BEYOND POPULATION EXPOSURE

ACCOUNTING FOR **VULNERABILITY DYNAMICS** IN GLOBAL-SCALE CLIMATE RISK ASSESSMENTS

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GLOBAL-SCALE CLIMATE RISK ASSESSMENTS

According to the IPCC's risk framework (Fig 1), climate change risks result from the interaction of climatic hazards, exposure to these hazards, and vulnerability of the exposed elements[1]. Thus far, global-scale risk assessments have focused on assessing exposure to climatic hazards and have largely neglected vulnerability. If accounted for in such assessments, vulnerability is often characterized with the help of depth-damage functions, which are unsuitable for characterizing social vulnerability of potentially exposed population groups.

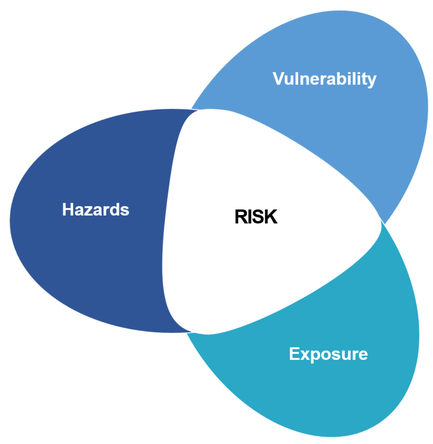


Fig 1 The IPCC risk framework (modified from Ref [1])

VULNERABILITY IS DYNAMIC

Social vulnerability changes in time and space with evolving socioeconomic development[2]. The uncertainty related to these dynamics can be explored with the help of socioeconomic scenarios such as the Shared Socioeconomic Pathways (SSPs). The SSPs provide national-level projections of key vulnerability variables at the global scale until 2100, including population by age, gender, and education[3], as well as GDP[4] (Fig 2).

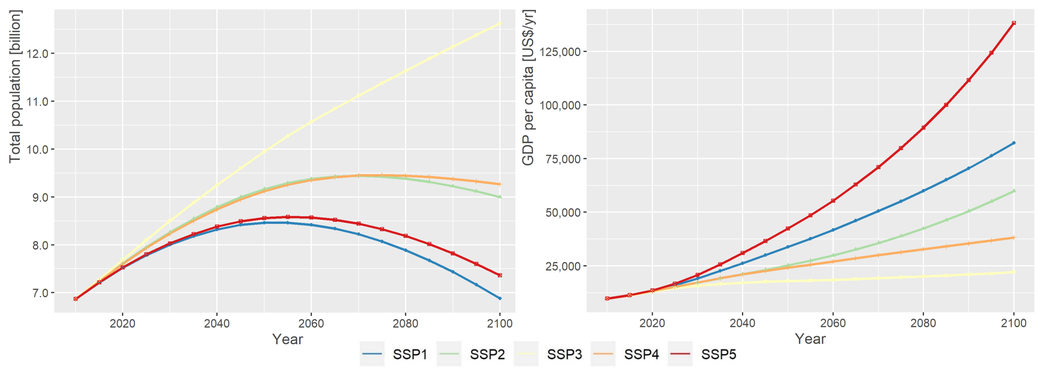


Fig 2 Global-scale population[3] and GDP per capita[3,4] projections of the five SSPs until 2100

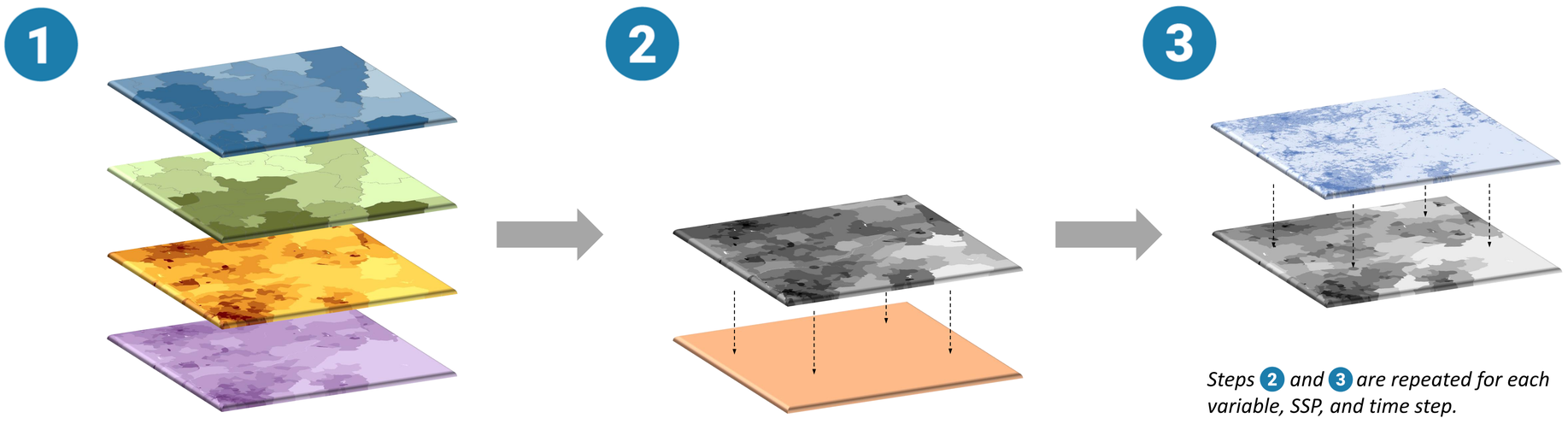
SPATIAL VULNERABILITY PROJECTIONS

To allow for assessing future changes in social vulnerability spatially, we develop spatially explicit population projections by age, gender, education, and GDP for each SSP and 10-year time step until 2100. Our projections are grounded in global-scale, high-resolution spatial datasets of these vulnerability variables that have been assembled from (micro-)census and household survey data[5,6]. For producing these projections, which will be available at a spatial resolution of 30 arc seconds (~1 km at the equator), we follow a three-step process:

1. We analyze the *observed spatial patterns* of each vulnerability variable per country on administrative unit level.
2. We *spatially distribute* the national-level SSP projections of each vulnerability variable based on the observed patterns.
3. We further downscale the subnational vulnerability projections with the help of *raster-level population projections*[7].

VARIABLES

- INCOME
- EDUCATION
- AGE
- GENDER



A MAJOR STEP FORWARD

We develop a set of **vulnerability projections** that account for the spatial and temporal dynamics of social vulnerability and can therefore be used in a wide range of global-scale risk assessments.

Our projections allow for the **integration of all risk drivers** – hazard, exposure, and vulnerability – in assessing the uncertainties related to future climate risks.

We expect these projections to be particularly useful for establishing global **vulnerability hotspots** where vulnerable population groups such as the elderly or people with low income levels are concentrated, as well as for exploring how these hotspots change over time, depending on the respective SSP.

The results of assessments using these projections can provide more refined **insights for decision-making**, for instance in the context of adaptation planning, as strategies can be steered towards vulnerability hotspots.

[1]IPCC 2014: Summary for policymakers. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. [2]Cardona et al. 2012: Determinants of risk: exposure and vulnerability. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK, and New York, NY, USA,pp. 65-108. [3]KC & Lutz 2017: The human core of the shared socioeconomic pathways: Population scenarios by age, sex and level of education for all countries to 2100. Global Environmental Change, 42, 181-192. [4]Dellink et al. 2017: Long-term economic growth projections in the Shared Socioeconomic Pathways. Global Environmental Change, 42, 200-214. [5]Center for International Earth Science Information Network - CIESIN - Columbia University, 2018: Gridded Population of the World, Version 4 (GPWv4): Basic Demographic Characteristics, Revision 11. NASA Socioeconomic Data and Applications Center (SEDAC), Palisades, NY. [6]Smits & Permanyer 2019: The subnational human development database. Scientific data, 6(1), 1-15. [7]Merkens et al. 2016: Gridded population projections for the coastal zone under the Shared Socioeconomic Pathways. Global and Planetary Change, 145, 57-66.

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Poster link: