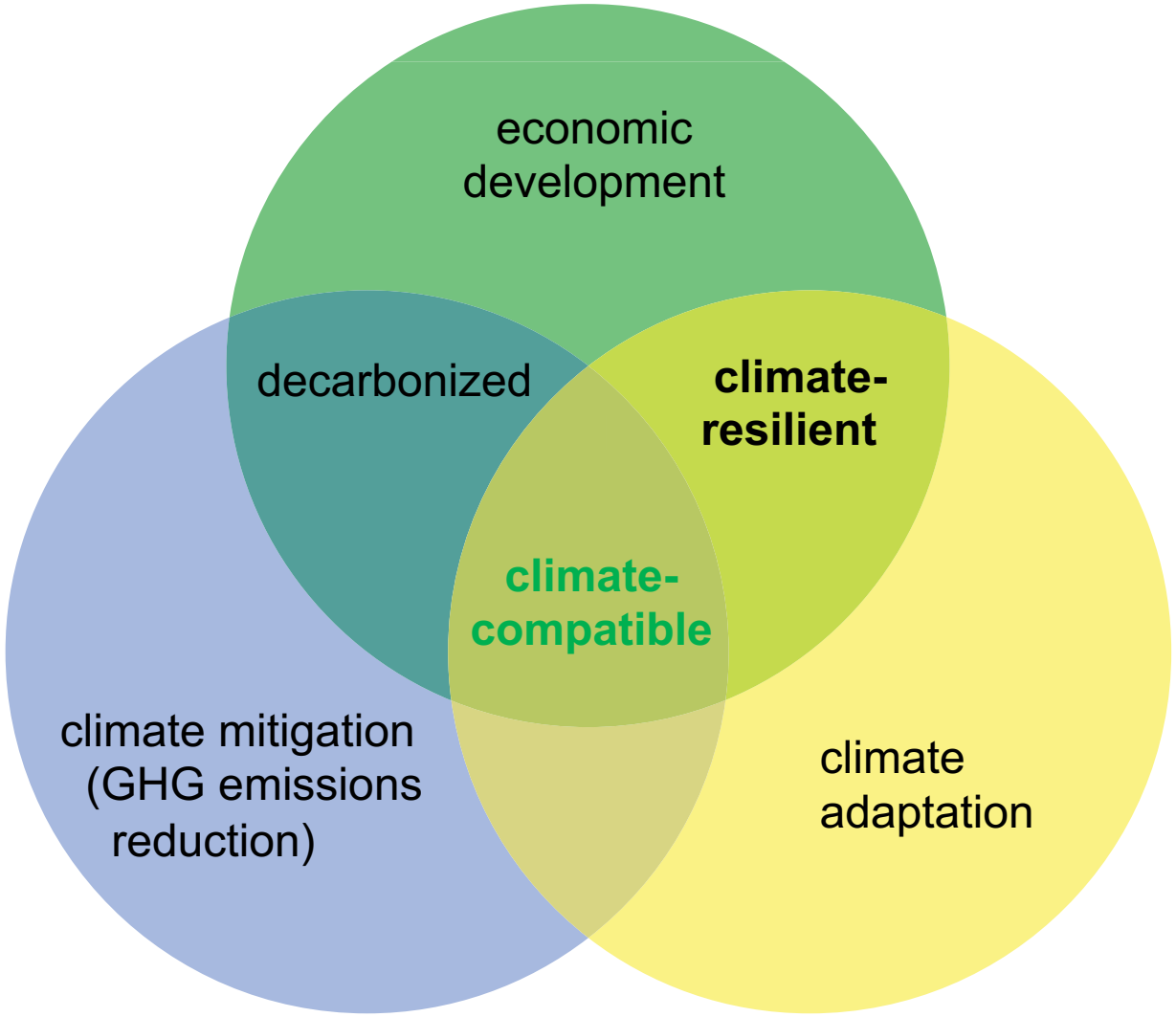
Prof. Dr. David N. Bresch, Institute for Environmental Decisions, ETH Zurich / MeteoSwiss, www.wcr.ethz.ch

Linking empirical climate impact research with projections of future damages from climate change

How do we make sure that weather and climate information is adequately considered in decision-making?

www.wcr.ethz.ch

The need for climate-resilient development



GHG: Greenhouse gas emissions

Enabling climate-resilient development
Economics of Climate Adaptation (ECA)

Objectives

- Provide decision makers with the facts and methods necessary to design and execute a climate adaptation strategy

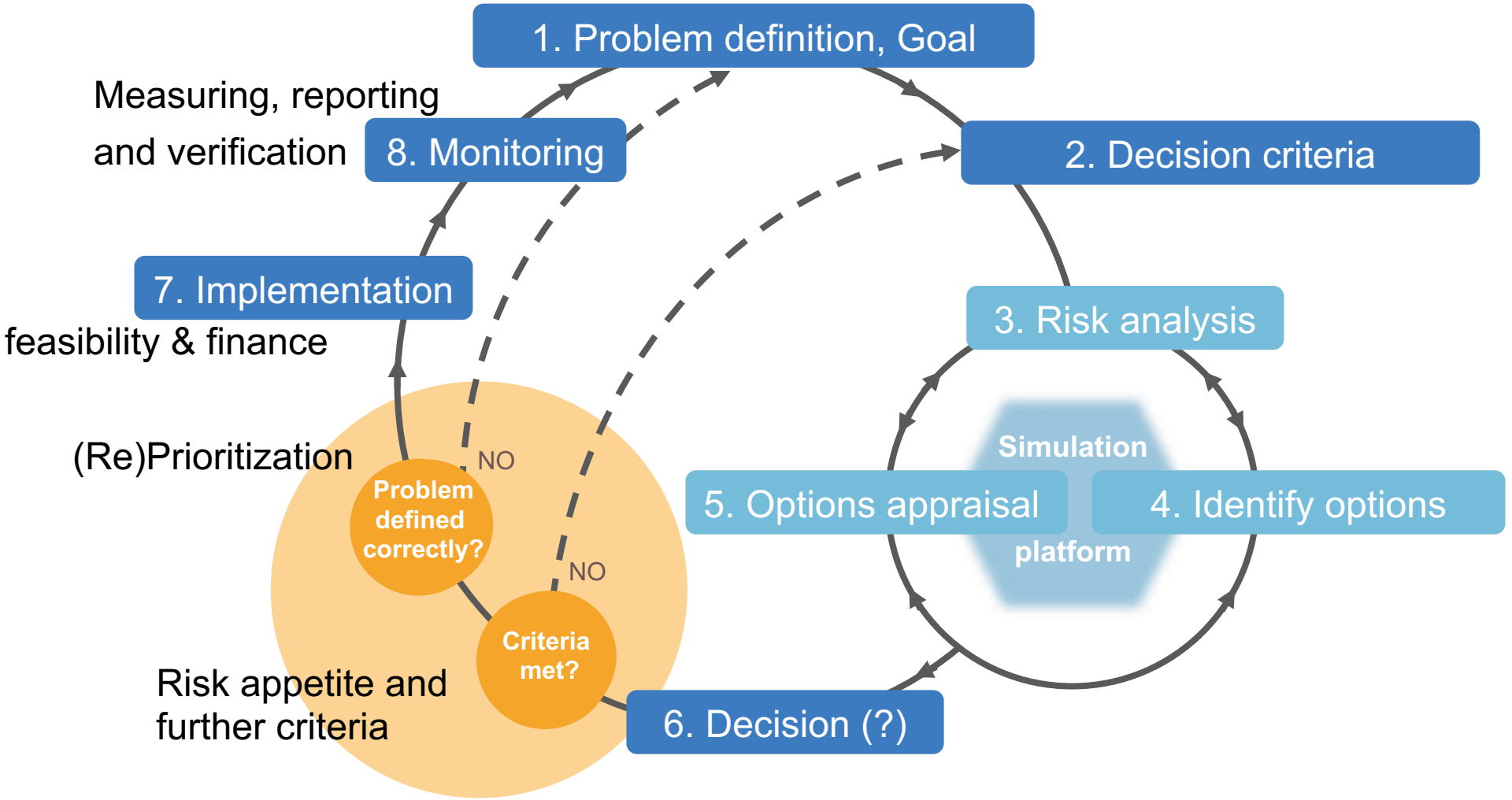
Key features of the methodology:

- Follow a rigorous risk management approach to **assess** **weather climate risk**, the sum of
  - **today's weather and climate risk**,
  - the **economic development paths** that might put greater population and value at risk (→ projections)
  - the additional risks presented by **climate change** (→ scenarios)
- Propose and prioritize a basket of adaptation measures (i.e. options) to **address** **weather and climate risk** on an economic basis

Supported by the open-source and -access CLIMADA simulation platform

https://www.ethz.ch/content/dam/ethz/special-interest/usys/ied/wcr-dam/documents/Economics_of_Climate_Adaptation_ECA.pdf, https://github.com/CLIMADA-project/climada_python and Aznar & Bresch, 2019: CLIMADA ... weather and climate risk assessment ..., https://doi.org/10.5194/gmd-12-3085-2019

Risk, uncertainty and decision-making



CLIMADA

[1] Siehe zB: Souvignet, Wieneke, Müller & Bresch, 2016: Economics of Climate Adaptation (ECA) - Guidebook for Practitioners. Materials on Development Financing, UNU, KfW.
https://www.kfw-entwicklungsbank.de/PDF/Download-Center/Materialien/2016_No6_Guidebook_Economics-of-Climate-Adaptation_EN.pdf

Figure based upon IPCC und UKCIP

More than twenty adaptation case studies worldwide[1]: Many hazards, economic sectors and risk cultures

Florida: *Hurricane risk to public and private assets*

US Gulf Coast: *Hurricane risk to the energy system*

New York: *Cyclones and surge risk to a metropolis*

Hull, UK: *Flood and storm risk to urban property*

China: *Drought risk to agriculture*

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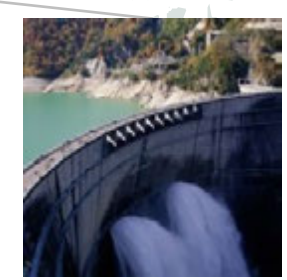

Tanzania: *Drought risk to health and power generation*

Samoa: *Risk of sea level rise to a small island state*

Swiss Re

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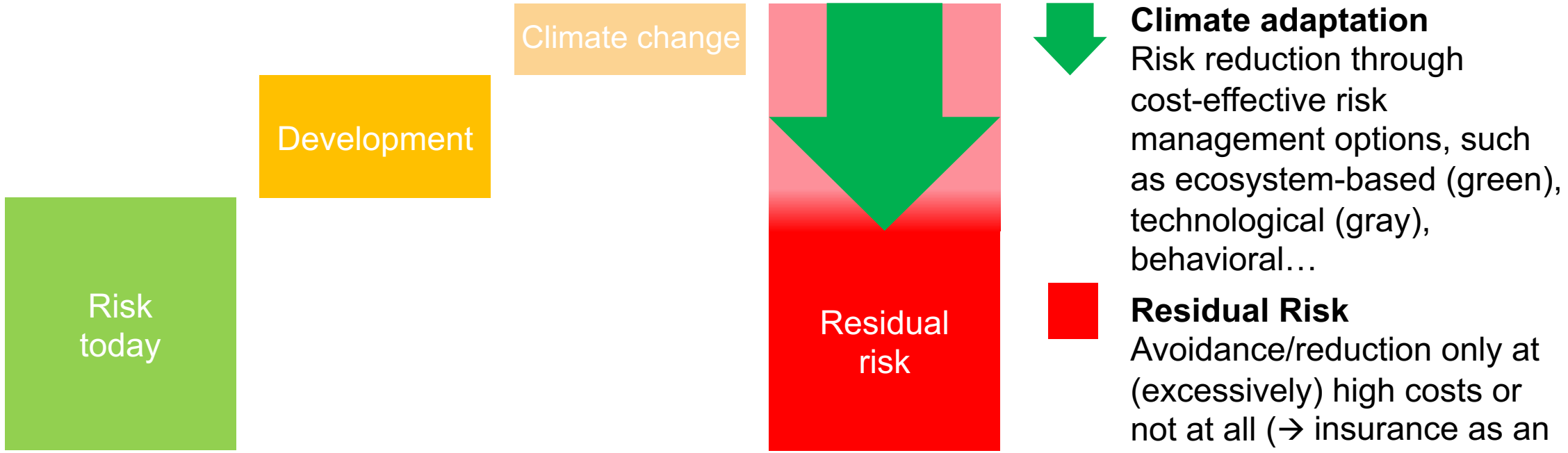
eca ECONOMICS OF CLIMATE ADAPTATION

Economics of Climate Adaptation (ECA) Working Group, a partnership between the Global Environment Facility, McKinsey & Company, Swiss Re, the Rockefeller Foundation, ClimateWorks Foundation, the European Commission, and Standard Chartered Bank. Later studies powered by open-source model CLIMADA

[1] ECA working group, supported by CCRIF/WorldBank, see: http://www.wcr.ethz.ch/research/casestudies.html

General finding[1]:
40-60% of risk can be cost-effectively avoided up to 2030, but…



Climate adaptation
Risk reduction through cost-effective risk management options, such as ecosystem-based (green), technological (gray), behavioral…

Residual Risk
Avoidance/reduction only at (excessively) high costs or not at all (→ insurance as an option)

- Risk due to today's weather (extremes)
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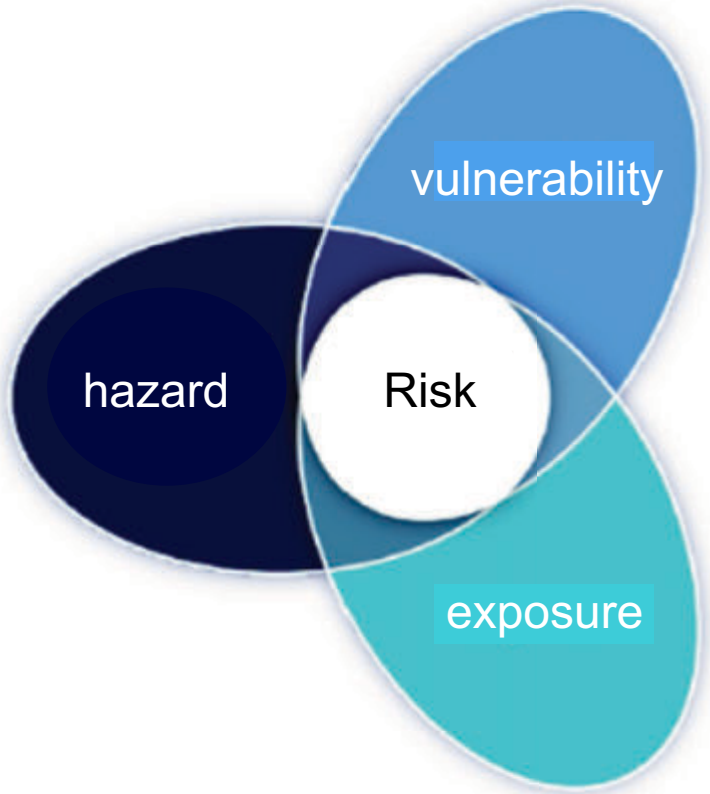
[Weather] Risk

The “effect of uncertainty on objectives”[1]

risk = **probability** x **severity**

expected utility



risk = hazard x exposure x vulnerability

= (**probability** x intensity) x exposure x vulnerability

severity

[1] … a positive or negative deviation from what is expected [ISO 31000]

Illustration: IPCC AR5

From the Concept of Vulnerability, i.e.

the degree to which a system is susceptible to, or **unable to cope with**, adverse effects of [weather and] climate […], including […] extremes.[1]

To [Weather and Climate] Resilience, namely

the capacity to survive, **successfully adapt and prosper** in the face of change and uncertainty related to disturbances, whether they be caused by resource stresses, societal stresses and/or acute [weather and climate-related] events.[2]

[1] IPCC, 2001, p. 995

[2] Bresch et al., 2014, in: Turbulence, Amsterdam University Press

Economics of Climate Adaptation (ECA)
Case study Barisal, Bangladesh[1]
Focus on river flood and storm surge

Swiss Re
Ecorys
KFW

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resilience measures
(for example:
prevention, spatial planning,
building codes ...)

vulnerability

impact

intensity

cyclone footprints

weather
→ hazard

CLIMADA
probabilistic
event-based
simulation
open-source[1]

climate scenarios

development scenarios

assets in Bangladesh

exposure

outputs:
risk analysis, -mapping
+ (impact-oriented)
warnings ...

example: economic impact

https://vimeo.com/198389316

+ appraisal of resilience measures / options (effectiveness of options, cost/benefit …)
+ Quantification of uncertainty

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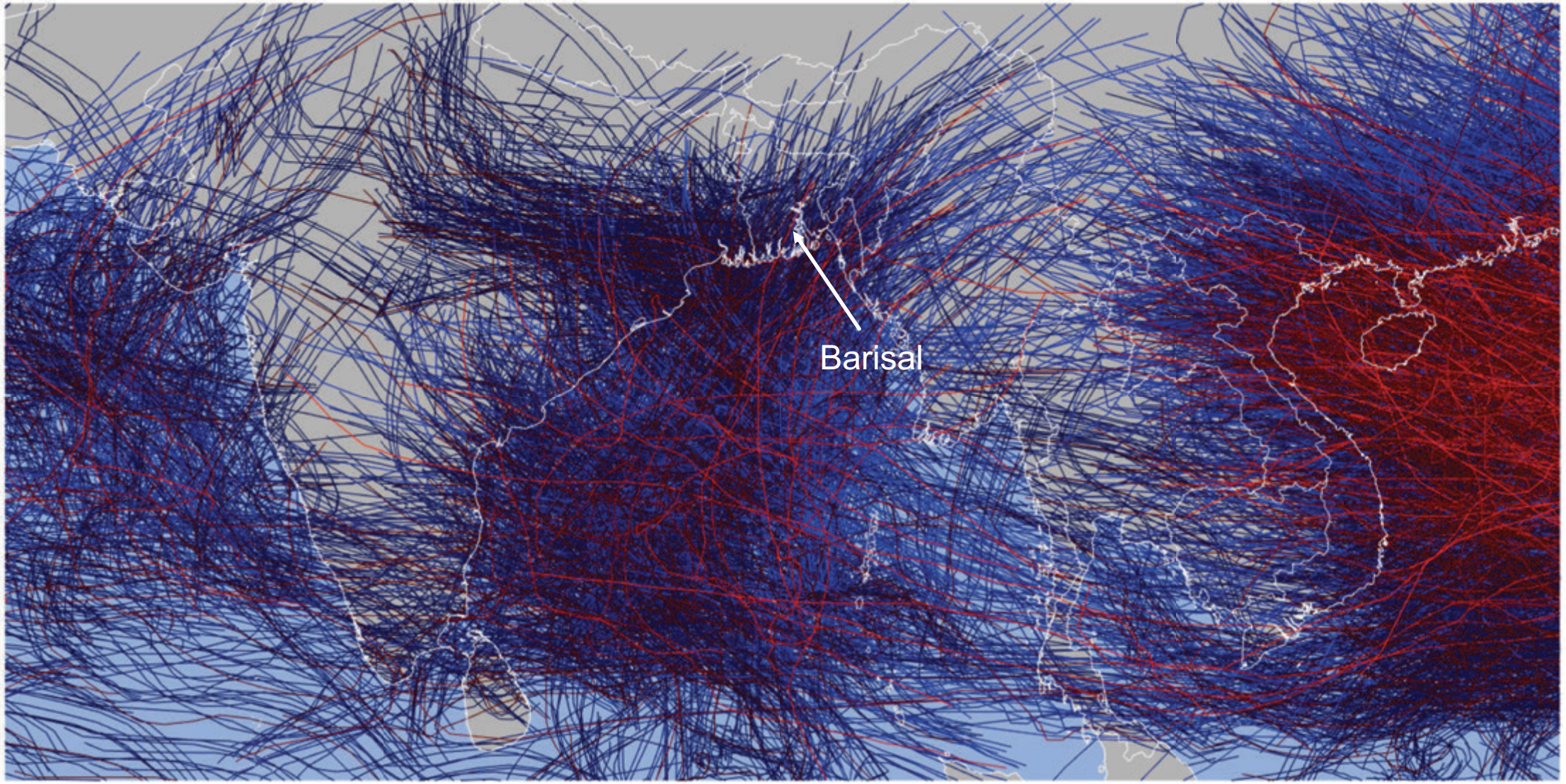
[1] https://github.com/CLIMADA-project/climada_python und Aznar & Bresch, 2019: CLIMADA ... weather and climate risk assessment ..., https://doi.org/10.5194/gmd-12-3085-2019

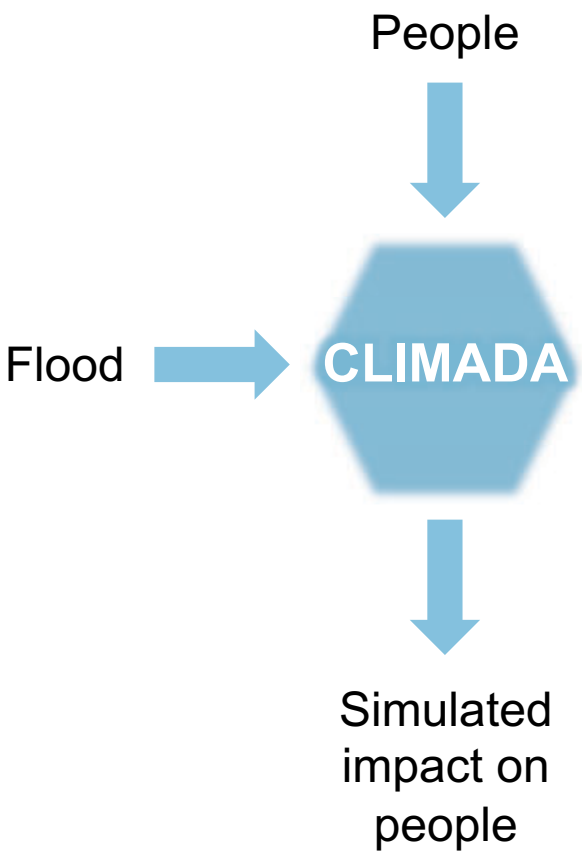
Tropical cyclones 1950-2016 (historic) x 100 (probabilistic)

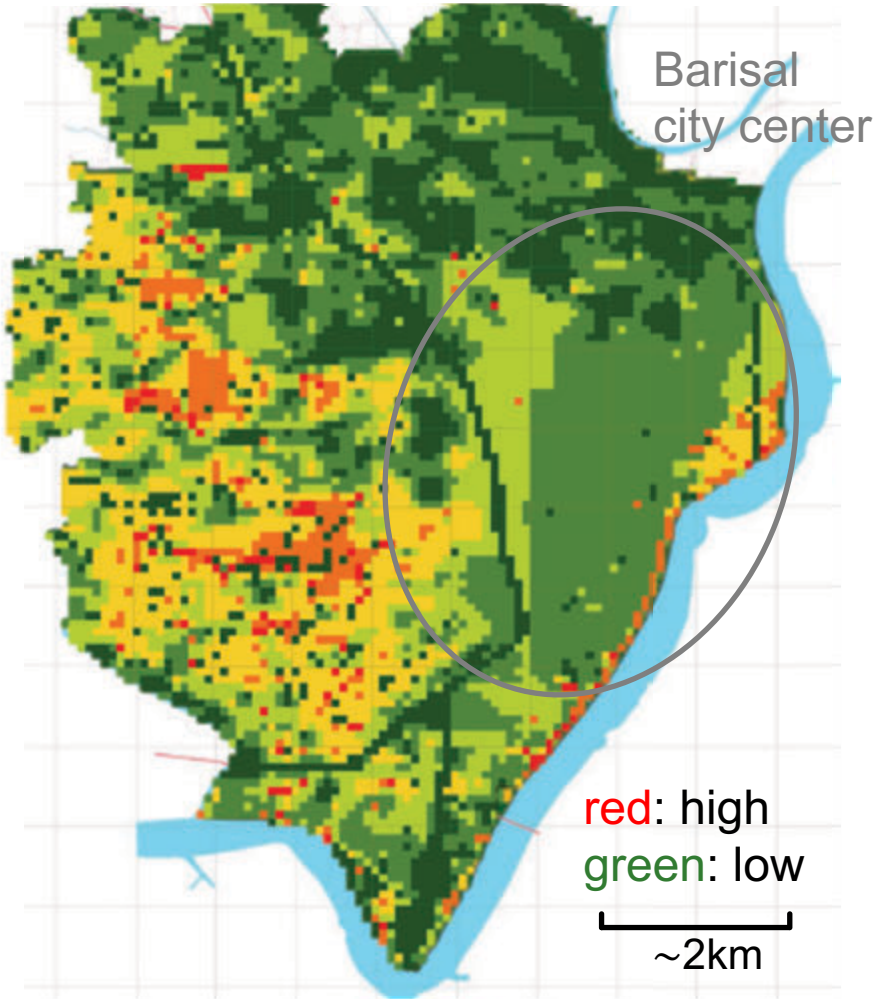


Instead of simulating the past, we generate a large number of physically consistent, plausible tropical cyclones (probabilistic events)

CLIMADA

From assets to impacts[1]: The poor in the western part of the City suffer most of the damages in relative economic terms





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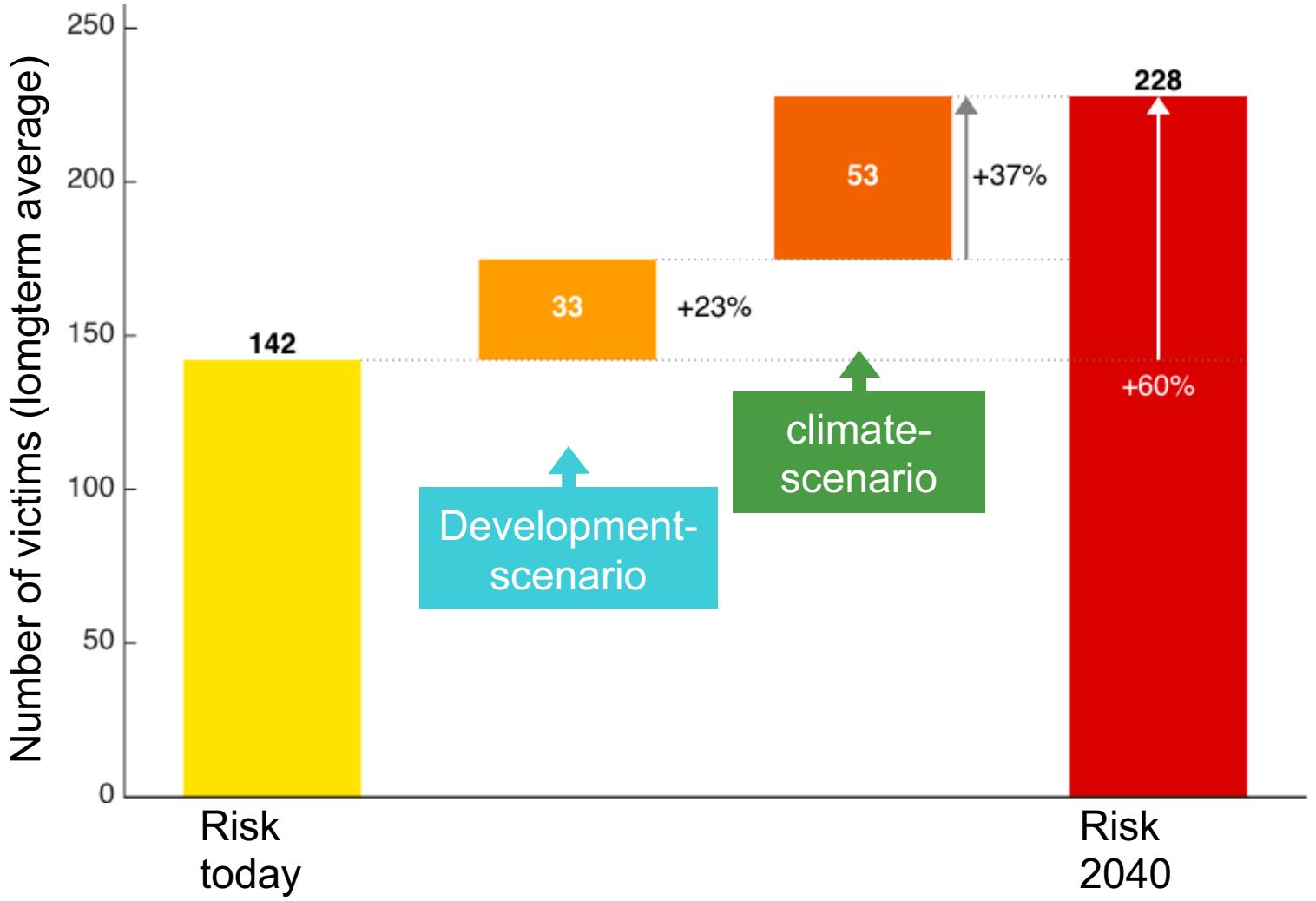
Quantification of impacts: Simulated flood victims in Barisal



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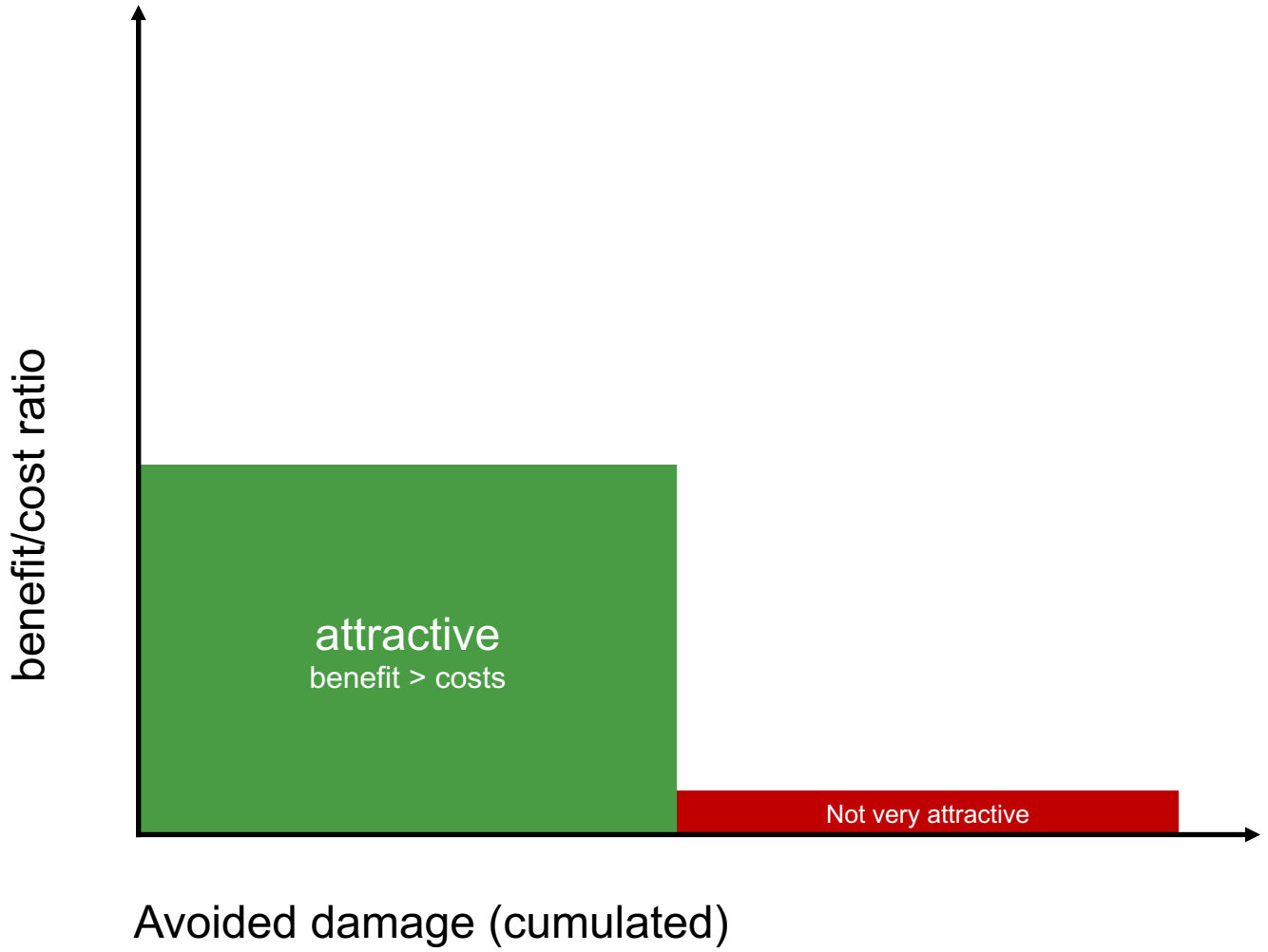
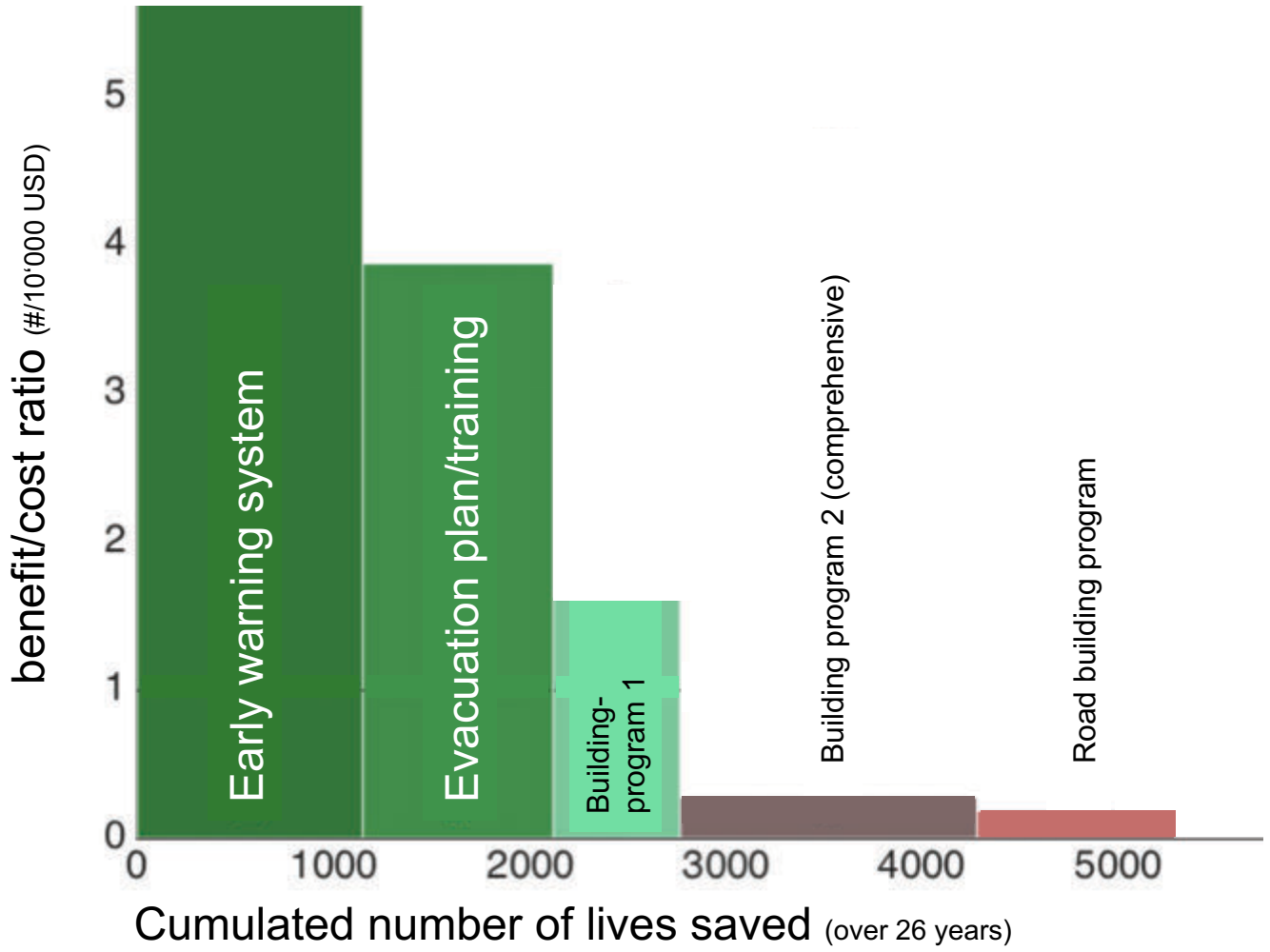
Adaptation options – benefit/cost ratio



Adaptation options to avoid flood victims in Barisal, Bangladesh



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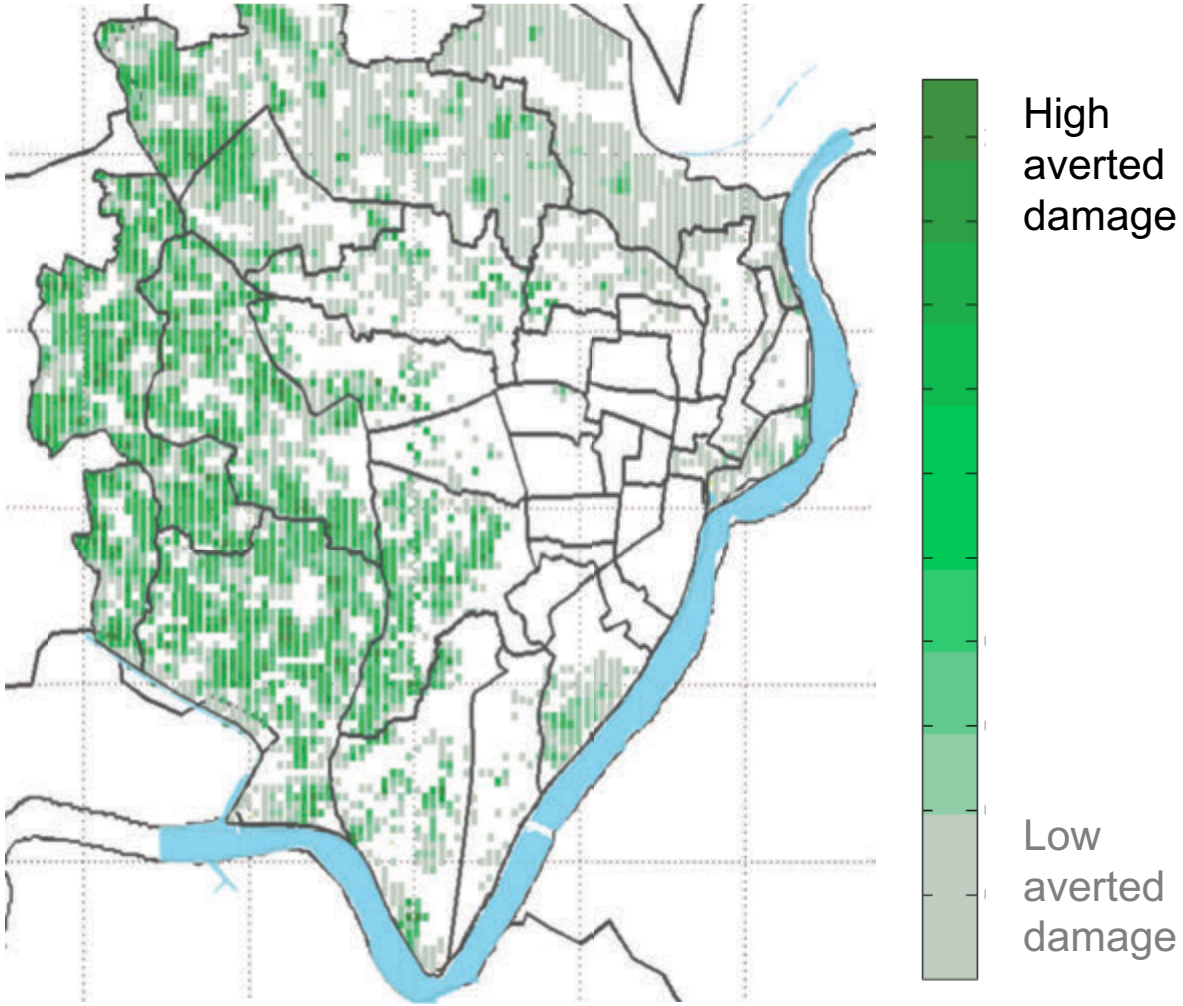
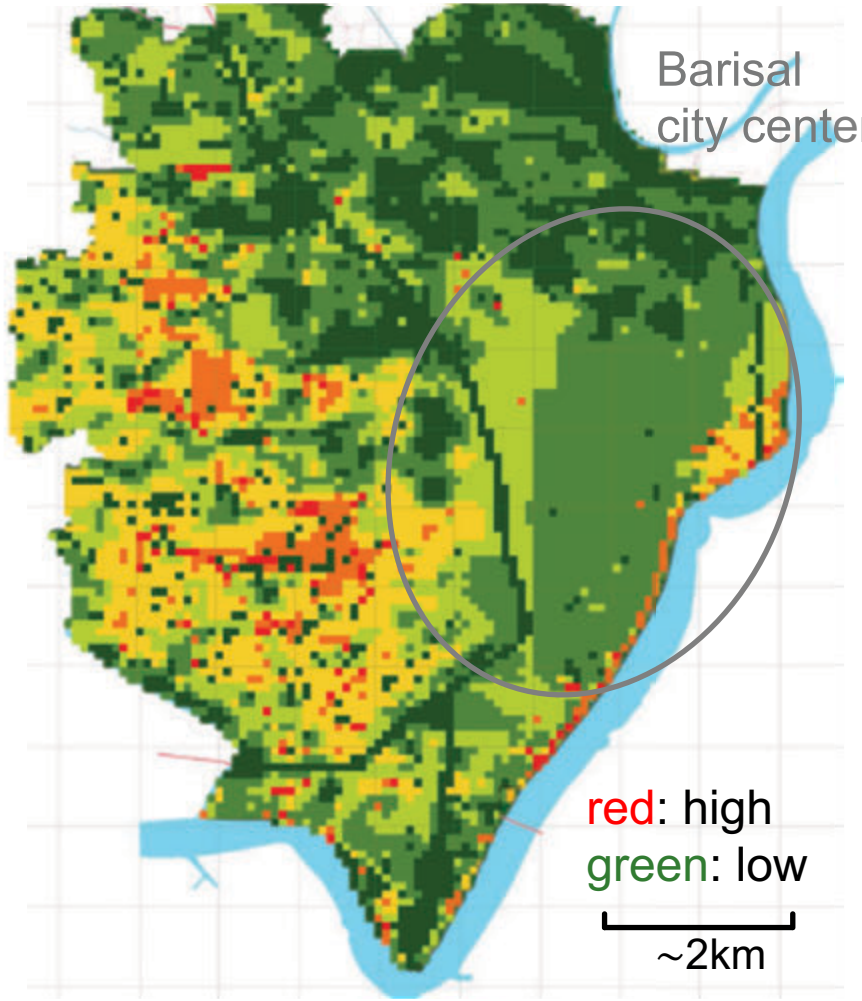
Flood resilient crops reduce agricultural losses by 40%, mostly in the western part of the city of Barisal[1]



High averted damage

Low averted damage

relative damage



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Economics of Climate Adaptation (ECA)
Case study San Salvador[1]
Focus on river flood and landslide risk

Study partners

GFA Consulting Group

Swiss Re

funded by

KfW

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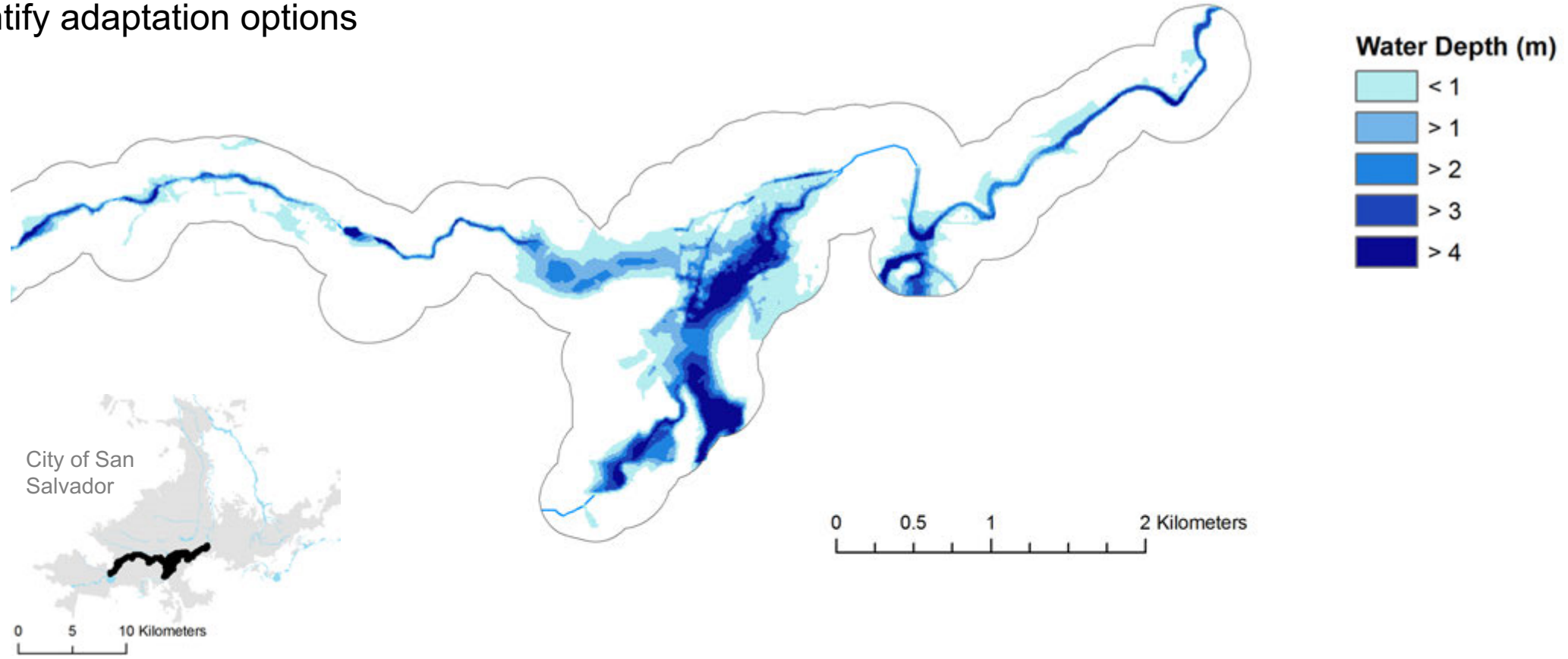
100 year flood event around Acelhuate River, San Salvador, reaches up to 4 m water depth

Acelhuate region, as a part of the metropolitan area of San Salvador, is selected to analyse flood risk and identify adaptation options



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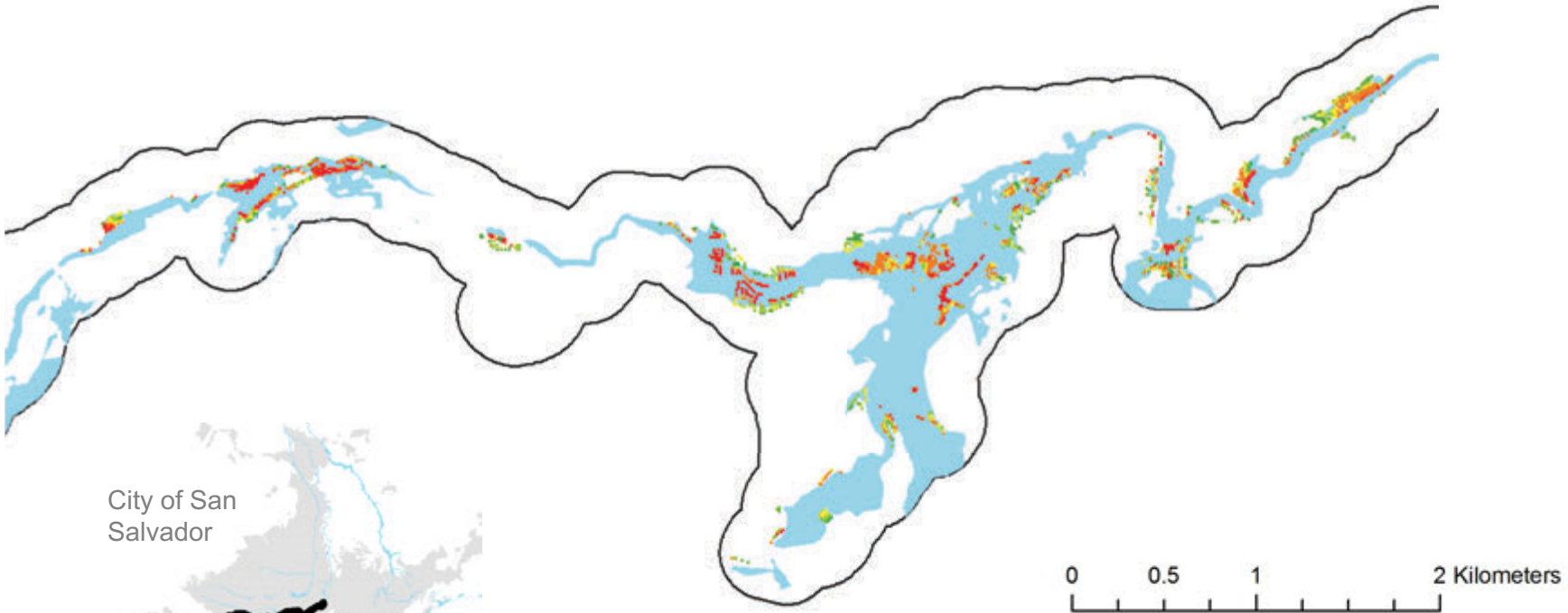
Ecologic restauration in the upper catchment area an reduce up to USD 50 million flood damage until 2040

The restoration of forest areas in the upper catchment of Acelhuate leads to increased infiltration of rainwater and therefore reduces flood runoff in the city



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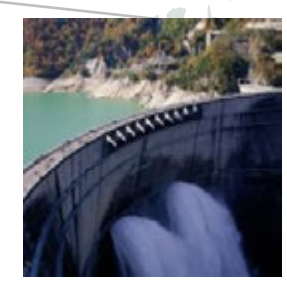

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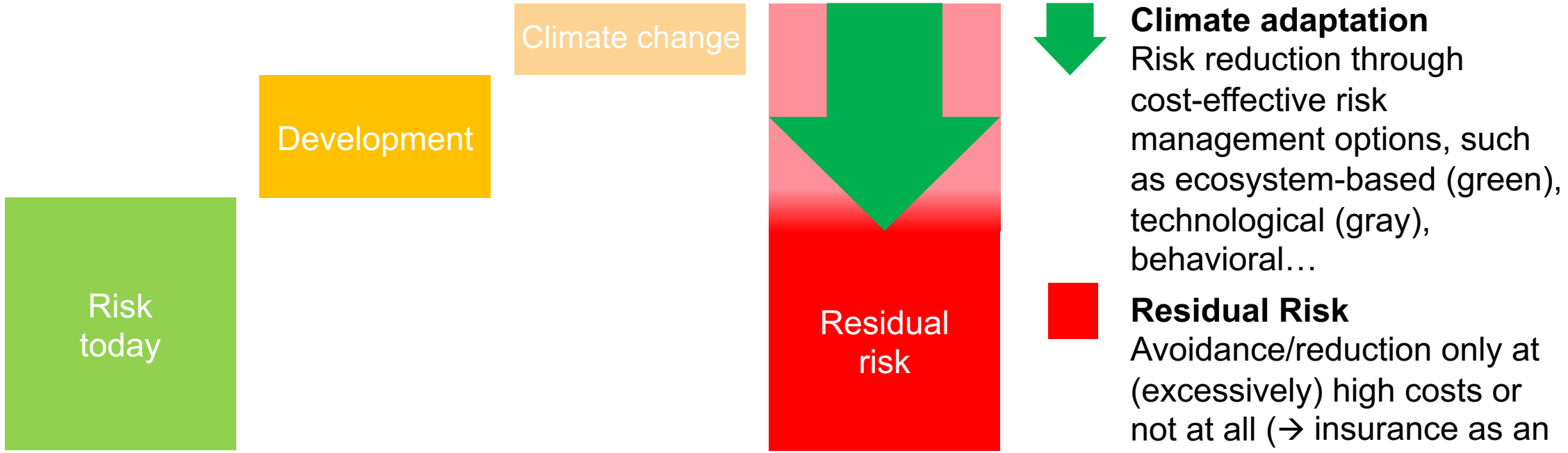

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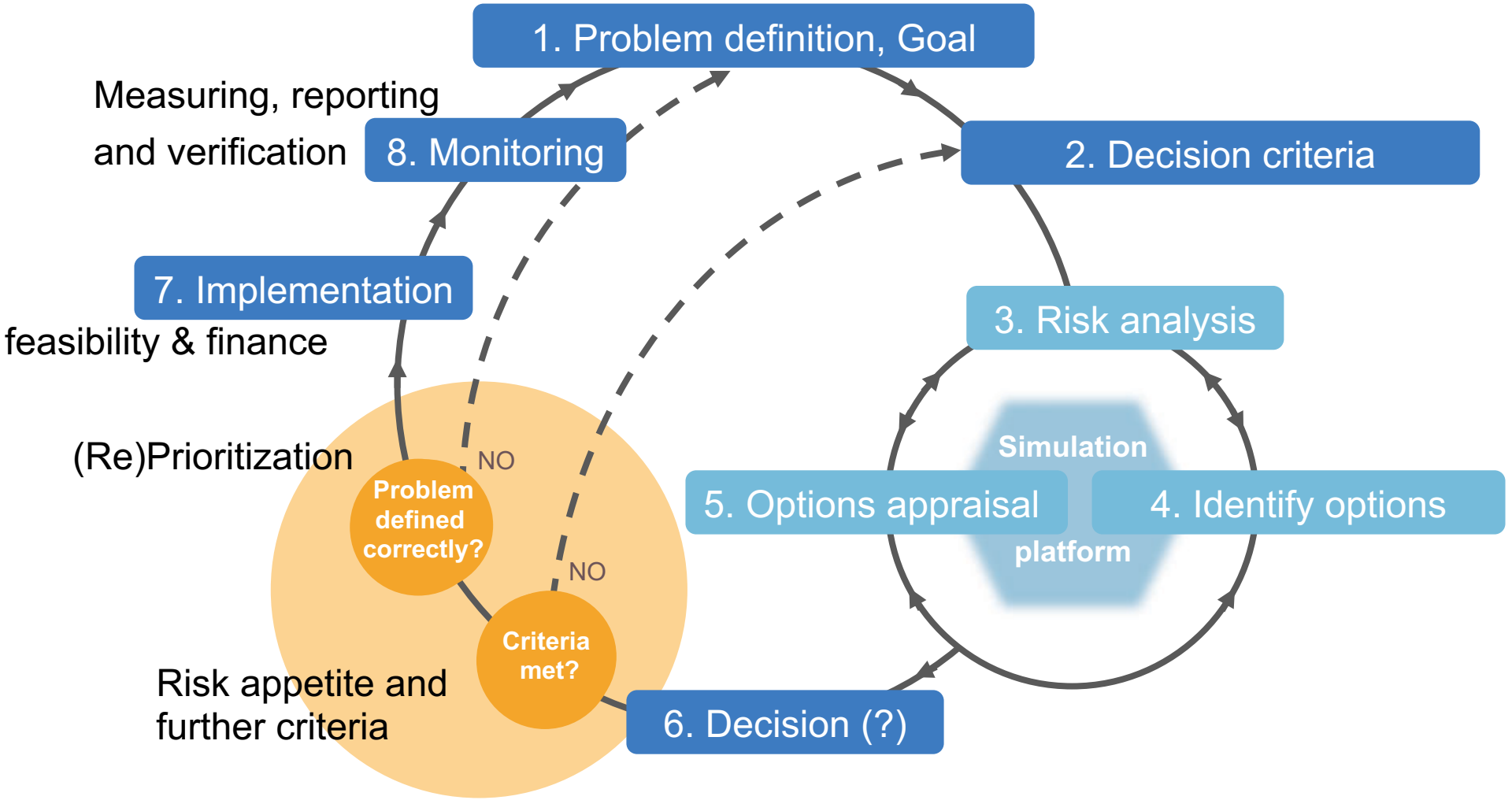

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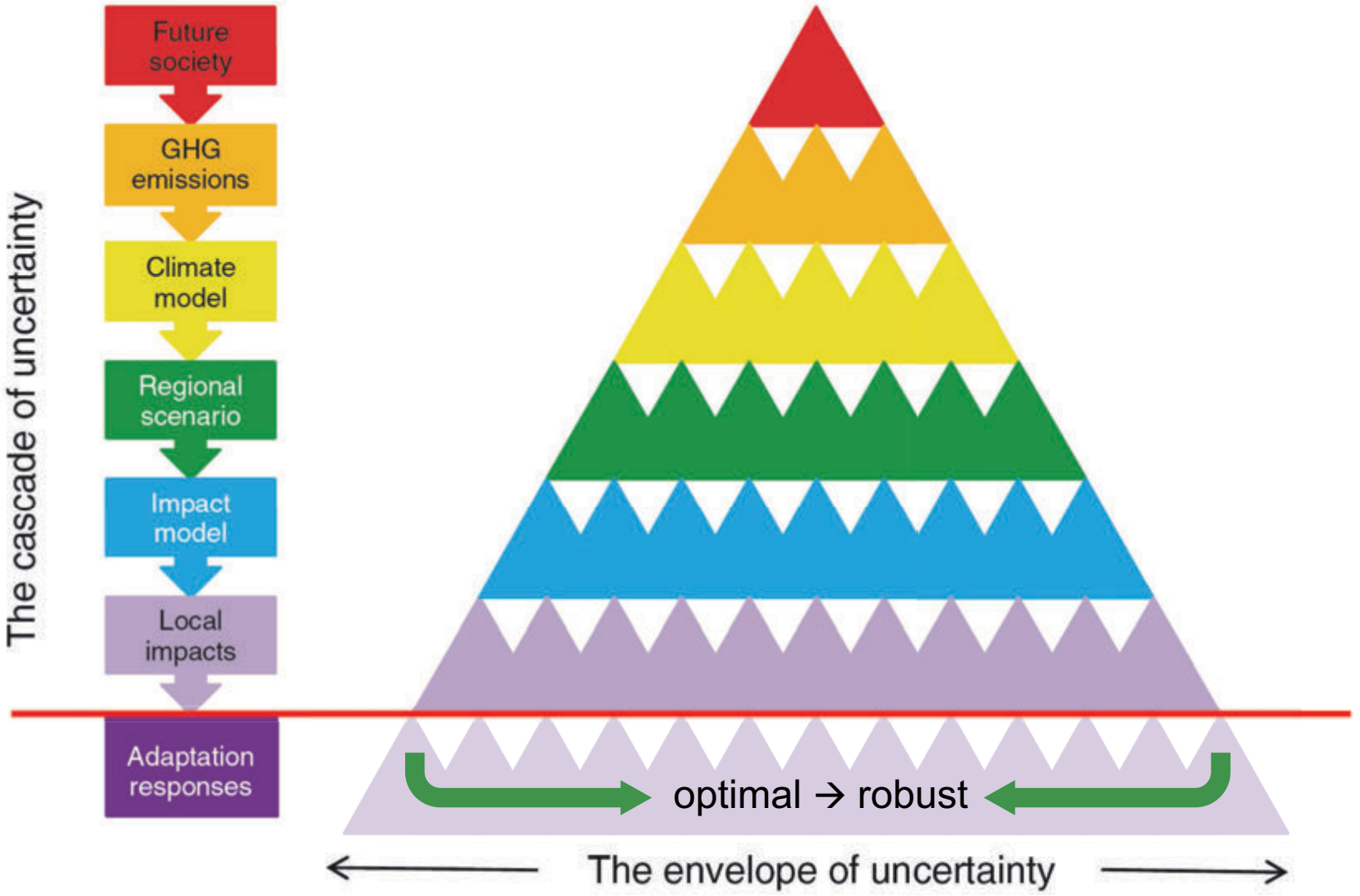
Figure based upon IPCC und UKCIP

Uncertainty along the chain of impact



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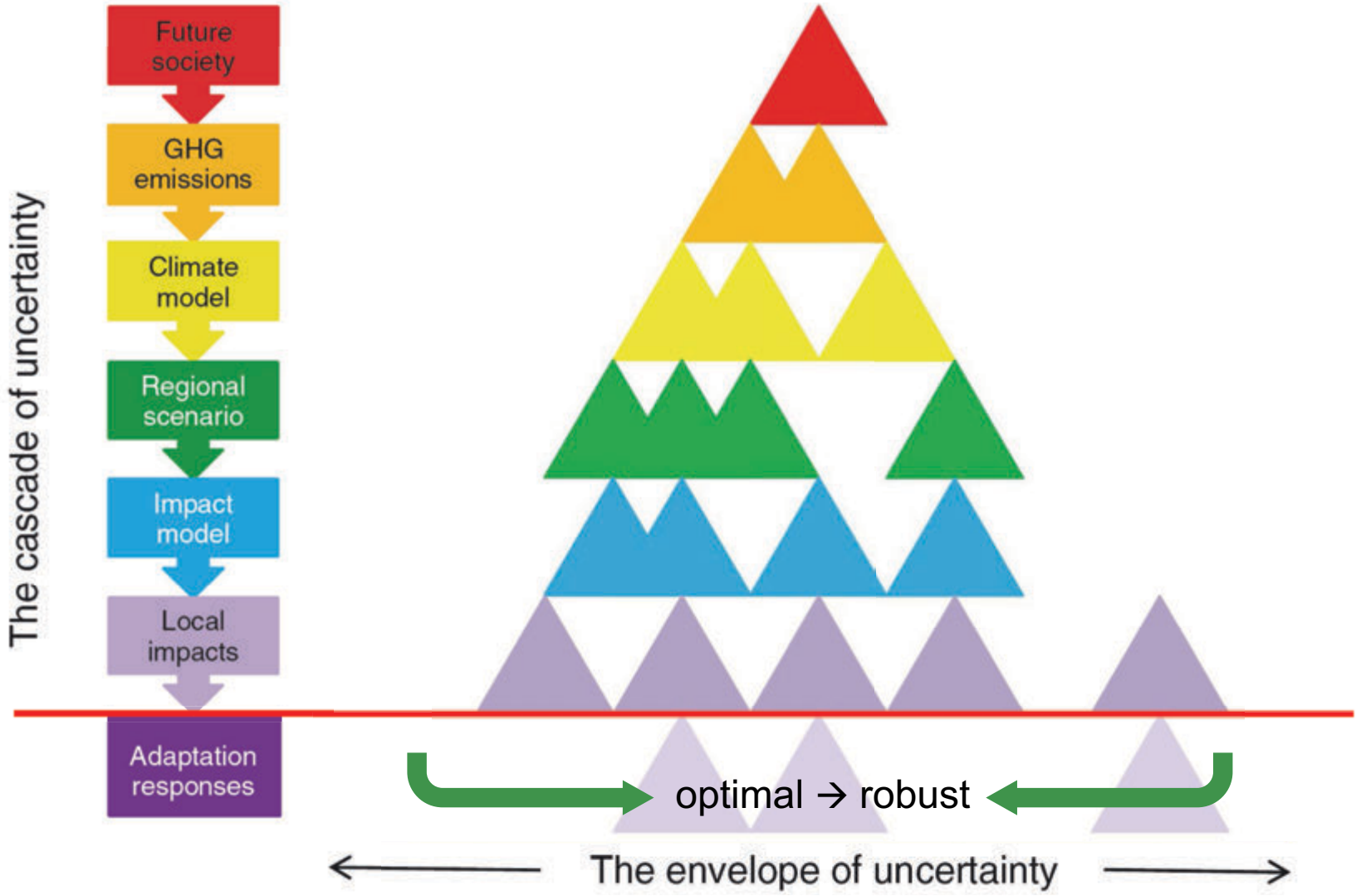

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resilience measures
(for example:
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vulnerability

impact

intensity

cyclone footprints

weather
→ hazard

CLIMADA
probabilistic
event-based
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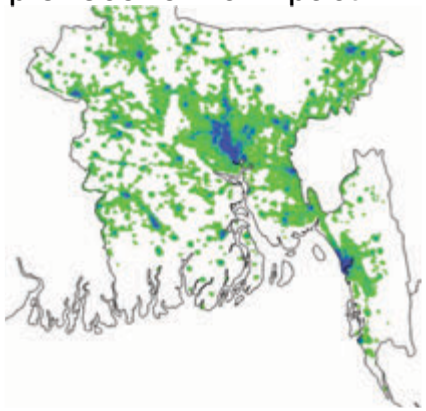

https://vimeo.com/198389316

+ appraisal of resilience measures / options (effectiveness of options, cost/benefit …)
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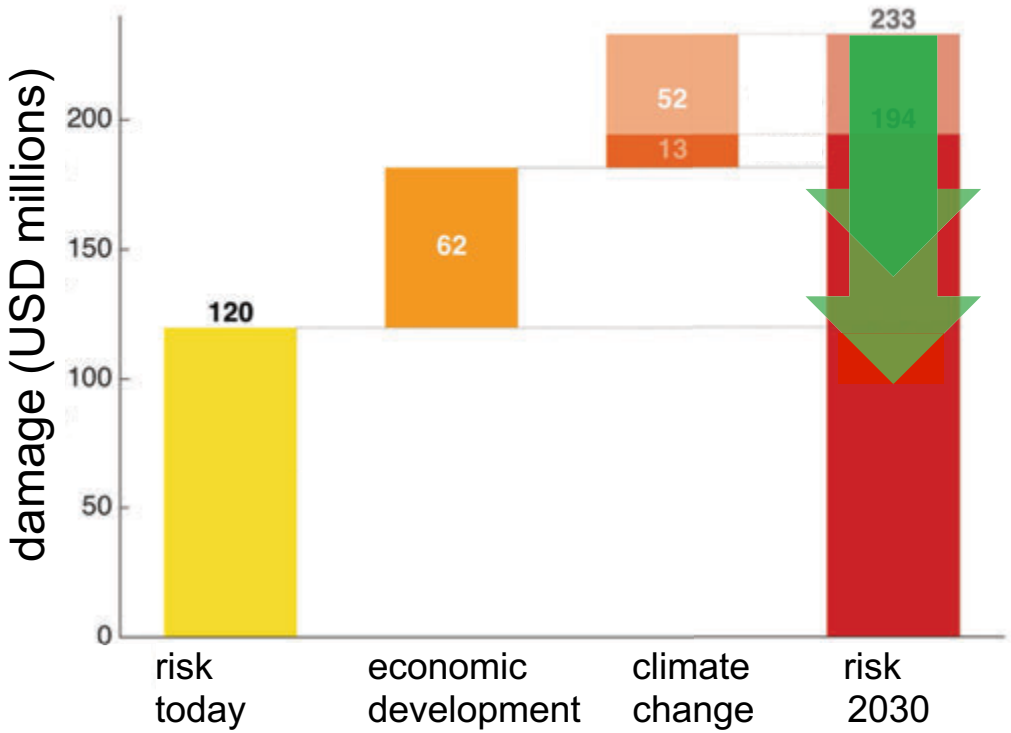
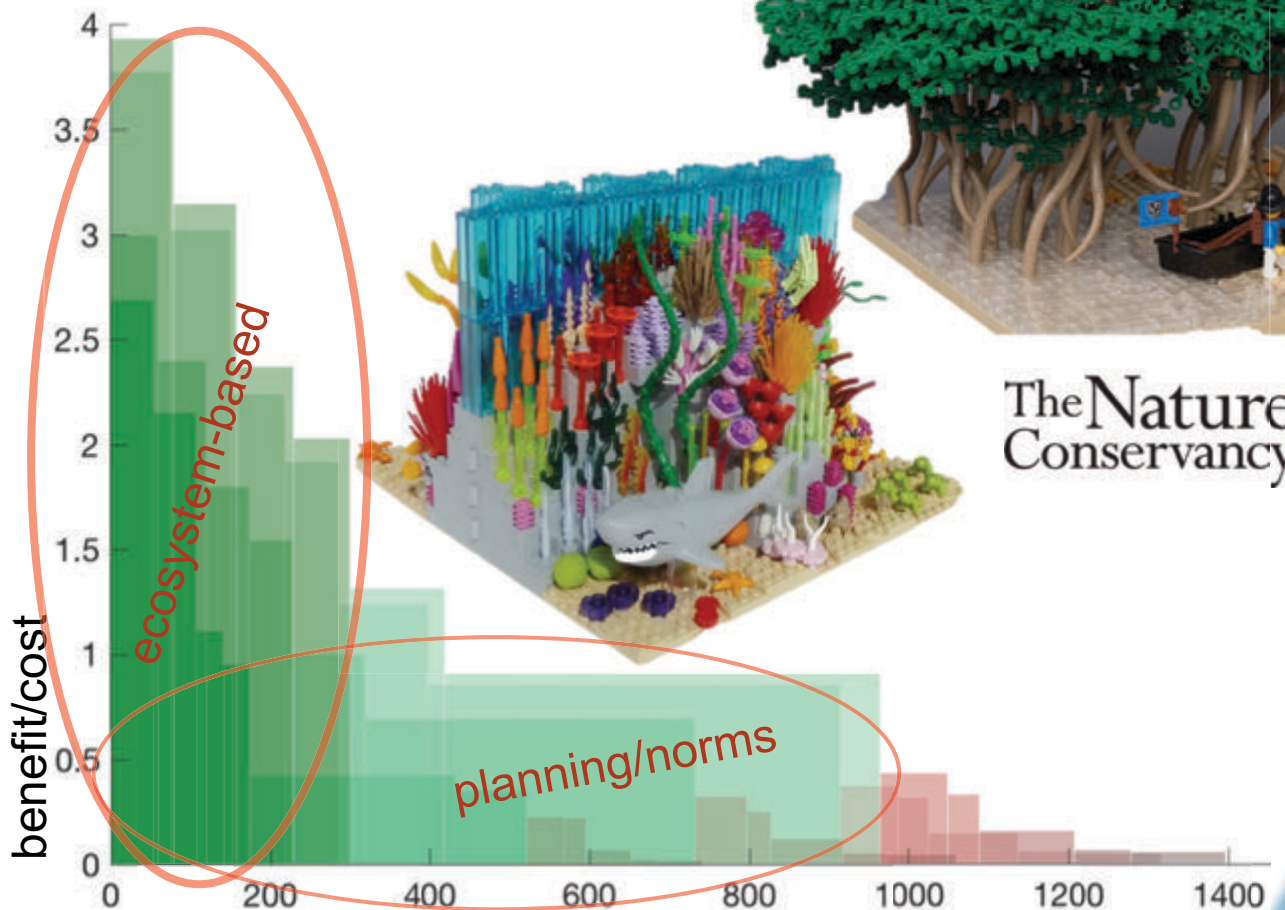
Barbados case study[1] – damage due to tropical cyclones

risk analysis:



adaptation measures:



The Nature Conservancy

CLIMADA

[1] ECA working group, supported by CCRIF/WorldBank, http://www.wcr.ethz.ch/research/casestudies.html and http://www.wcr.ethz.ch/research/Researchsummaries/costeffectiveness.html

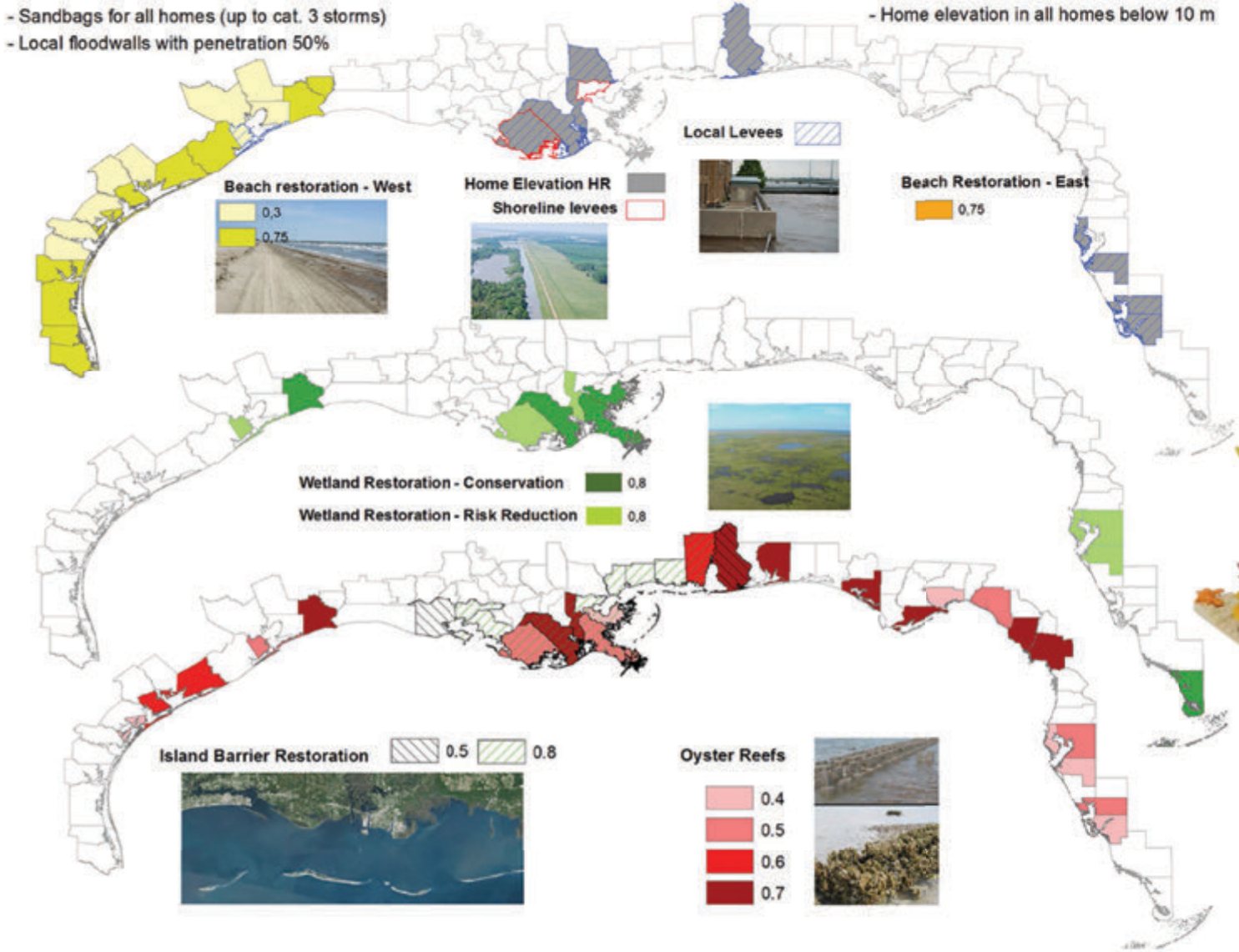


Fig 4. Spatial portfolio of adaptation measures. Adaptation measures are represented by counties where they are implemented. These measures were defined from existing projects and they type of coastline in each county (see Methods). For measures deployed at the shoreline, it is assumed they protect the counties in its lee according to their penetration (for example, sea walls along the shoreline are assumed to protect all the assets in its lee, at each site of implementation). Values and color intensity represent the percentage of assets affected or penetration of each measure (e.g. a penetration value of 0.4 in oyster reefs assumes only 40% of the assets in their lee are protected). It is assumed all assets are protected if no value is given. Sources of images: flickr from U.S. Geological Survey, National Oceanic and Atmospheric Administration, U.S. Fish and Wildlife Service, and U.S. Geological Survey LandSat imagery.

The Nature Conservancy

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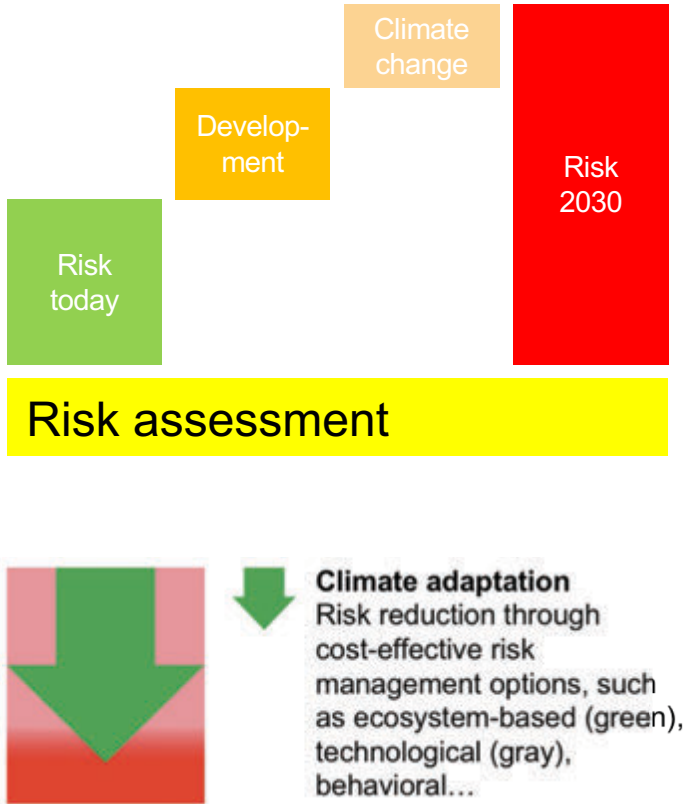
www.wcr.ethz.ch/research/Researchsummaries/costeffectiveness.html

Integration into NAPs and speeding-up adaptation action



What if we …

... specify our risk appetite in line with development priorities

... incorporate further criteria relevant to us in addition to cost-benefit ratio

... (re-)prioritize risk mitigation and transfer measures based on our priorities

... **integrate into NAPs and related planning documents**

... develop a roadmap including priority initiatives

... use roadmap for funding discussions

... speed-up implementation with the additional funding and hence further strengthen resilience