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Limits to adaptation strategies for heat impacts on rural labors filtered through stabilized climate mitigation scenarios.

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With global warming, increased heat stress will substantially impact the rural labor force. Understanding and quantifying this impact is difficult, especially due to regional differences: Does the temperature increase? Is there more solar exposure? Does humidity respond non-linearly with respect to temperature changes? Furthermore, humans are resourceful, and local environments could provide adaptation methods to decrease heat impacts.

A policy-relevant assessment in the context of the Paris Agreement is even more difficult with existing CMIP-type simulations with prescribed greenhouse gas trajectories that lead to a different and often non-stable warming for each model. To resolve the impacts climate mitigation and adaptation on heat stress on warming levels with specific relevance for the Paris Agreement, we use the Community Earth System Model (CESM2) driven by emissions from the Adaptive Emissions Reduction Approach (AERA) to generate climate mitigation scenarios stabilized at 1.5°C, 2.0°C and 3.0°C of global warming.

One form of adaptation to heat stress impacts is to use the local environment for cooling. Within CESM2, we compare the direct and indirect exposure to solar radiation within the vegetated canopy as an inexpensive form adaptation. To diagnose the heat stress conditions we use the International Organization for Standardization (ISO) 7243, the Wet Bulb Globe Temperature (WBGT), realized by first principles representation of the globe, dry bulb, and natural wet bulb thermometers utilizing CESM2's temperature, humidity, winds, and radiation. The WBGT values are transformed into labor capacity using standardized algorithms (e.g. NIOSH or Lancet) and the above canopy (no adaptation) and below canopy (with adaptation) labor capacity are directly compared to each other.

We show that the potential to adapt by using the local environment for cooling is not uniform

across regions. For example, evaluating the hottest seasonal period (defined as a local summer), at the 3.0°C mitigation scenario in equatorial Southeast Asia, adaptation can save up to 50% of total labor capacity losses. However, in northern South Asia, adaptation saves only 10% of the seasonal labor capacity losses. These results demonstrate that rural laborers in some locations may have limited capacity to adapt to differing global mitigation strategies and may require mechanical cooling or other expensive forms of adaptation.