Systems Analysis for Reducing Footprints and Enhancing Resilience
16-17 November 2022
Vienna, Austria

International Institute for Applied Systems Analysis
IIASA www.iiasa.ac.at

Global scenarios of access to basic residential cooling and adaptation to heat stress

Alessio Mastrucci*, Edward Byers, Shonali Pachauri, Narasimha Rao, Bas van Ruijven

*Corresponding author. Email: mastrucc@iiasa.ac.at

Introduction

Heat stress is a growing concern affecting health and well-being of populations worldwide. Air-conditioning (AC) can provide relief from high temperatures, but can entail high electricity demand and emissions. Future access to basic cooling is not only key for heat stress adaptation, but it also has important linkages with climate change mitigation and sustainable development goals.

We assess the evolution of the global residential "**cooling gap**" - the extent of population lacking access to basic cooling where needed - for the Shared Socioeconomic Pathways SSP1-3, and estimate minimum energy required for bridging this gap for the global South.

Methods

We use the bottom-up modelling framework **MESSAGEix-Buildings** (Mastrucci et al., 2021) to project AC access and energy demand for space cooling.

We calculate **cooling gaps** as the difference between the population requiring cooling for basic thermal comfort and the population with access to cooling (Mastrucci et al., 2019), and **minimum energy requirements** according to previously identified decent living standards (Kikstra et al., 2021).

Results: cooling gap projections

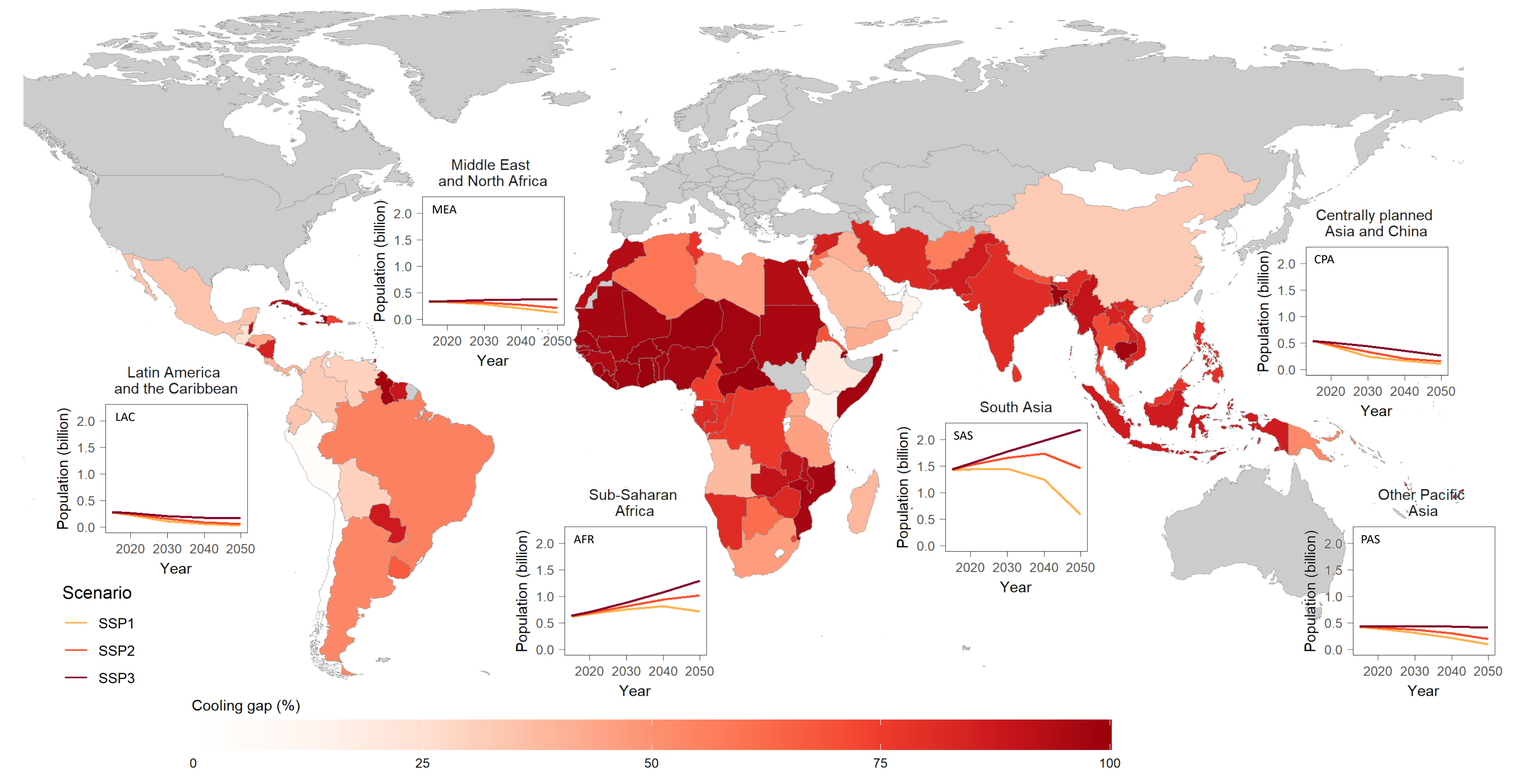


Figure 1. Map: Share of population lacking access to cooling where needed (cooling gap) in 2015. **Line plots:** evolution of the cooling gap for different regions of the global South in SSP1-3.

Cooling gap in 2050:

1.9 (SSP1) to **5.1** (SSP3)

billion people

without access to basic cooling where needed in the global South

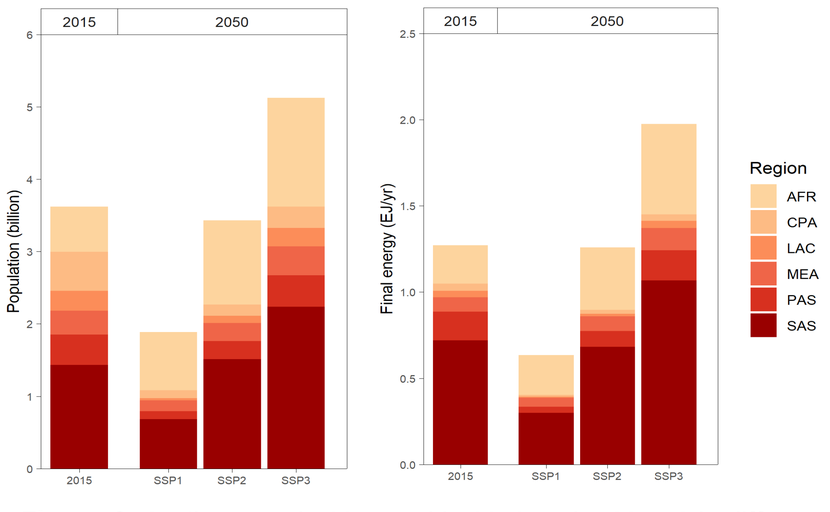


Figure 2. Cooling gaps in 2015 and in 2050 under SSP1-3 in different regions of the global South. **Left:** population affected by the gap. **Right:** total final energy demand to fill the gap under current climate.

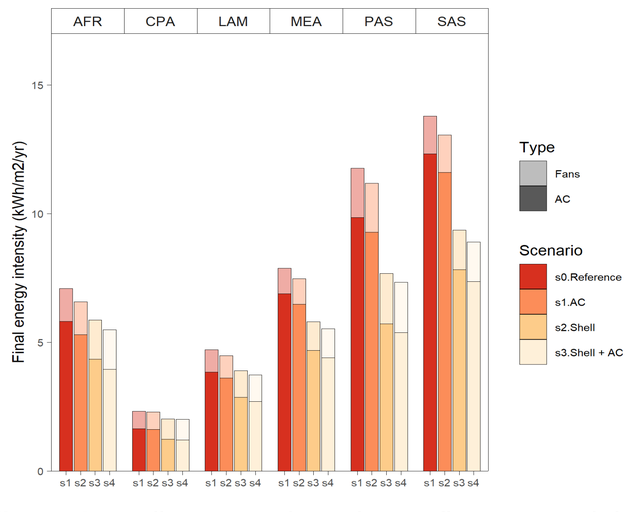


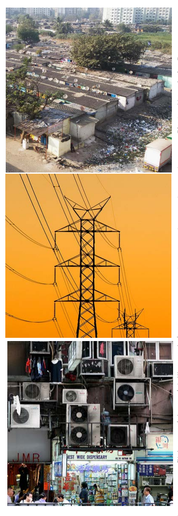
Figure 3. Cooling energy intensity per floorspace unit in different regions under current climate and different **technology scenarios**: **S1.** Reference; **S2.** Improved AC; **S3.** Improved building shell; **S4.** Combined S2 and S3.

Conclusions

Our results show that, despite improved AC access, **cooling gaps will persist in all considered SSPs**, with 1.9 billion (SSP1) to 5.1 (SSP3) billion people lacking access to basic thermal comfort by 2050. Cooling gaps are severe in many regions of the global South, especially in South Asia and Sub-Saharan Africa.

Technological improvements can reduce average energy requirements up to one-third while decreasing the need for active cooling, and can contribute to advancing multiple sustainable development goals.

Strategies to reduce the cooling gap



Energy-efficient and affordable housing

Electrification

Efficient, affordable cooling technologies

References

Kikstra, et al. (2021) Decent living gaps and energy needs around the world. Envron.Res.Lett.

Mastrucci, et al. (2019) Improving the SDG energy poverty targets: Residential cooling needs in the Global South. Energy Build.

Mastrucci, et al. (2021) Global scenarios of residential heating and cooling energy demand and CO2 emissions. Clim. Change.

Acknowledgments: This work received funding from the European Union's Horizon 2020 research and innovation programme under grant agreements no. 821124 (NAVIGATE) and from the SHAPE project, which is part of AXIS, an ERA-NET initiated by JPI Climate, and funded by FORMAS (SE), BMBWF/FFG (AT), DLR/BMBF (DE, Grant No. 01LS1907A-B-C), NWO (NL) and RCN (NO) with co-funding by the European Union (Grant No. 776608).