Energy for adaptation
Connecting the Paris Agreement with the Sustainable Development Goals

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Increased effort to cope with the rapidly emerging impacts of climate change is urgently needed. Whether **adaptation bears the risk of inducing a negative feedback loop** through its energy requirements needed to spread benefits to society has not been investigated.

We examine **139 Nationally Determined Contributions** submitted by world governments under the Paris Agreement with the aim of identifying the **adaptation options associated with energy use** and of defining energy use for adaptation.

We **define energy for adaptation** as those adaptation strategies that most directly affect energy use according to either of the following criteria:

1) Are energy-intensive or relate to energy-intensive sectors
2) Are a precondition for access to basic energy services
3) Require access to energy to spread benefits and reach targeted population
4) Can save energy directly or indirectly, by reducing the use of other resources that would require energy

Water

Desalination	ANTIGUA&BARBUDA: Increase seawater desalination capacity by 50% above 2015 levels by 2025.
Irrigation	UGANDA: Expand the use of off-grid solar systems to support value addition and irrigation.
Water distribution	GAMBIA: Use of renewable energy for lifting water from wells and boreholes.
Water conservation & improved efficiency	IRAQ: Water use efficiency in distribution network and water consumption meters.
Water recycling & reuse	SINGAPORE: Use advanced membrane technologies to purify reclaimed and treated water, making the water ultra-clean and safe to drink.
Water harvesting & groundwater recharge	MOROCCO: Artificial replenishment of groundwater tables.
Efficiency in irrigation	JORDAN: Introduce water saving technologies such as drip, micro-spray, and night irrigation.

Living conditions

Heating & Cooling	JORDAN: Expand the use of solar cooling in commercial and industrial facilities.
Water heating	SEYCHELLES: Promote the use of solar water heating and cogeneration for hot water in hotels.
Building standards	MALAWI: Develop and implement climate related building codes to account for climate change.

Food

Livestock	MOLDOVA: Improve ventilation and air conditioning systems in livestock farms.
Food storage	ETHIOPIA: Implement methods that prevent deterioration of food and feed in storage facilities.

Energy efficieny & Renewable energy

Energy efficiency	SWAZILAND: Reduced vulnerability to climate change through energy efficiency.
Renewable energy	ETHIOPIA: Expand electric power generation from geothermal, wind and solar to minimize the adverse effects of droughts on hydroelectricity.

Health

Medical services	MALAWI: Build capacity to diagnose, prevent and control climate-sensitive diseases. Construction of health centers to improve access to health facilities within a walking distance.
Early warning systems	JORDAN: Early warning systems to protect health from the potential impacts of climate change.

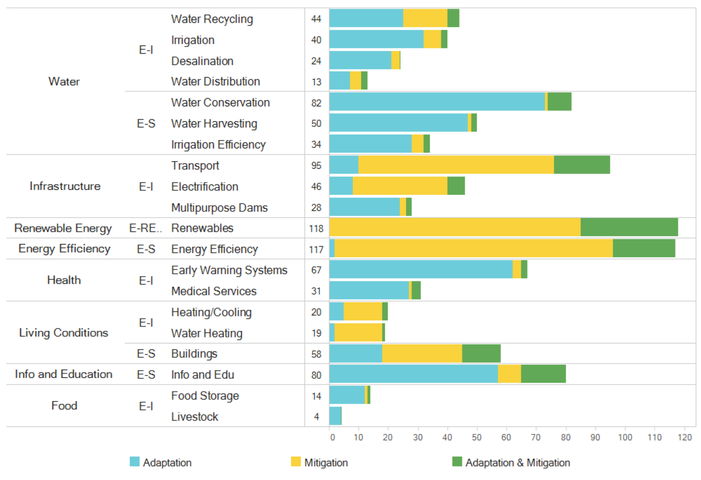
Infrastructure

Multi-purpose dams	JORDAN: Dams for storing floodwaters during wet winter seasons and releasing water during the summer seasons.
Rural electrification	BANGLADESH: Key areas to address adverse impacts of climate change include Increased Rural Electrification.
Transport	MOLDOVA: Promote the use of heat-tolerant streets and highways landscape protection.

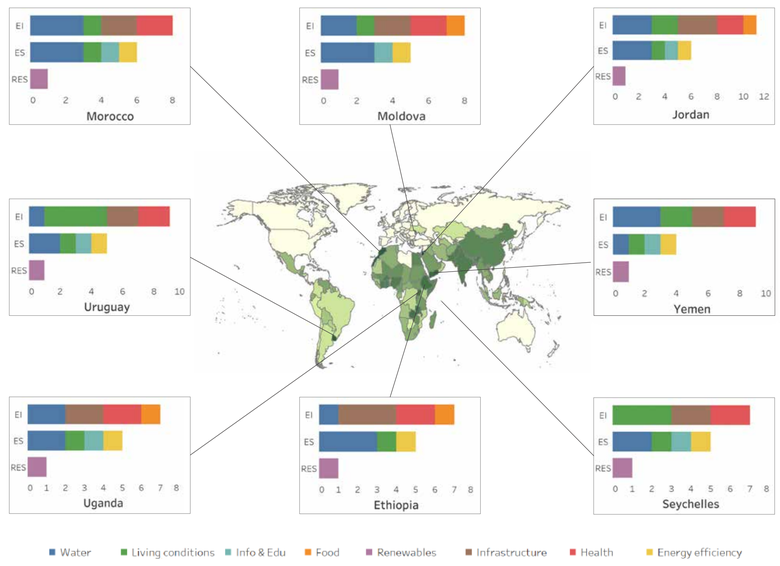
Information & education

Information & education	MALDIVES: Improve climate data collection, management and forecasting is a critical gap area. Education, training and public awareness is a key priority.

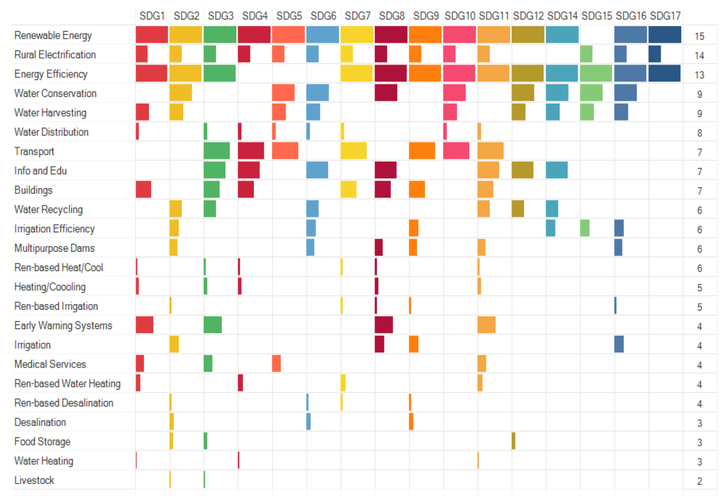
Frequency of energy for adaptation options



Geographic distribution of energy for adaptation options



Contribution of energy for adaptation options



The energy-related adaptation options emerging from the (I)NDC plans can be grouped into the 8 major sectors shown in the barchart. One third of energy for adaptation measures are related to the water sector and infrastructure.

Renewable energy sources and energy efficiency measures account for 12% of all the 990 options identified across the 138 countries.

EI measures refer to energy increasing options, ES are energy saving while RES options use renewables.
The SDGs that would benefit the most from the implementation of the adaptation strategies highlighted in our work are SDG 11, SDG2, SDG3.

Building on an extended review of the literature carried out by the authors in this paper, we associate each of the energy for adaptation options identified in the first step, to the SDG targets or indicators to which it contributes, focusing on positive linkages.

Directions for future research

The (I)NDCs submitted under the Paris Agreement provide a unique opportunity to investigate the energy needs of adaptation, as well as the implications for sustainable development, two topics that has received low recognition in the literature.

Quantifying the energy requirements of the adaptation options identified in this work, accounting for the great heterogeneity across space and technology would provide valuable input for climate policy scenario analysis.

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