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The energy and infrastructure costs associated with controlling heat stress in Africa under climate change

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Heat stress is the inability of a person to cool themselves sufficiently to maintain a healthy body temperature. High temperature and water vapour pressure reduces the efficacy of sweating and can lead to a dangerous build-up of body heat. We use two metrics, Apparent Temperature and Humidex to calculate heat stress in both present and future climates. Both Apparent Temperature and Humidex are functions of temperature and water vapour pressure.

We use an ensemble of CORDEX-Africa simulations to estimate the heat stress values during the 1986-2005 control period and at two specific warming levels, +2K (2020-2049) and +4K (2060-2089). The future climate projections are based on simulations performed as part of CMIP5 RCP 8.5K scenario. The increase in temperatures and changes to the precipitation distribution under climate change are projected to increase the intensity of heat stress events in Sahelian Africa and introduce new heat stress events in Northern and Central Africa. Current responses to heat stress include passive and active cooling, however as the intensity of heat stress increases it is expected that the use of active cooling will dominate. The energy system therefore will need to be able to supply more energy to power fans or air conditioning units to prevent heat stress.

The cooling demand to turn a heat stress event into a non-heat stress event is computed and recorded for each grid cell in Africa. This value is then weighted by the population in each grid cell to find the total cooling required to prevent heat stress. We use the TIAM-UCL global optimisation model to find the least-cost future energy system that meets the projected increase in demand and derive the increase in energy system costs, which includes the construction and operational costs of the additional generation capacity. The increase in energy costs to prevent heat stress in Africa is found to be 0.03% of the continental GDP by 2035 and 0.05% by 2075.