

This thesis investigates the impacts of climate change on human well-being and economic systems through a multidimensional and uncertainty-aware framework. In contrast to most of the literature focusing on aggregate income effects from mean temperature, this thesis argues that such approaches underestimate the true costs of climate damages by neglecting broader dimensions of human development and the complex dynamics of climate variability, extremes and hazards.

The thesis advances the empirical literature in three key directions, which compose its chapters. First, it demonstrates that climate change significantly affects all components of human development, notably income, health, and education, revealing substantial and more widespread impacts than those identified by GDP-based assessments alone. Second, it highlights persistent and long-lasting consequences of climate overshoot for regional economic systems and human welfare. Third, it advances the literature on long-lasting climate hazards by providing a dynamical assessment of drought's effects on regional economies in Europe.

Across all studies, it incorporates multiple layers of uncertainty, including socio-economic pathways and climate variability, to provide a comprehensive and policy-relevant assessment of future risks.

The findings indicate that a significant share of projected global human development gains may be eroded under unabated climate change, with adverse impacts observed across nearly all regions. If the global mean temperature were to overshoot and return to 1.5 or 2 degrees above preindustrial levels, only part of the lost development would be recovered. Finally, accounting for the dynamical and cumulative effects of multi-year events, such as droughts, highlights the risks of approaching 2 degrees of warming. For instance, in Europe, recent events could double their average impact.

By integrating multidimensional welfare metrics, extreme-event dynamics, and uncertainty analysis, this thesis contributes to a more complete and temporally realistic accounting of climate impacts. The results underscore the importance of moving beyond income- and mean-temperature-centric evaluations and provide a stronger empirical basis for climate policy aimed at safeguarding human development in a changing climate.