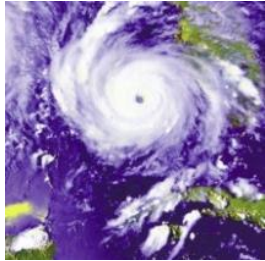


The background of the slide is a blurred photograph of a park. In the foreground, there are trees with green and yellow leaves. In the background, a body of water is visible, with some buildings and a red boat in the distance.

Open-source economics of climate adaptation - learnings and challenges from case studies worldwide

Prof. Dr. David N. Bresch, Institute for Environmental Decisions, ETH Zurich/MeteoSwiss
www.wcr.ethz.ch, dbresch@ethz.ch, open-source: <https://github.com/davidnbresch/climada>

More than twenty adaptation case studies worldwide¹: Many hazards, economic sectors and risk cultures



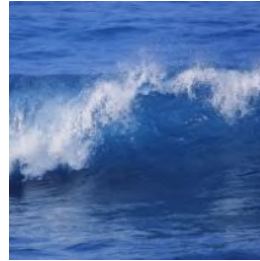
Florida: Hurricane risk to public and private assets



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



Bangladesh: Flood risk to a fast-developing city



Caribbean: Hurricane risk to small islands



El Salvador: Flood and landslide risk to vulnerable people



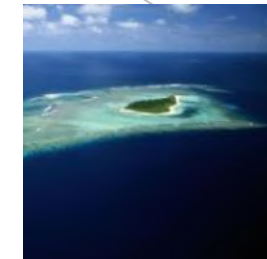
Guyana: Flash flood risk to a developing urban area



Mali: Risk of climate zone shift to agriculture



Tanzania: Drought risk to health and power generation



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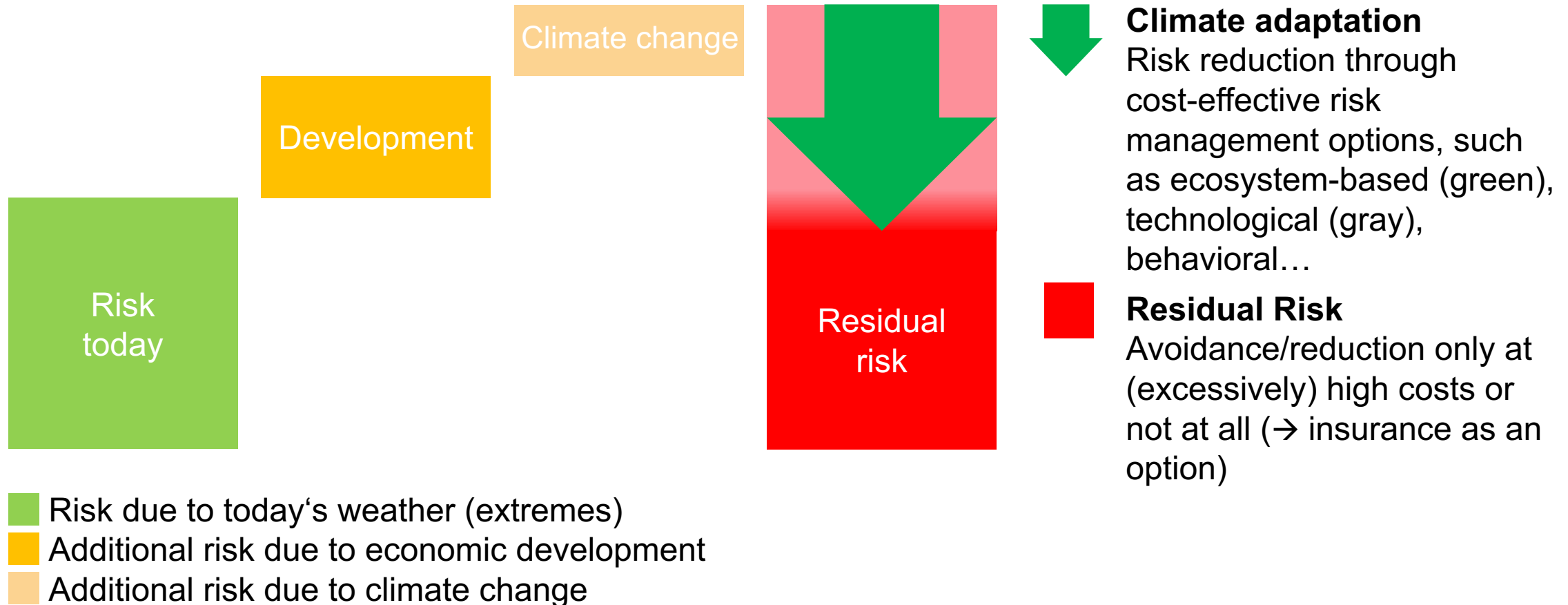


India: Drought risk to agriculture



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

General finding¹: 40-60% of risk can be cost-effectively avoided up to 2030, but...

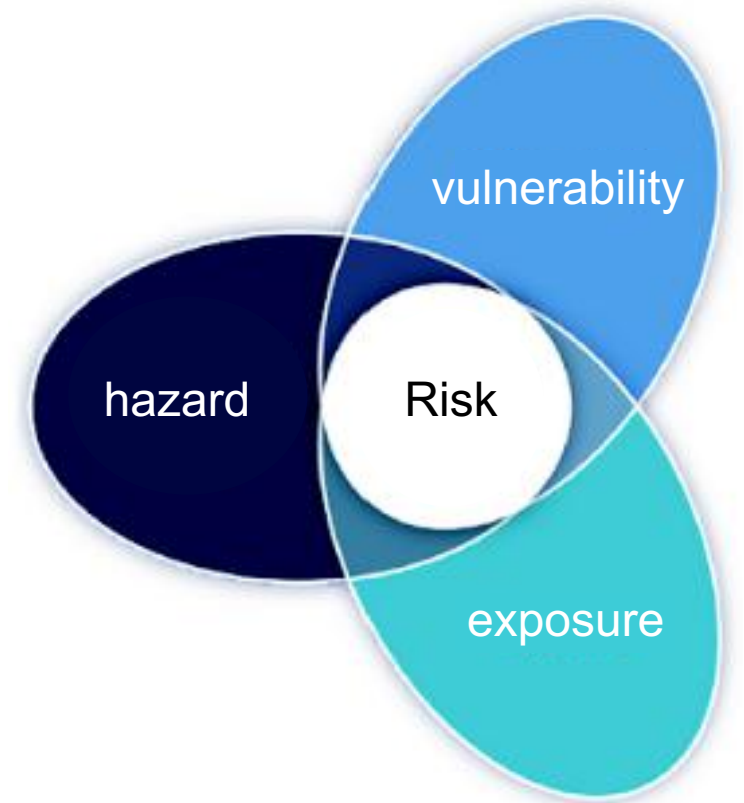


¹ ECA working group, supported by CCRIF/WorldBank, see: <http://www.wcr.ethz.ch/research/casestudies.html>

[Weather] Risk

The “effect of uncertainty on objectives”¹

risk = **probability** x **severity**
expected utility



$$\begin{aligned}\text{risk} &= \text{hazard} \times \text{exposure} \times \text{vulnerability} \\ &= (\text{probability} \times \text{intensity}) \times \text{exposure} \times \text{vulnerability}\end{aligned}$$

severities

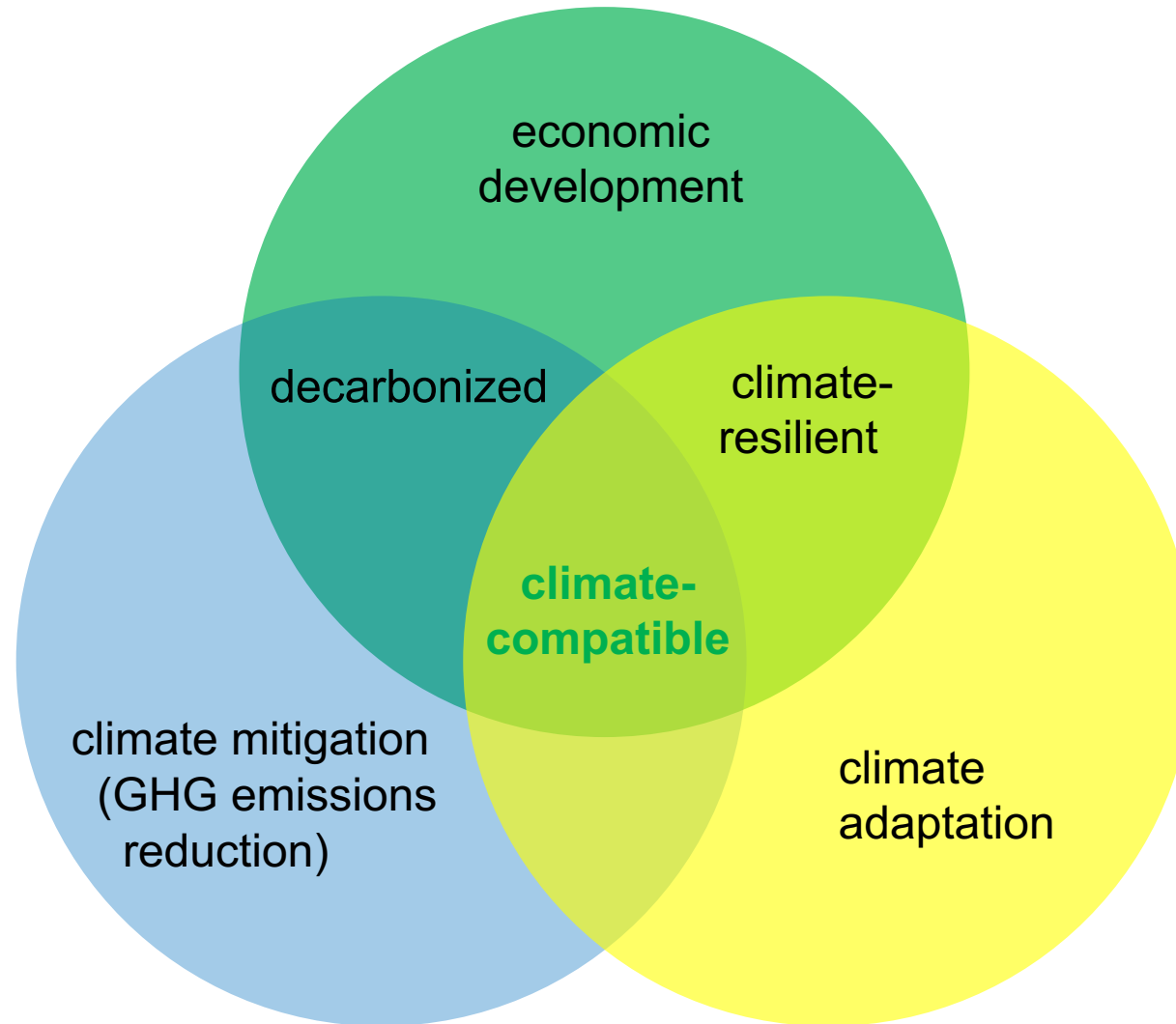
¹ ... a positive or negative deviation from what is expected [ISO 31000]

Economics of Climate Adaptation (ECA)

Case study Barisal, Bangladesh¹



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:

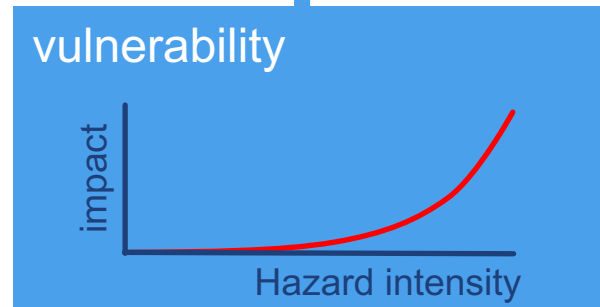
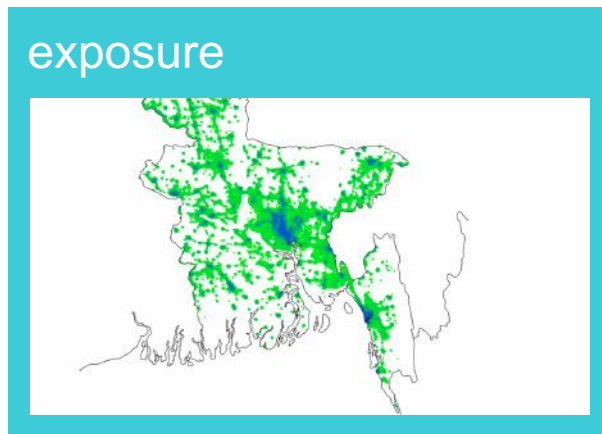
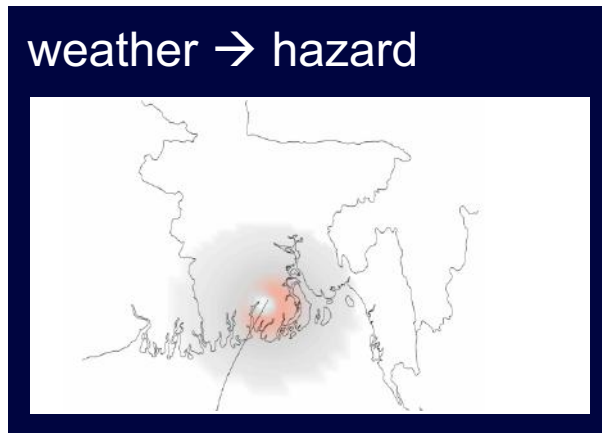
- Follow a rigorous risk management approach to **assess weather climate risk**, the sum of
 - **today's weather and climate risk**,
 - the **economic development paths** that might put greater population and value at risk (→ projection)
 - the additional risks presented by **climate change** (→ scenarios)
- 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 CLIMADA simulation platform

https://www.ethz.ch/content/dam/ethz/special-interest/usys/ied/wcr-dam/documents/Economics_of_Climate_Adaptation_ECA.pdf

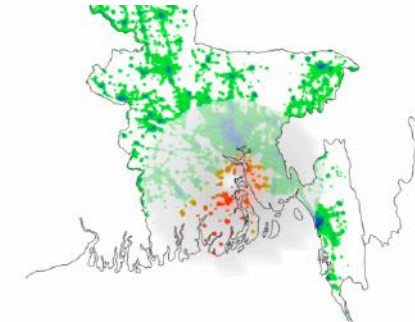
<http://www.iac.ethz.ch/edu/courses/master/modules/climate-risk.html>, <https://github.com/davidnbresch/climada>

CLIMADA simulation platform: Probabilistic risk analysis



CLIMADA
(open source¹):
fully probabilistic
event-based
simulation

risk analysis
+ risk mapping,
early warning...

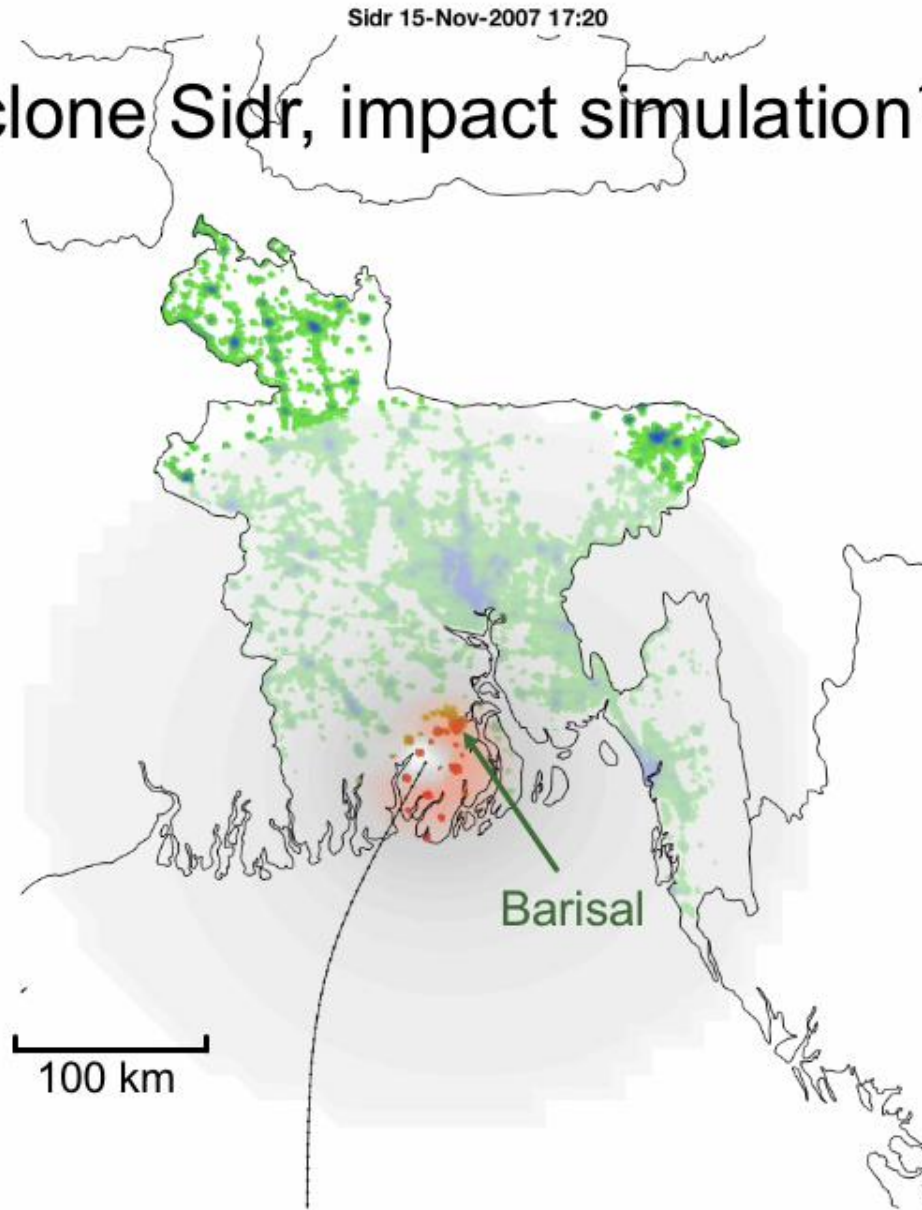


Welker, Martius, Stucki, Bresch, Dierer & Brönnimann, 2015
Schwierz, Köllner-Heck, Zenklusen, Bresch, Vidale, Wild, Schär, 2010
Della-Marta, Liniger, Appenzeller, Bresch, Köllner-Heck, Muccione, 2010

CLIMADA

¹ <https://github.com/davidnbresch/climada>

14 Nov 2007, tropical cyclone Sidr, impact simulation¹



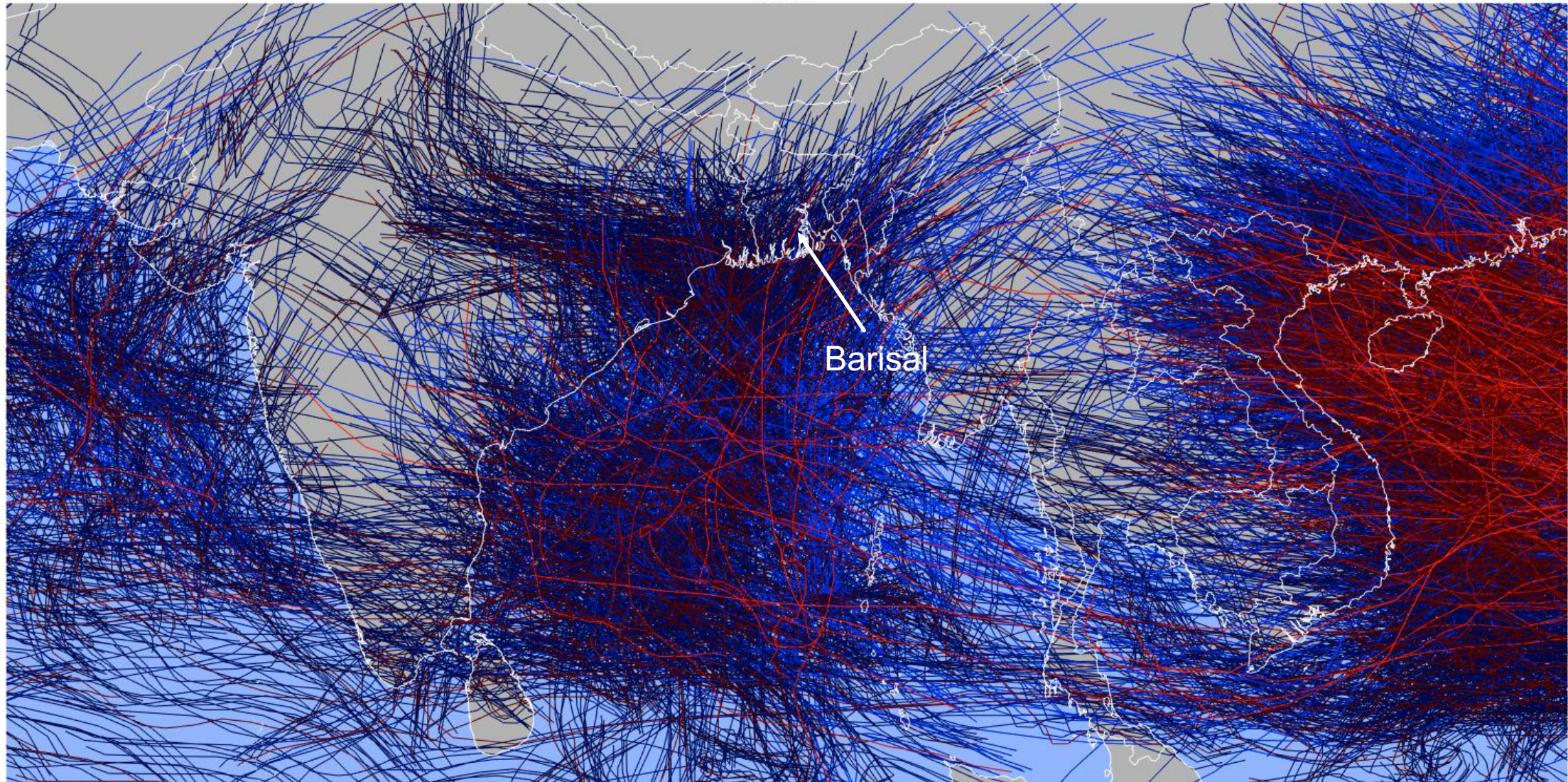
<https://vimeo.com/198389316>

green-blue: exposure, orange-red: simulated impact

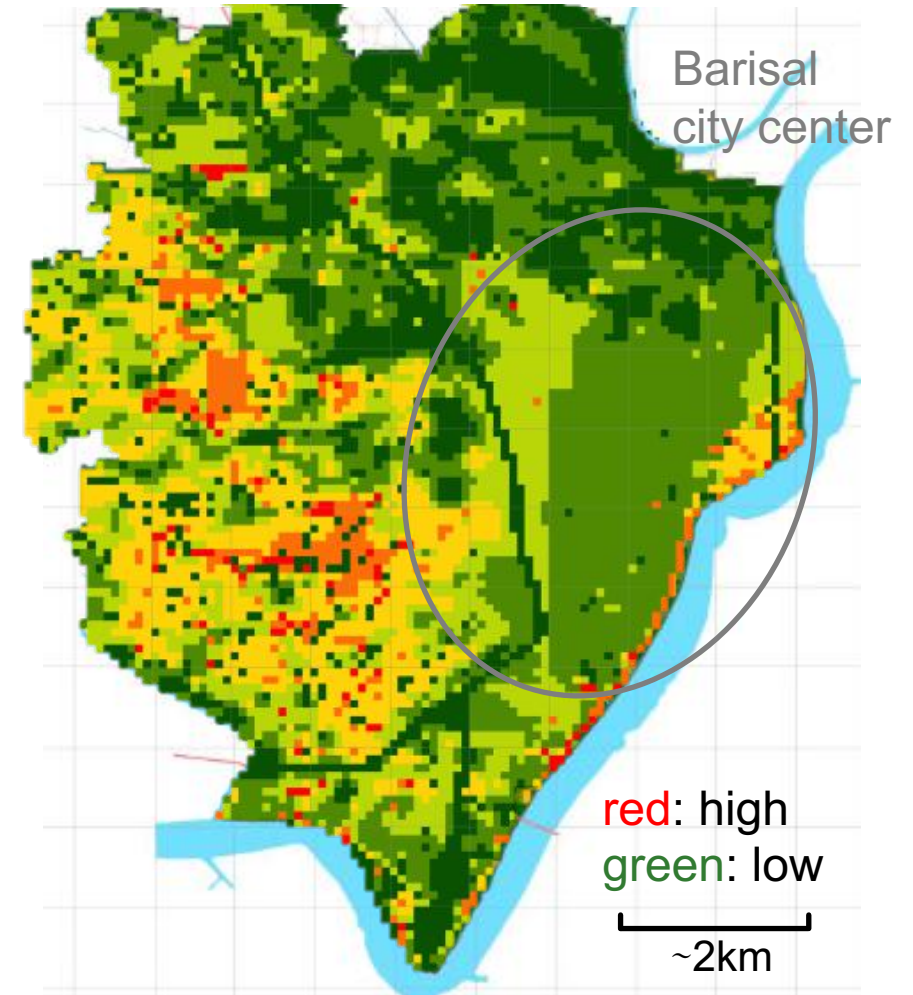
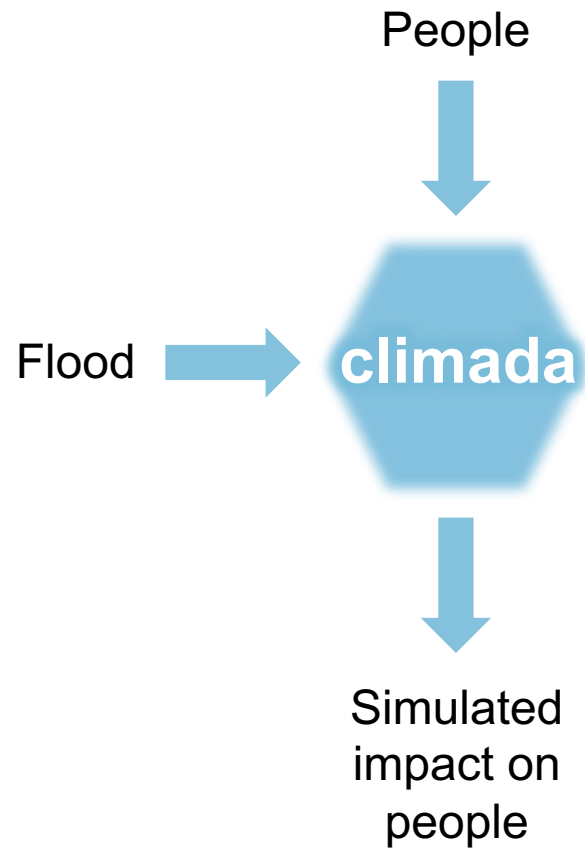
CLIMADA

¹ track data from Joint Typhoon Warning Center, wind field based on Holland, 2008; impact model CLIMADA, <https://github.com/davidnbresch/climada>

Tropical cyclones 1950-2016 x 100 (probabilistic)

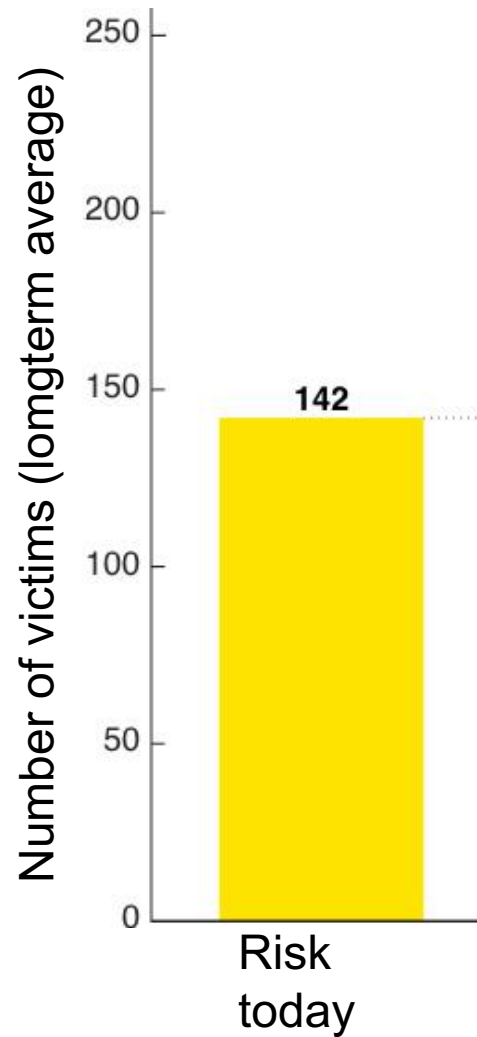


From assets to impacts¹: The poor in the western part of the City suffer most of the damages in relative economic terms



¹ Wieneke & Bresch, 2016: Economics of Adaptation (ECA) in Development Cooperation: A Climate Risk Assessment Approach Supporting decision making [...]. [Materials on Development Financing](#), UNU, KfW.

Quantification of impacts: Simulated flood victims in Barisal

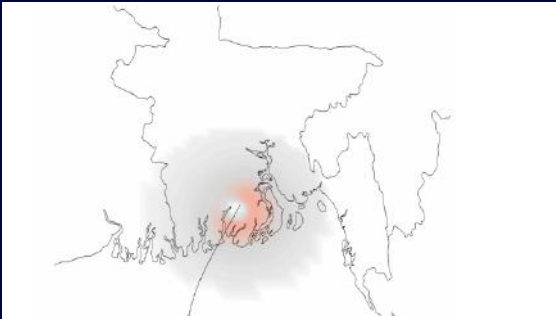


CLIMADA simulation platform: Probabilistic risk analysis under various development and climate scenarios

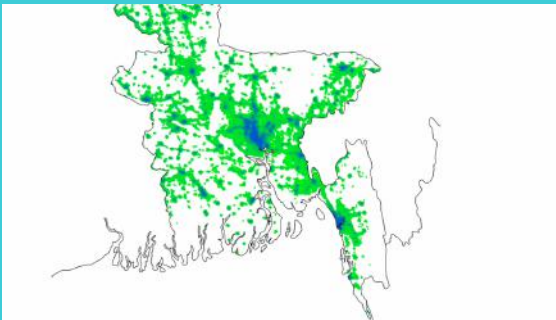


regional scenarios

weather → hazard



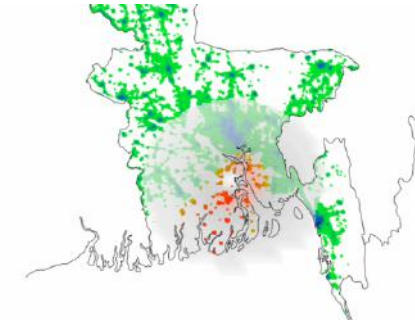
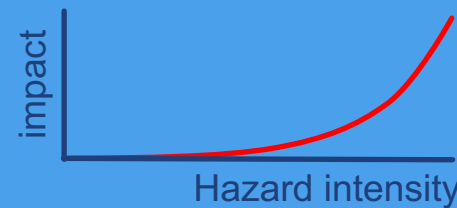
exposure



climada
(open source¹):
fully probabilistic
event-based
simulation

risk analysis
+ risk mapping,
early warning...

vulnerability



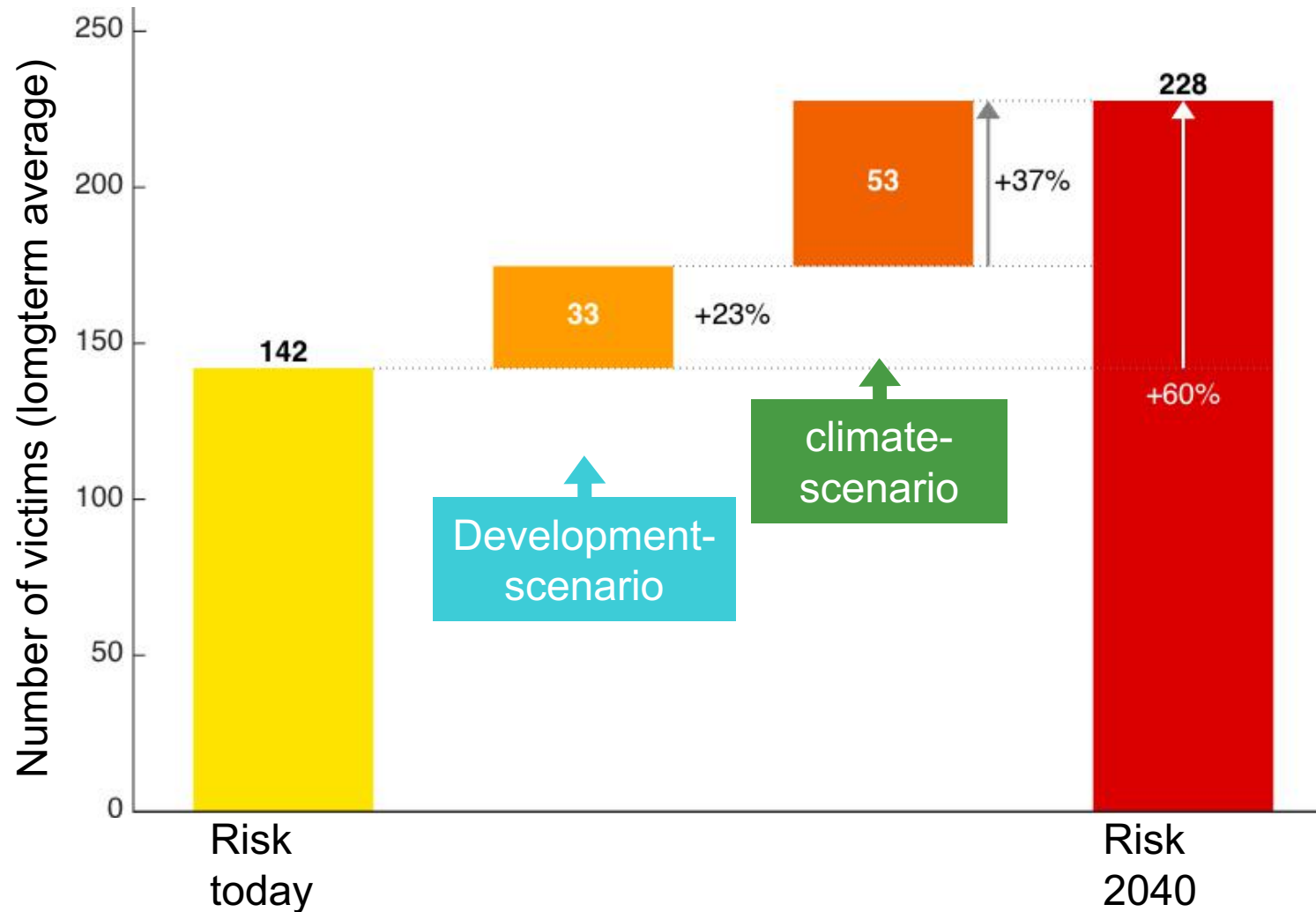
Development
scenarios

Welker, Martius, Stucki, Bresch, Dierer & Brönnimann, 2015
Schwierz, Köllner-Heck, Zenklusen, Bresch, Vidale, Wild, Schär, 2010
Della-Marta, Liniger, Appenzeller, Bresch, Köllner-Heck, Muccione, 2010

climada

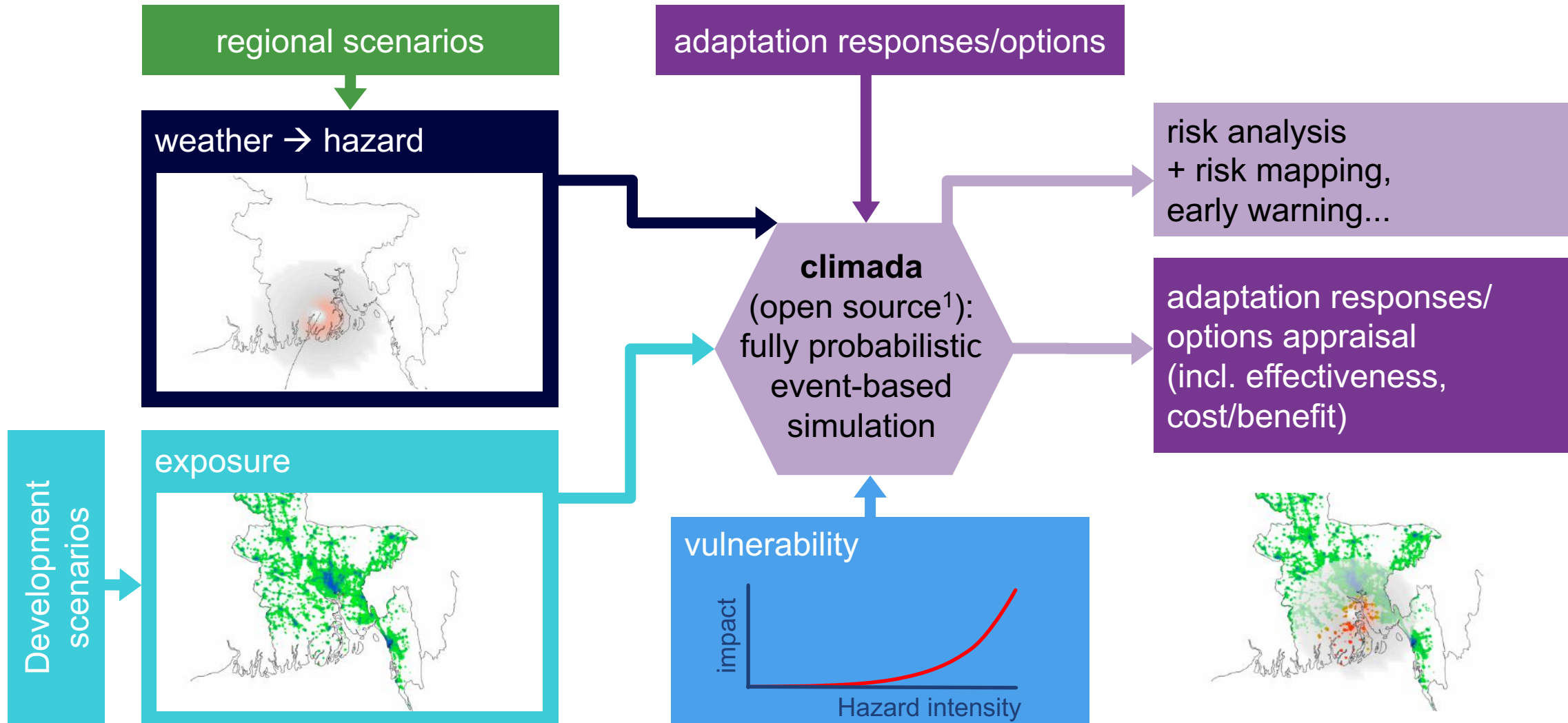
¹ <https://github.com/davidnbresch/climada>

Quantification of impacts: Simulated flood victims in Barisal





CLIMADA simulation platform: Probabilistic risk analysis and adaptation responses/options appraisal



Welker, Martius, Stucki, Bresch, Dierer & Brönnimann, 2015
Schwierz, Köllner-Heck, Zenklusen, Bresch, Vidale, Wild, Schär, 2010
Della-Marta, Liniger, Appenzeller, Bresch, Köllner-Heck, Muccione, 2010

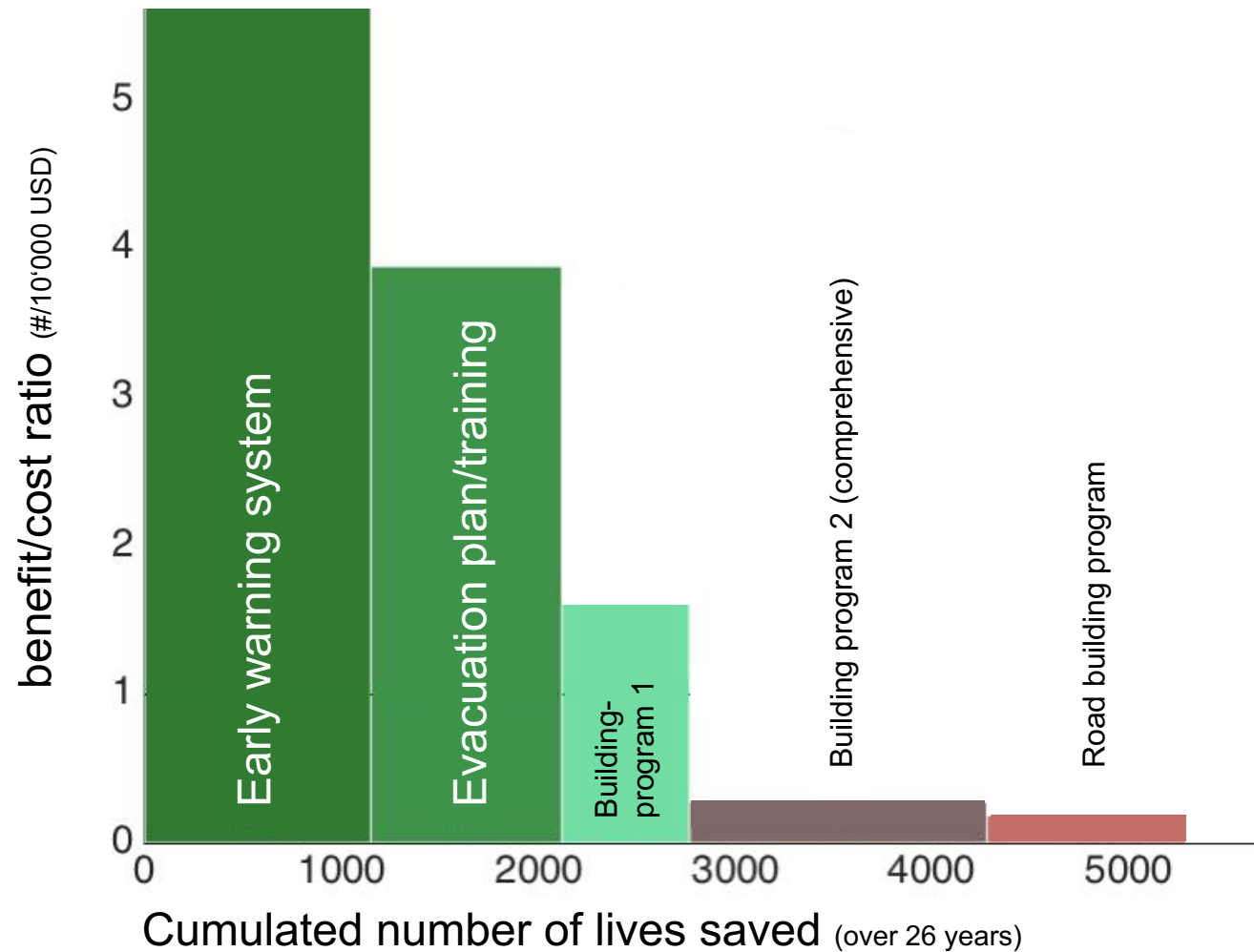
CLIMADA

¹ <https://github.com/davidnbresch/climada>

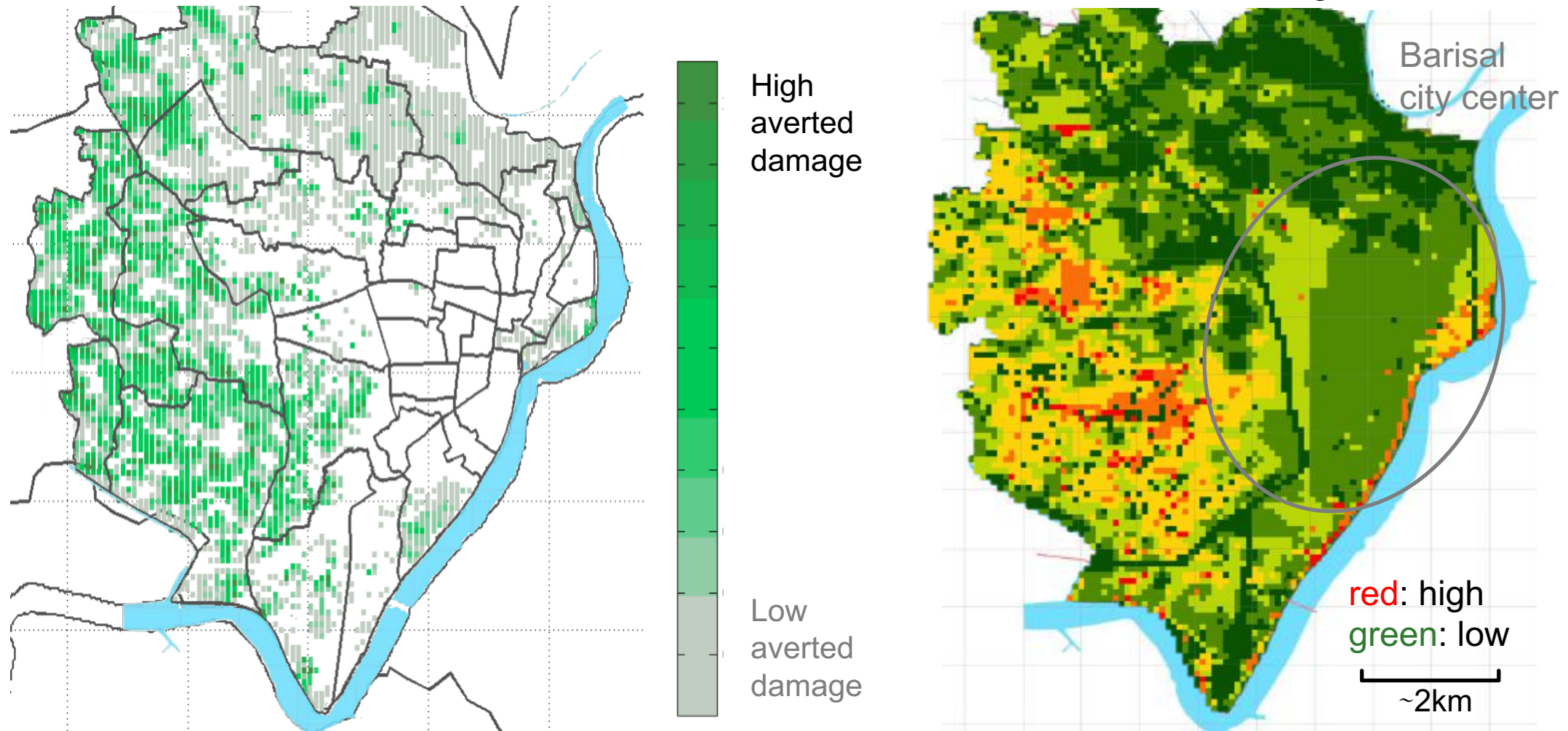
Adaptation options – benefit/cost ratio



Adaptation options to avoid flood victims in Barisal, Bangladesh



Flood resilient crops reduce agricultural losses by 40%, mostly in the western part of the city of Barisal¹



¹ Wieneke & Bresch, 2016: Economics of Adaptation (ECA) in Development Cooperation: A Climate Risk Assessment Approach Supporting decision making [...]. Materials on Development Financing, UNU, KfW.

Applied in more than twenty case studies worldwide¹: Many hazards, economic sectors and risk cultures



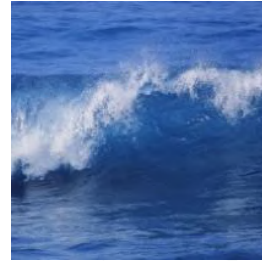
Florida: Hurricane risk to public and private assets



US Gulf Coast: Hurricane risk to the energy system



New York: Cyclones and surge risk to a metropolis



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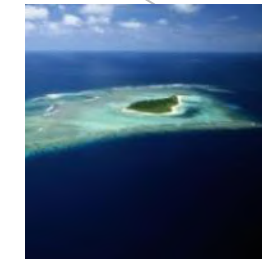
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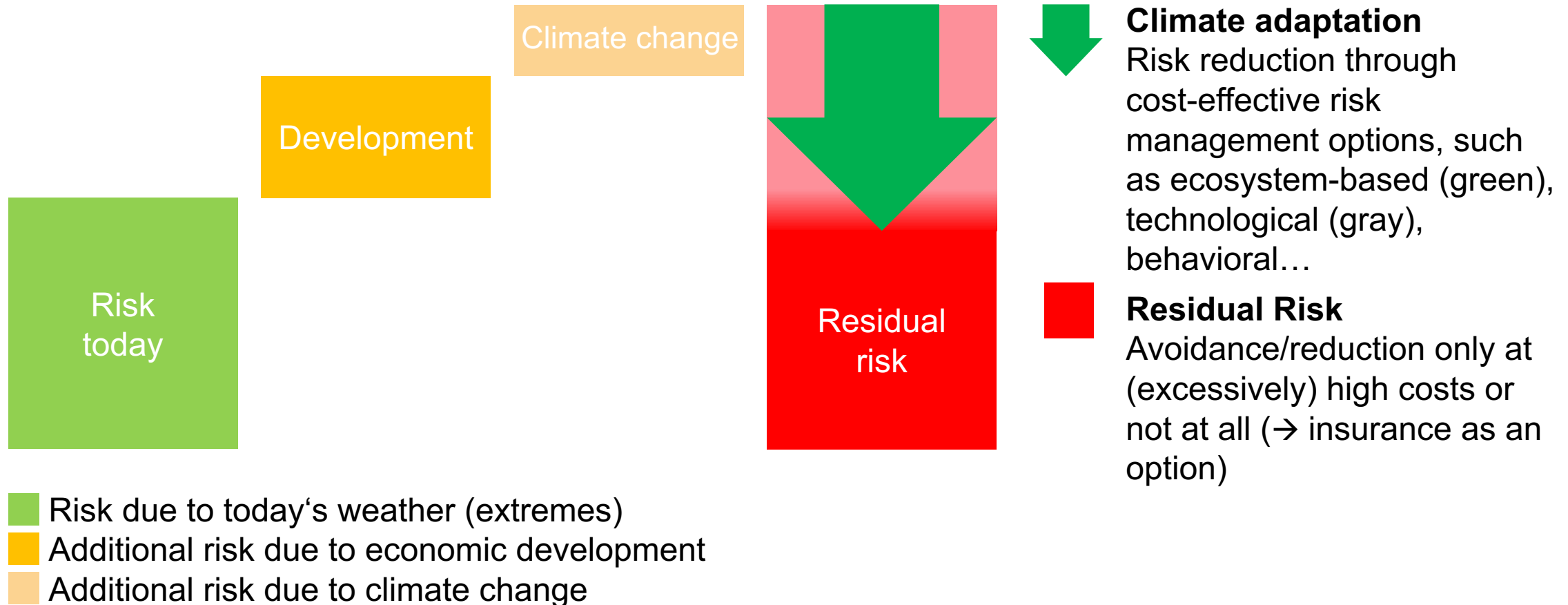


India: Drought risk to agriculture



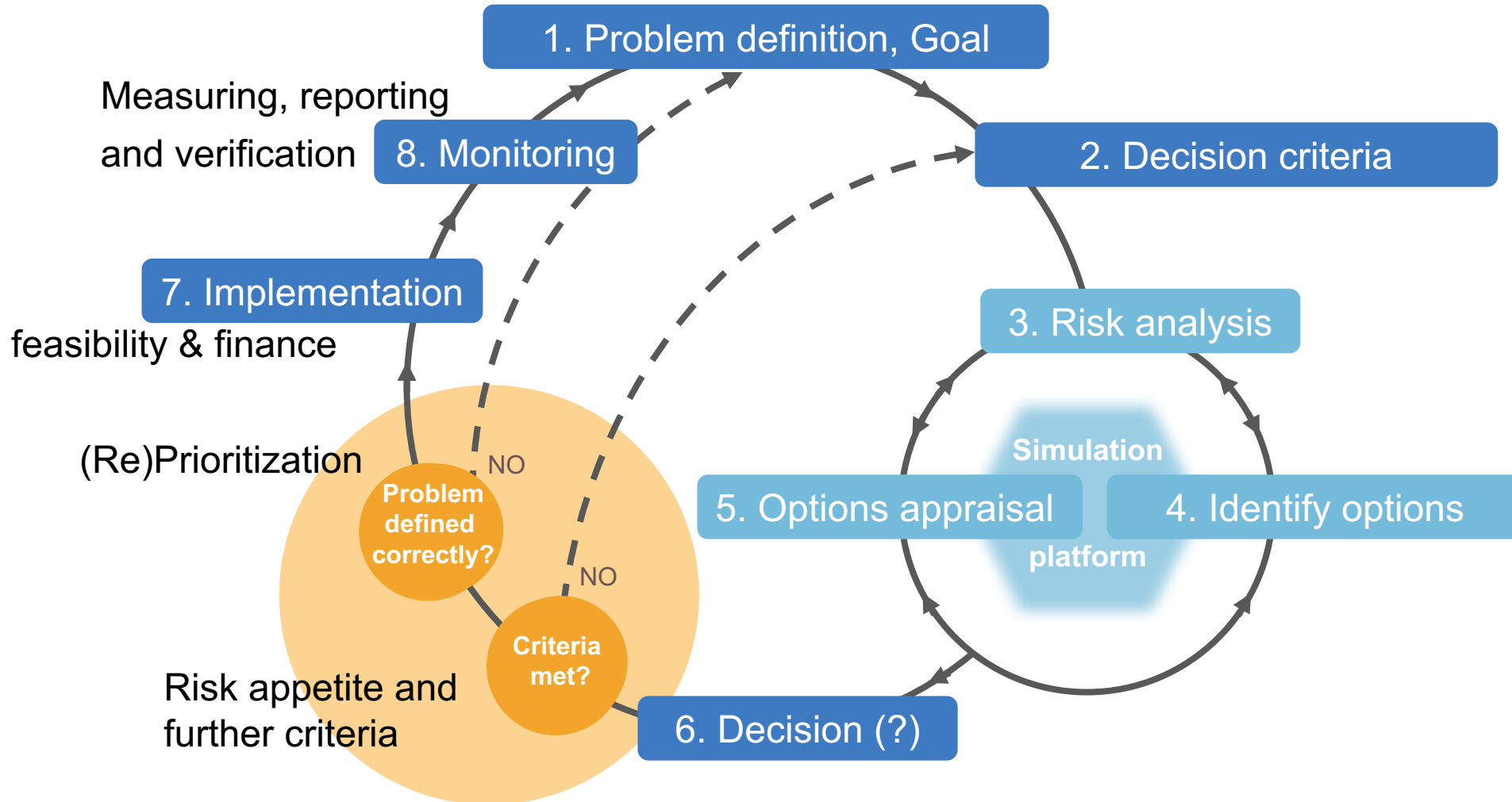
¹ ECA working group, supported by CCRIF/WorldBank, see: <http://www.wcr.ethz.ch/research/casestudies.html>

General finding¹: 40-60% of risk can be cost-effectively avoided up to 2030, but...



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

Risk, uncertainty and decision-making

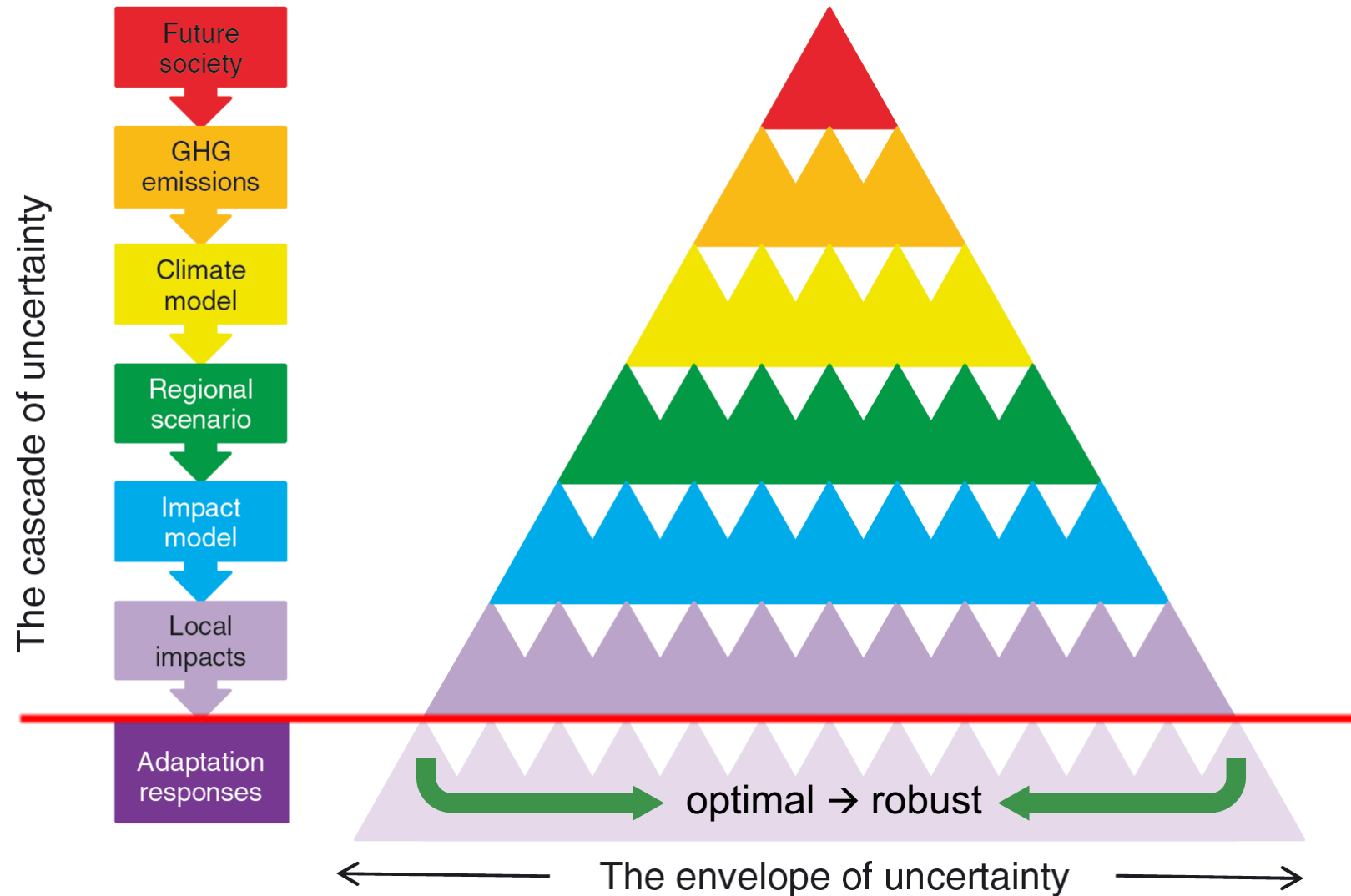


CLIMADA

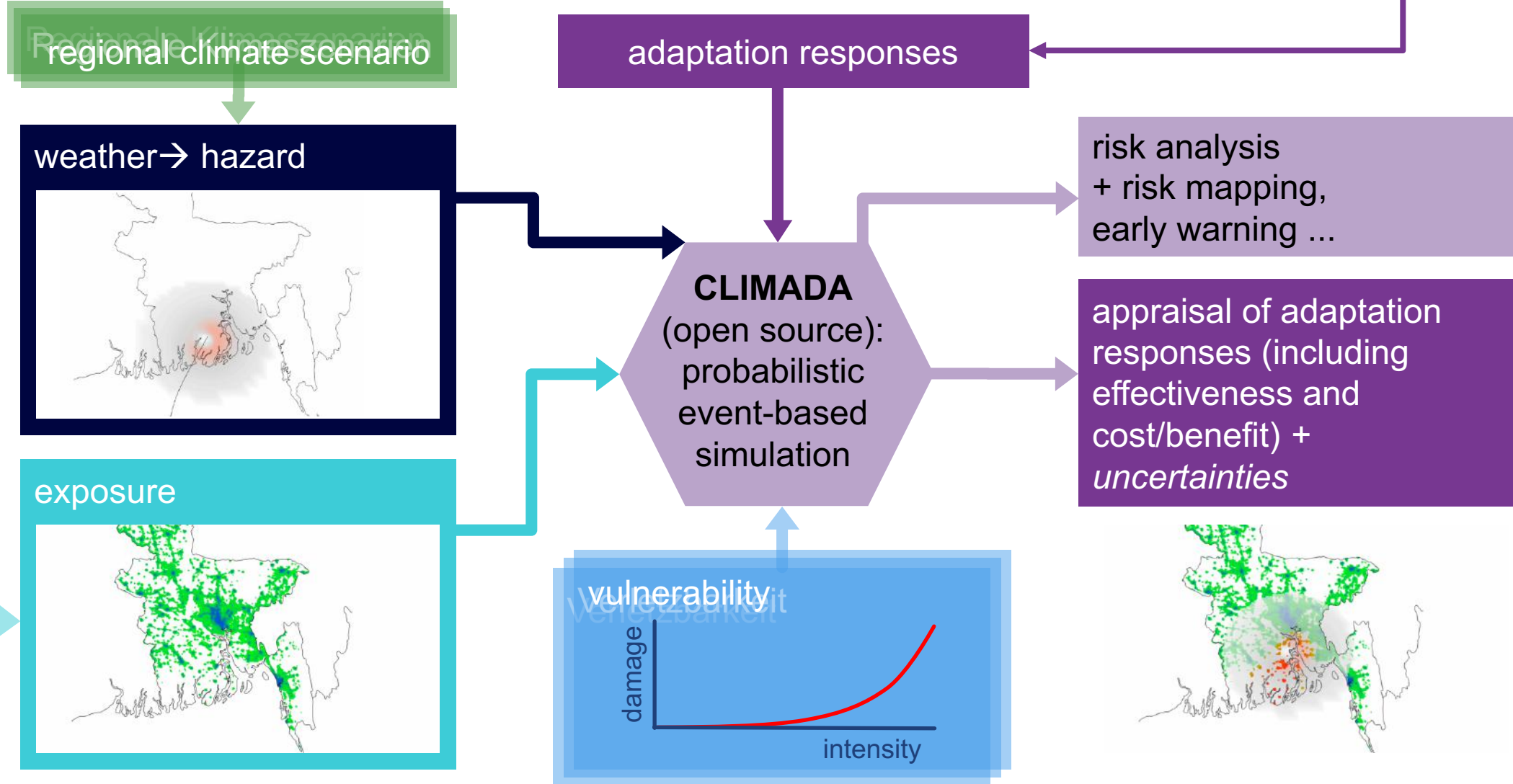
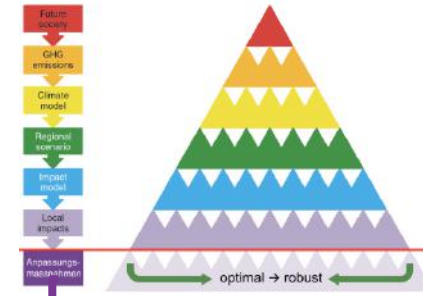
¹ Siehe zB: Souvignet, Wieneke, Müller & Bresch, 2016: Economics of Climate Adaptation (ECA) - Guidebook for Practitioners. Materials on Development Financing, UNU, KfW. https://www.kfw-entwicklungsbank.de/PDF/Download-Center/Materialien/2016_No6_Guidebook_Economics-of-Climate-Adaptation_EN.pdf

Figure based upon IPCC und UKCIP

Uncertainty along the chain of impact



CLIMADA simulation platform: comprehensive appraisal of adaptation responses + the uncertainty of their effectiveness

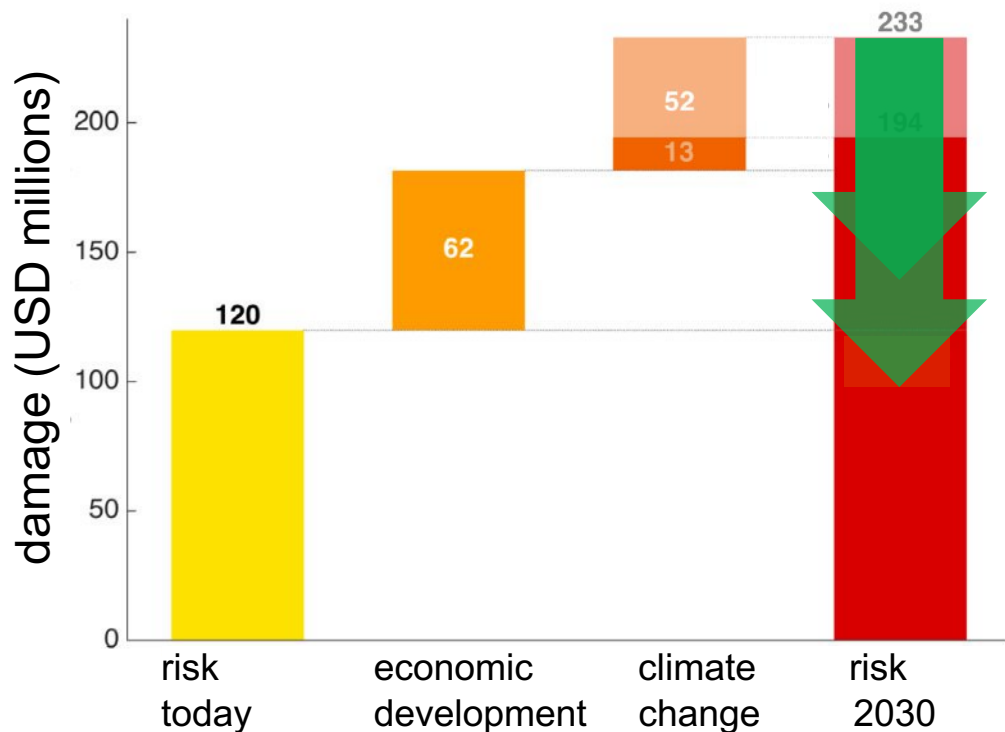


Welker, Martius, Stucki, Bresch, Dierer & Brönnimann, 2015
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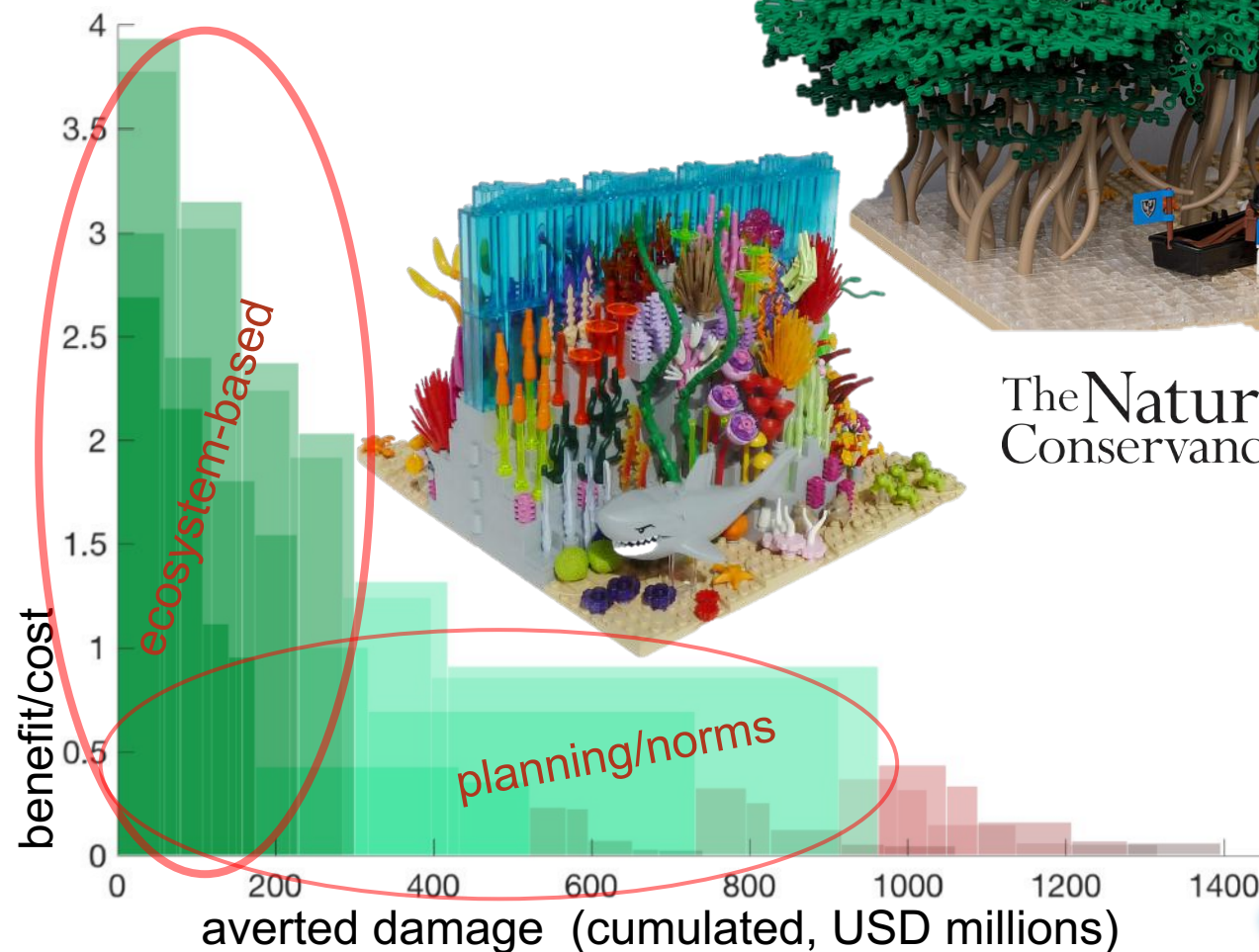


Barbados case study¹ – damage due to tropical cyclones

risk analysis:



adaptation measures:



The Nature Conservancy

CLIMADA

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