ETH zürich

Weather and Climate Risks

CLIMADA
Economics of Climate Adaptation

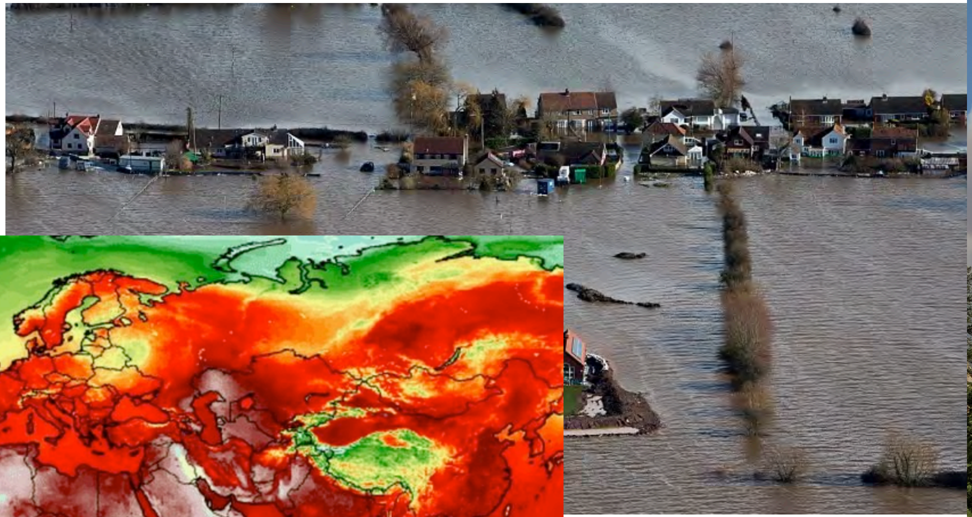
A risk model for everyone: making extreme weather impact models accessible to decision-maker

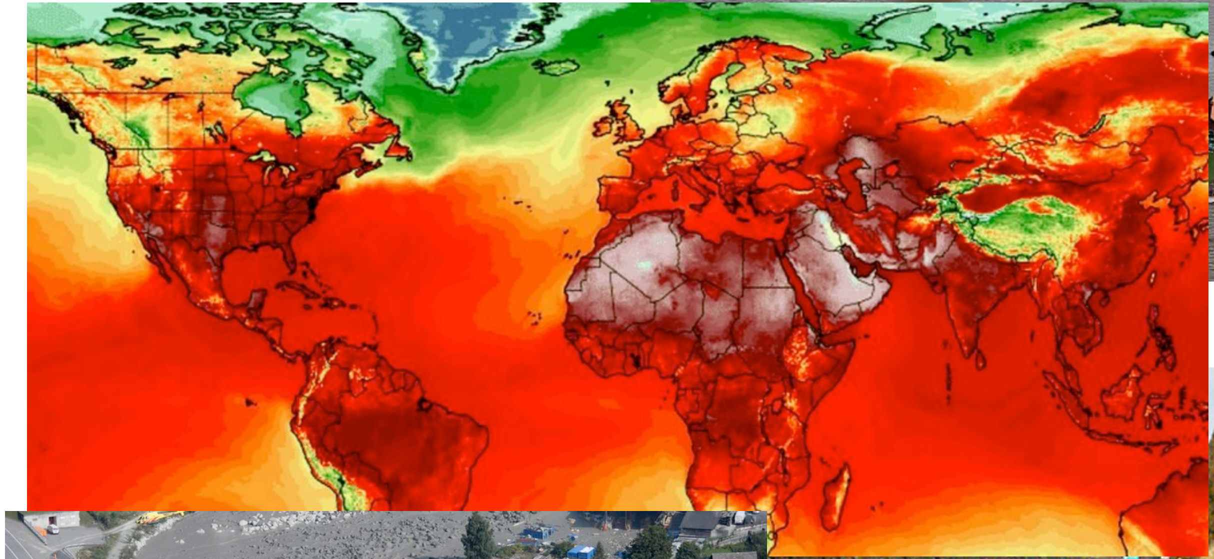
Cross-sectoral ISIMIP and PROCLIAS Workshop
16-19 May 2022
Chahan Kropf

CLIMADA - an open-source and -access global probabilistic risk modelling and adaptation economics platform

Cross-sectoral ISIMIP and PROCLIAS Workshop
16-19 May 2022
Chahan Kropf

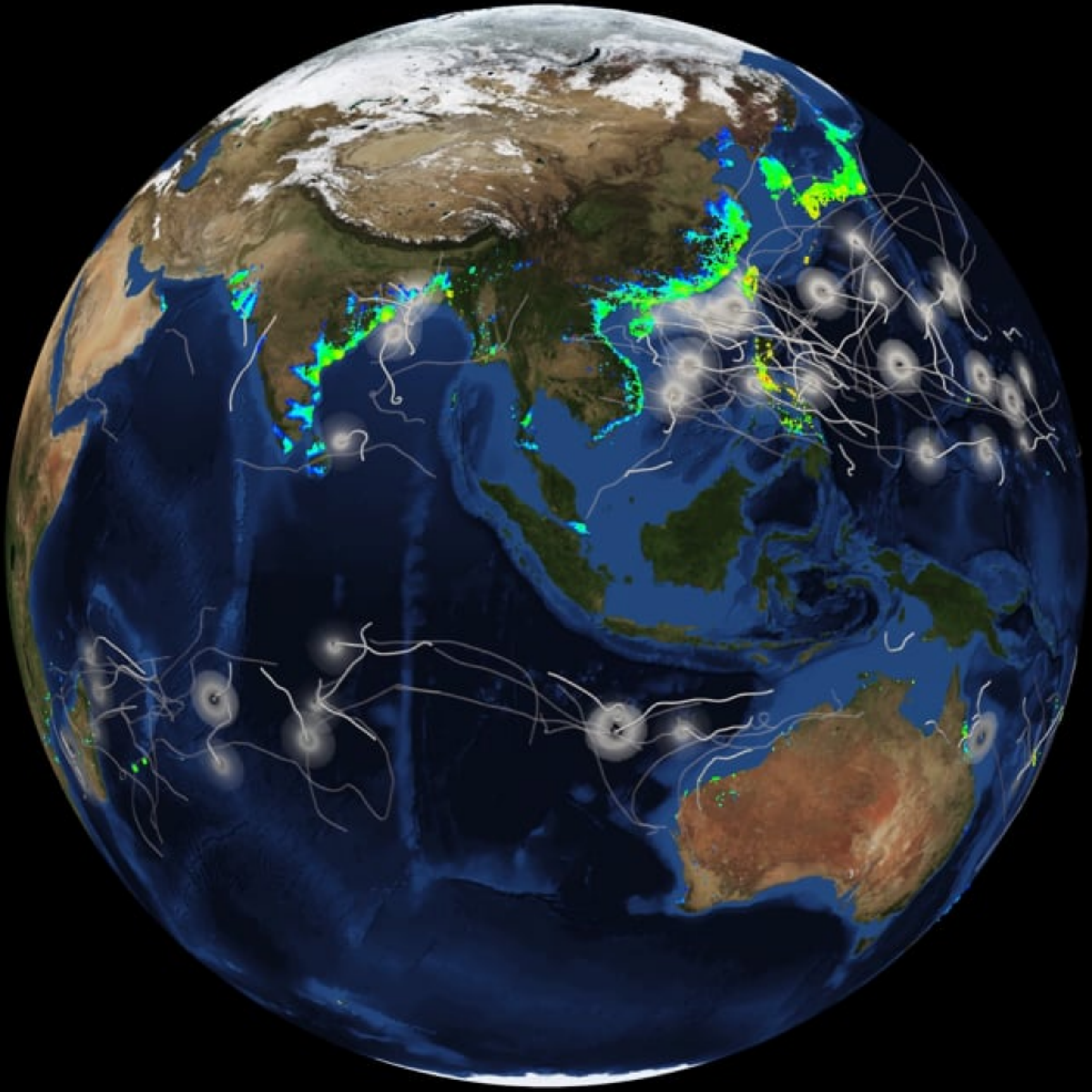
Natural hazards



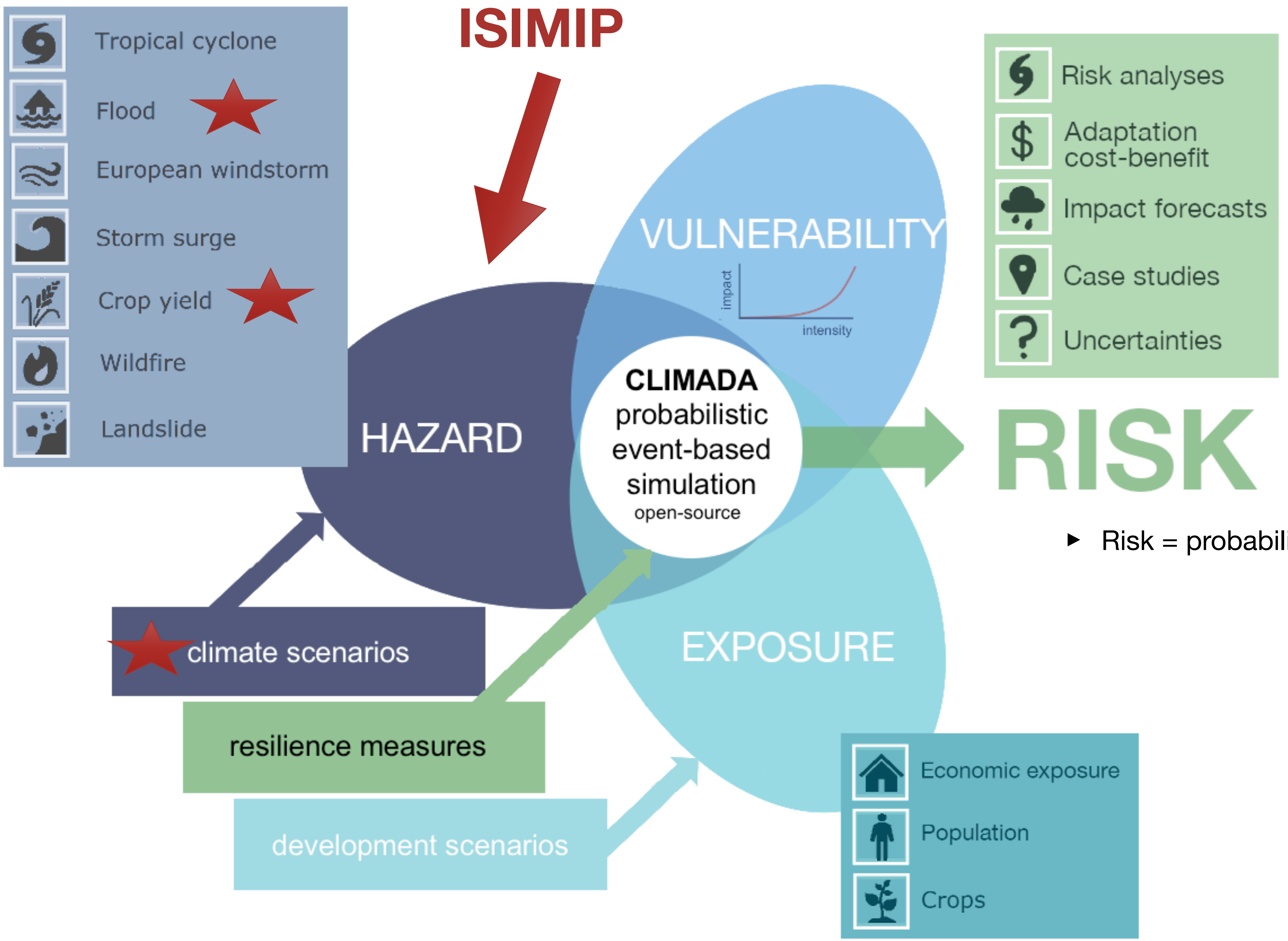







2010

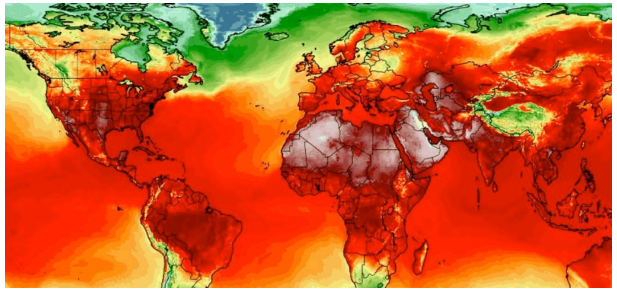
CLIMADA v3.1.2

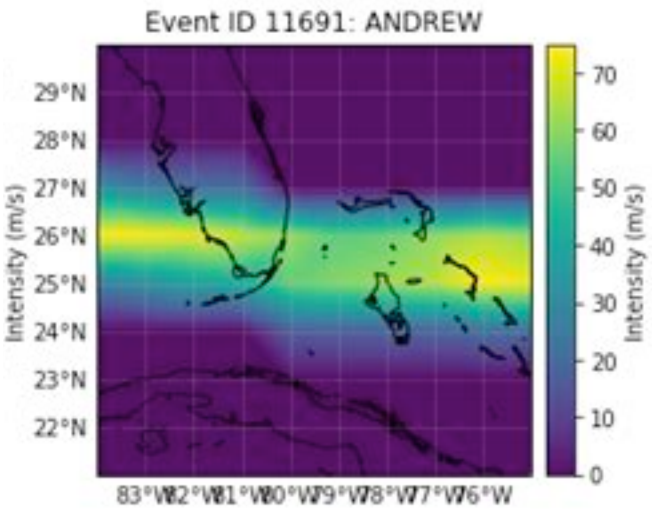


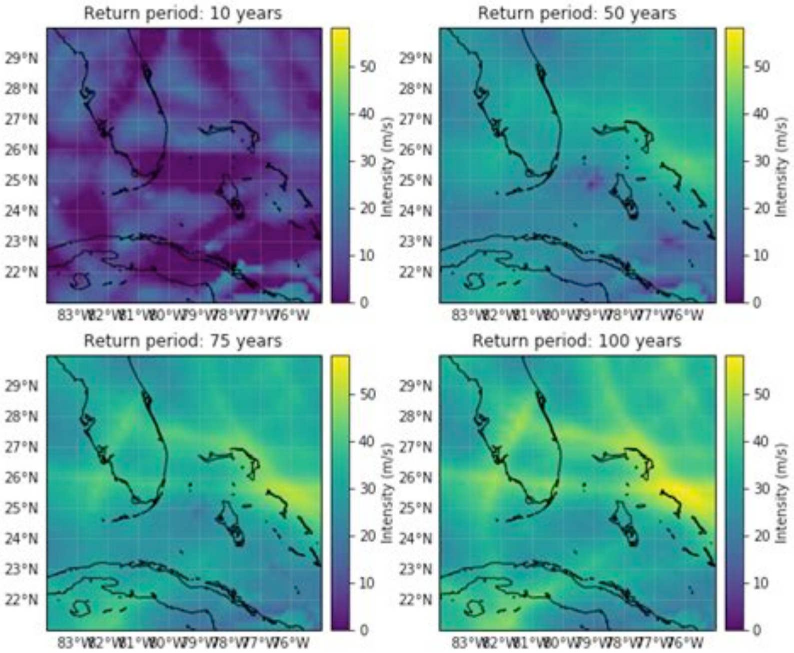
- Risk = probability x severity

Hazard

- Weather hazard events
  - Probability of event
  - Intensity at location



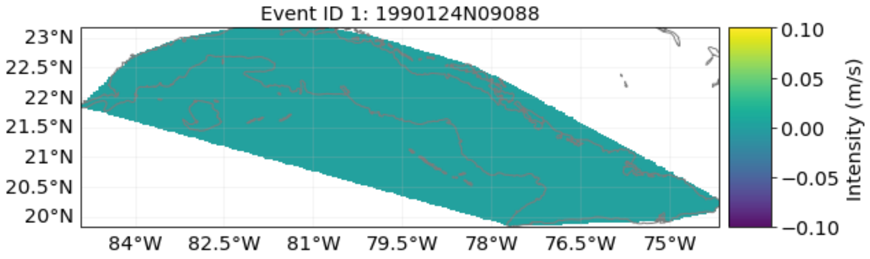




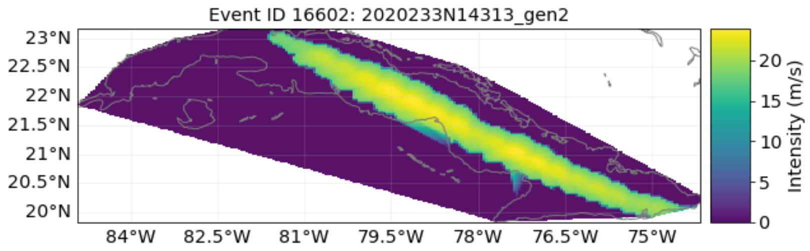
Hazard

- Probabilistic ensemble
  - Physical modelling
  - Historical data + statistical modelling

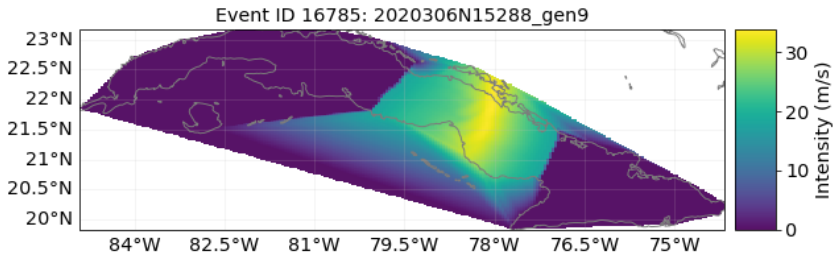
P = 1/2 Years



P = 1/10 Years

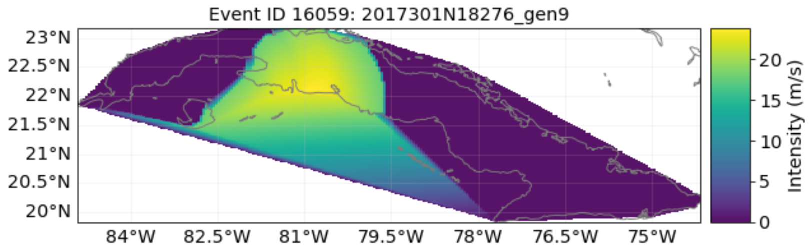


P = 1/10 Years



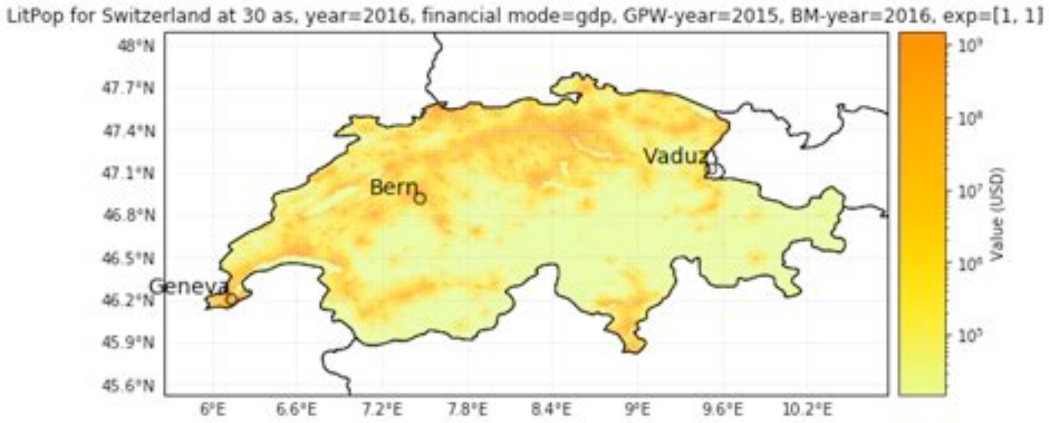
...

P = 1/12 Years

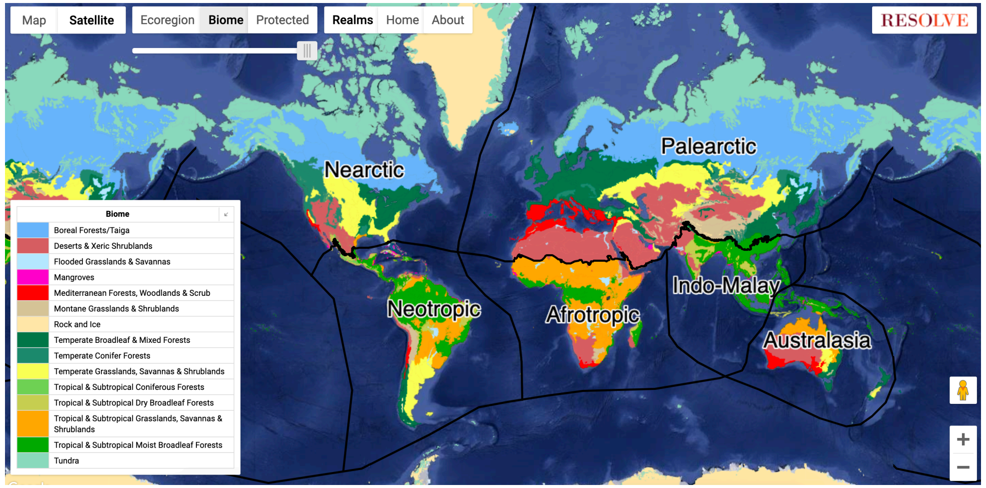


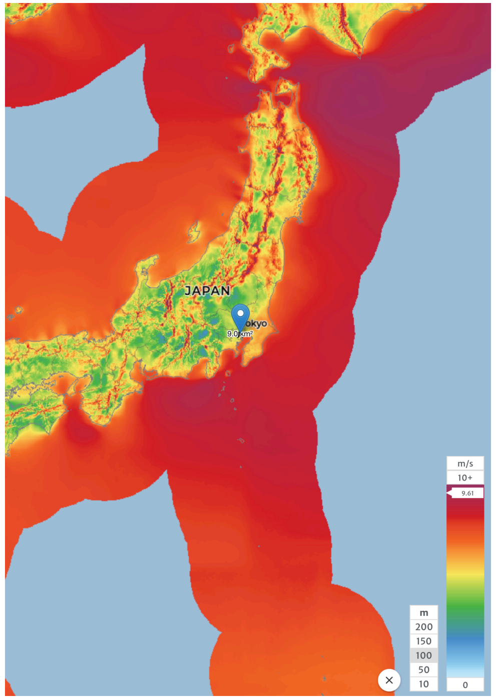
Exposures

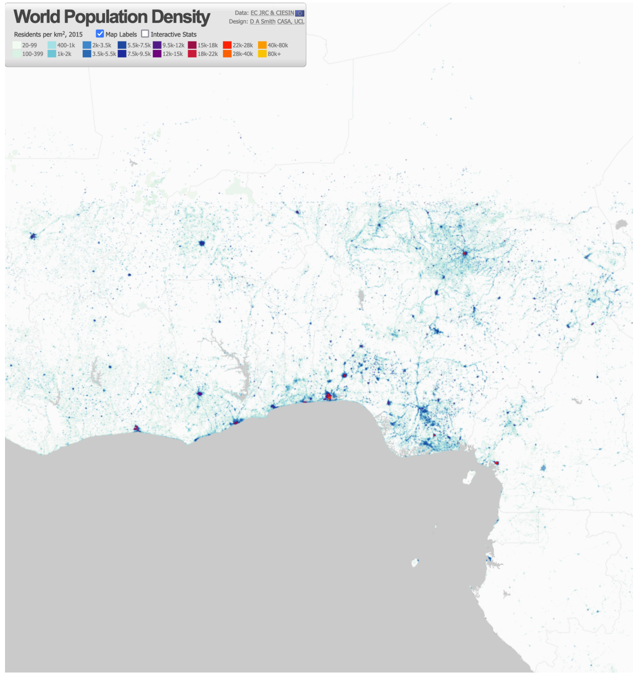
- Exposure - value at given place
  - Value at location



	value	geometry	latitude	longitude	region_id	impf_
0	183961.258736	POINT (8.54583 47.79583)	47.795833	8.545833	756	1
1	209830.757151	POINT (8.55417 47.79583)	47.795833	8.554167	756	1
2	176574.663650	POINT (8.56250 47.79583)	47.795833	8.562500	756	1
3	125076.058282	POINT (8.57083 47.79583)	47.795833	8.570833	756	1
4	56323.656151	POINT (8.57917 47.79583)	47.795833	8.579167	756	1

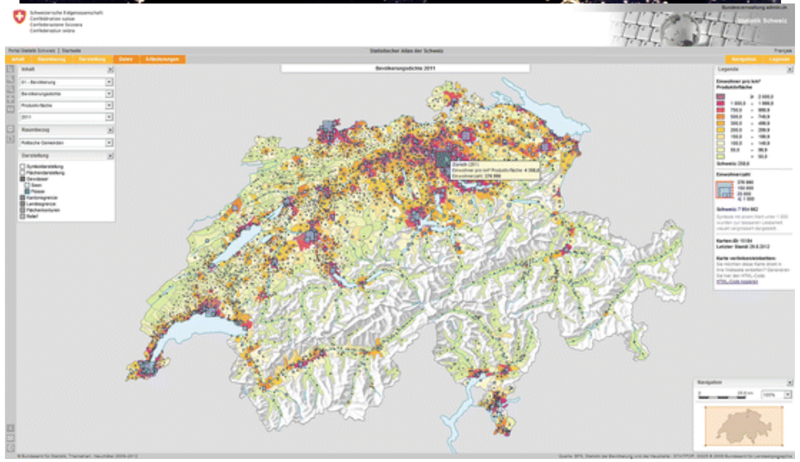


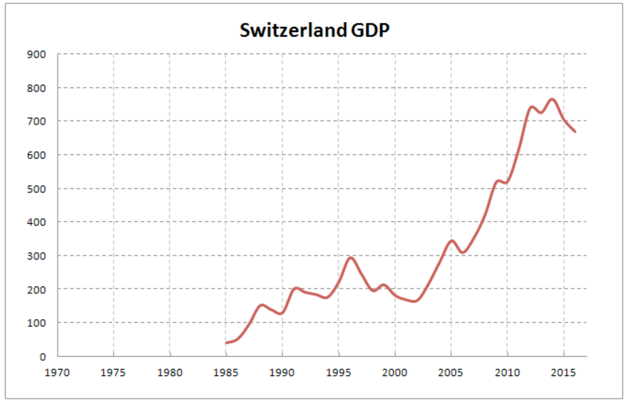


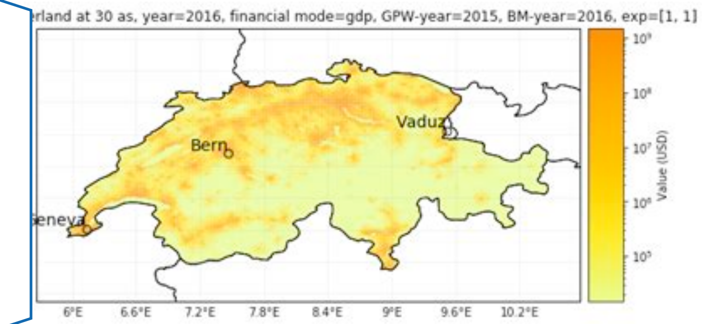


Exposures

- LitPop
  - Nightlight images
  - Population sensus data
  - GDP

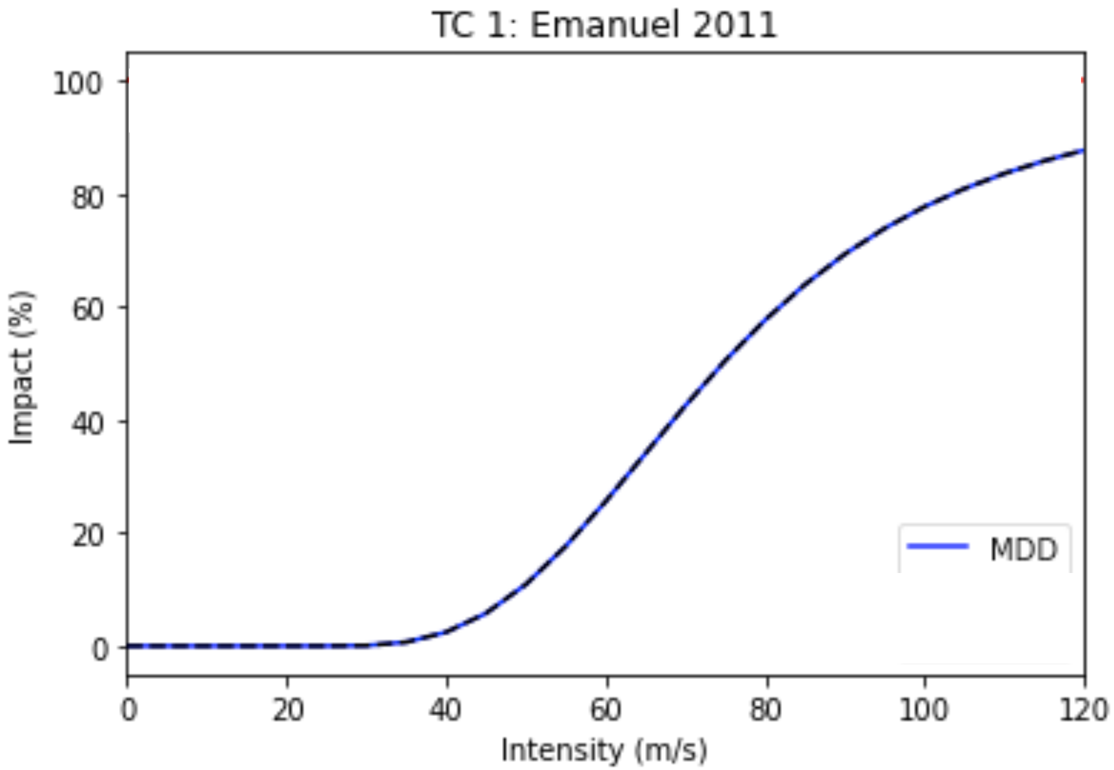






Impact function

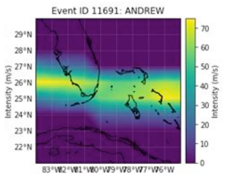
- Vulnerability i.e., impact function
  - How is value changed at given intensity



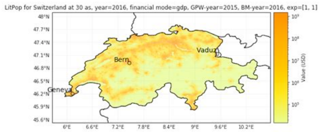
- E.g.: Damage to property value, power-generated from wind-turbine, surface of forest affected

Impact and risk in CLIMADA

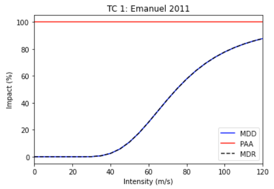
- Risk is the combination of the probability [or likelihood] of a consequence and its magnitude
  - Risk = probability x impact



- Weather hazard events
  - Probability of event
  - Intensity at location

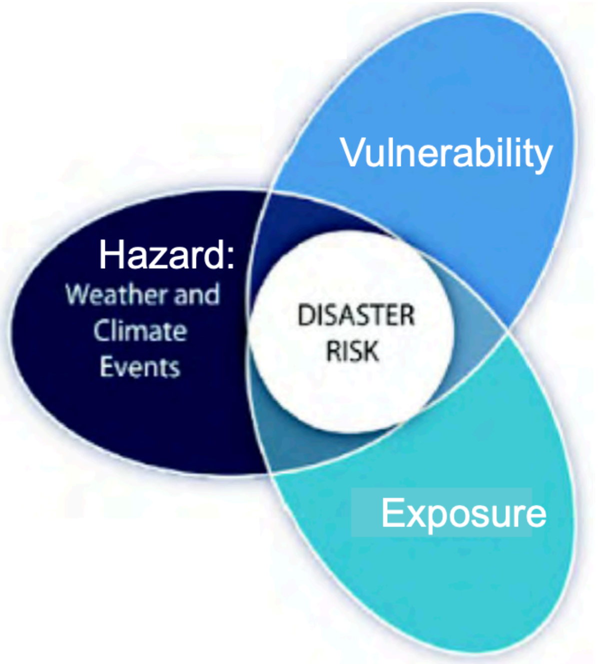


- Exposure - value at given place
  - Value at location



- Vulnerability i.e., impact function
  - How is value changed at given intensity

- Impact = impf(intensity) * value
- Risk = probability * impf(intensity) * value



Core impact computation

- Exposures value at given location : $E(x)$
- Intensity of hazard event epsilon at modelled location $\tilde{x}$ closest to x : $h_\epsilon(\tilde{x})$
- Frequency (probability) of event : ν_ϵ
- Impact function of exposures at location x : $f(E(x)) = f_x$
- Impact matrix:

$$I_{\epsilon,x} = f_x(h_\epsilon(\tilde{x}))E(x)$$

Impact and risk metrics

- Impact at event

$$I_\epsilon = \sum_x I_{\epsilon,x}$$

- Expected average impact at exposures

$$\overline{I}_x = \sum_\epsilon I_{\epsilon,x} \nu_\epsilon$$

- Average impact over all exposures and all events (total annual expected risk)

$$\overline{R} = \sum_{\epsilon,x} I_{\epsilon,x} \cdot \nu_\epsilon$$

CLIMADA summary

- CLIMADA is a **framework** NOT a model.
- **Scale** all: Worldwide, Country, Region, City
- Extreme events (**probabilistic** or single events)
- Now or Near-future casting (e.g., risk warnings), **Current and future risk** (e.g. Socio-economic development + Climate change), Adaptation option
- **Exposures**: People, Ecosystems, Assets, Economic supply chains, Critical infrastructure, …
- **Hazards**: Tropical cyclones, Winter storms, Wildfires, Flood, Drought, Heatwaves
- **API**: data obtainable directly - Worldwide consistent at 4x4km
- Open-source and open-access **Python platform.**
- **Uncertainty**: uncertainty and sensitivity analysis
- Various **output metrics** (e.g. return period curves, risk transfer, average impact, …)
- **Applications**: Risk assessment, adaptation option appraisal, story lines ,…
- Support for **decision**-making

Economics of Climate Adaptation

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

→ http://www.wcr.ethz.ch/research/casestudies.html

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

Many users and partners (logo style & size arbitrary, non-exhaustive)

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Federal Department of Home Affairs FDHA
Federal Office of Meteorology and Climatology
MeteoSwiss

u b
b UNIVERSITÄT BERN

MSCI | CARBON DELTA
An MSCI Company

CelsiusPro
Professional Weather Protection

KFW

DWD
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Receipt

ADB ASIAN DEVELOPMENT BANK

NCAR UCAR
National Center for Atmospheric Research

THE WORLD BANK

The Nature Conservancy

Universidad Católica de El Salvador UNICAES
"La Ciencia sin Moral es Vana"

iDMC internal displacement monitoring centre

PIK
Potsdam-Institut für Klimafolgenforschung

Frankfurt School of Finance & Management

InsuResilience
Solutions Fund

United Nations University

THE GLOBAL GOALS
For Sustainable Development

ISIMIP
Inter-Sectoral Impact Model Intercomparison Project

CCRIF
The Caribbean Catastrophe Risk Insurance Facility

THE ROCKEFELLER FOUNDATION

Columbia University in the City of New York

Atlantic Council | Adrienne Arsht-Rockefeller Foundation Resilience Center

NGFS
Central Banks and Supervisors Network for Greening the Financial System

Up-coming talks

- Case study
- Uncertainty
- Forecasting
- WildFire
- Heat-mortality
- Multi-hazard

Selected CLIMADA publications

- Aznar-Siguan, G. and Bresch, D. N.: CLIMADA v1: a global weather and climate risk assessment platform, 12, 3085–3097, https://doi.org/10.5194/gmd-12-3085-2019, 2019.
- Bresch, D. N. and Aznar-Siguan, G.: CLIMADA v1.4.1: towards a globally consistent adaptation options appraisal tool, 14, 351–363, https://doi.org/10.5194/gmd-14-351-2021, 2021.
- Eberenz, S., Stocker, D., Röösli, T., and Bresch, D. N.: Asset exposure data for global physical risk assessment, 12, 817–833, https://doi.org/10.5194/essd-12-817-2020, 2020.
- Eberenz, S., Lüthi, S., and Bresch, D. N.: Regional tropical cyclone impact functions for globally consistent risk assessments, 21, 393–415, https://doi.org/10.5194/nhess-21-393-2021, 2021.
- Kropf, C. M., Ciullo, A., Otth, L., Meiler, S., Rana, A., Schmid, E., McCaughey, J. W., and Bresch, D. N.: Uncertainty and sensitivity analysis for probabilistic weather and climate risk modelling: an implementation in CLIMADA v.3.1., 2022.
- Lüthi, S., Aznar-Siguan, G., Fairless, C., and Bresch, D. N.: Globally consistent assessment of economic impacts of wildfires in CLIMADA v2.2, 14, 7175–7187, https://doi.org/10.5194/gmd-14-7175-2021, 2021.
- Kropf, C. M., Ciullo, A., Otth, L., Meiler, S., Rana, A., Schmid, E., McCaughey, J. W., and Bresch, D. N.: Uncertainty and sensitivity analysis for probabilistic weather and climate risk modelling: an implementation in CLIMADA v.3.1.0, 1–32, https://doi.org/10.5194/gmd-2021-437, 2022.

Thank you!