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Making SDGs Work for Climate Change HOTSPOTS

by
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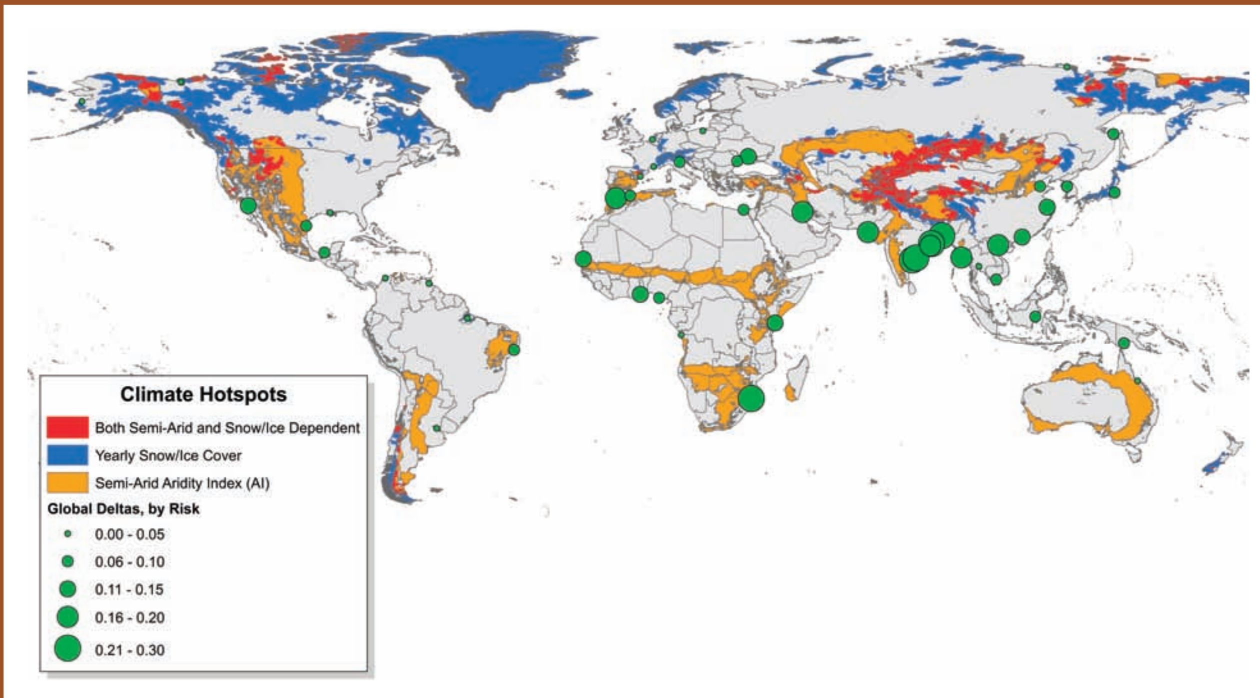
The impacts of climate change on people's livelihoods have been widely documented.[1] It is expected that climate and environmental change will hamper poverty reduction, or even exacerbate poverty in some or all of its dimensions. Changes in the biophysical environment, such as droughts, flooding, water quantity and quality, and degrading ecosystems, are expected to affect opportunities for people to generate income. These changes, combined with a deficiency in coping strategies and innovation to adapt to particular climate change threats, are in turn likely to lead to increased economic and social vulnerability of households and communities, especially amongst the poorest.

Perito Moreno Glacier in Patagonia, Argentina. Melting glaciers, a consequence of global warming, are one of the key contributing factors to sea level rise.

The impacts on communities and households will vary among social–ecological systems. De Souza et al.[2] identify three main types of climate change hotspots, which they define as a combination of areas where climate change signals overlap with vulnerable communities. The climate change hotspots are often interconnected and affect socioeconomic development. De Souza et al.[2] identified (1) deltas in Africa and South Asia, (2) semi-arid regions in Africa and parts of Asia, and (3) glacier- and snowpack-dependent river basins in the Himalayas. We consider these typologies as being relevant globally, covering a large portion of the world (Figure 1). These hotspots are areas that generally cut across administrative boundaries and have limited political representation. As a result, they are not often a focus of direct policy action, which has important implications for sustainable development and the well-being of local populations. In this commentary we propose climate change hotspot indicators that have a regional scope and complement subnational and national indicators. In doing so, this article contributes toward the requirements of the Sustainable Development Goals (SDGs), the Paris Agreement of the United Nations Framework Convention on Climate Change (UNFCCC), and the Sendai Framework for Disaster Risk Reduction (SFDRR) of the United Nations Office for Disaster Risk Reduction (UNISDR). The United Nations 2030 Agenda for Sustainable Development,[3] the Paris Agreement of the UNFCCC,[4] and SFDRR of the UNISDR[5] all acknowledge the imminent challenges and threats that climate change poses to human societies and recognize the interlinkages between resilience to climate change and sustainable development.[6]

Deltas, the first category of climate change hotspots, cover only 1% of the

Figure 1. Climate change hotspots requiring focused attention using the SDG indicator framework.



Note. The three major types of climate hotspots used in the proposed multiscale SDG framework are shown, including (1) major global delta locations (green dots),[8] varied according to contemporary risk due to sea-level rise and anthropomorphic factors as outlined by Tessler et al.[13]; (2) semi-arid regions (orange) where an Aridity Index (AI) falls between 0.2 and 0.5; (3) snow and ice runoff-dependent basins (blue), defined as basins with average yearly snow/ice cover ≥25%; and (4) overlapping areas with both semi-arid AI and snow/ice runoff dependency (red).

earth's area, but are home to over 500 million people.[7] Deltas are dynamic systems that are characterized by low elevation, frequent flooding, and high biodiversity, and they benefit from high agricultural and fisheries productivity, contributing to regional and global food security.[9] Climate change is leading to higher sea levels, to changes in major river discharges, and likely to increases in the frequency of cyclones and coastal storms in many susceptible areas. Collectively, this increases the risk of floods and salinization, often intensified by natural and human-induced land subsidence, and will affect coastal ecosystems and the services they provide.[9,10] *Semi-arid regions* are home to more than 2 billion people, most of them living in developing countries.[2] These regions are sensitive to climate change due to the harsh climatic conditions already experienced, and are particularly vulnerable to degradation and desertification,[11] with African dryland populations being most at risk due to the high population density in some localities and low-input farming systems.[12] Most dryland areas are projected to warm more quickly and experience greater relative increases in aridity than more humid regions, exacerbating these existing climatic sensitivities. Finally, *glacier- and snowpack-dependent river basins* are home to more than one-sixth of the world's population, or more than 1.2 billion people.[2] They face severe challenges in a warmer climate. These include declines in both seasonal snowpacks and glaciers, and changes in glacier and snowpack melting, and thus water release, putting additional pressure on dams and groundwater resources. Together, the threats to all three of these climate hotspots are exacerbated by projected high levels of population growth, directly affecting the lives of local people, and triggering the potential for increased population movement. The climatic impact on these hotspots calls for a substantial investment toward their integrated

We propose climate change hotspot indicators that have a regional scope and complement subnational and national indicators.

socioecological management, grounded on a better understanding of the biophysical and socioeconomic processes and trade-offs underpinning their dynamic ecosystem service provision, and sustainability.

Given the importance of climate hotspots to societal and ecological well-being, failing to adequately monitor the environment of these regions may impede their developmental progress and also hamper the achievement of wider SDGs. It is also likely to hamper the SDG accountability framework, which requires monitoring not only at the global level, but also at national, regional, and local scales. The choice of key environmental indicators will reflect climate and environmental priorities for 2030, and has direct implications for financing for development. Here we show the limitations of, and the gaps within, the currently proposed SDG indicator framework, and offer a complementary approach that enables better tracking of development progress in these key climate hotspots, focusing on environmental indicators. Hence, this piece contributes to progress in achieving the SDGs and improving people's well-being.

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A Multiscale SDG Indicator Framework

The human-development challenges in climate hotspots are addressed in a number of ways under the recently endorsed 2030 Agenda for Sustainable Development[3] and accompanying indicator framework.[14] First, there is a specific goal on climate change—SDG 13—that aims to "take urgent action to combat climate change and its impacts." This broad goal is subdivided into five specific targets, each focusing on different responses to climate-induced challenges. Additionally, targets and indicators relevant to climate hotspots are included under other "non-climate" goals, particularly covering different social and economic dimensions. The proposed indicator framework has a number of potential pitfalls.[15] Politically, a failure to specifically recognize the importance of investing in geographically explicit climate hotspots carries a risk of downplaying the significance and developmental impacts of these regions. Operationally, while the priorities and implementation practices of local authorities, national governments, and regional organizations are likely to differ, ensuring coordinated strategies between all institutions at all levels is key to effective program execution. The current approach fails to explicitly consider the overall regional risks faced by climate change hotspots that cross political boundaries and require accountability mechanisms at different implementation scales. The current approach outlined by the United Nations can be strengthened by ensuring that localized indicator sets are relevant and available to broader policy frameworks as well as the SDGs. Stratifying indicators into groups of high-level political and detailed technical indicators as proposed by Davis et al.[16] could be part of a solution, but would need to be complemented by an integrated framework that would incorporate indicators specifically relevant to key regions, such as climate hotspots.

A potentially powerful solution to avoid a development impasse resulting from omitting indicators critical to regions such as climate hotspots is to translate the existing SDG framework into an *integrated multiscale indicator framework*, which would (1) reflect the key developmental challenges found in all of these climate hotspots, and (2) allow monitoring of change at different

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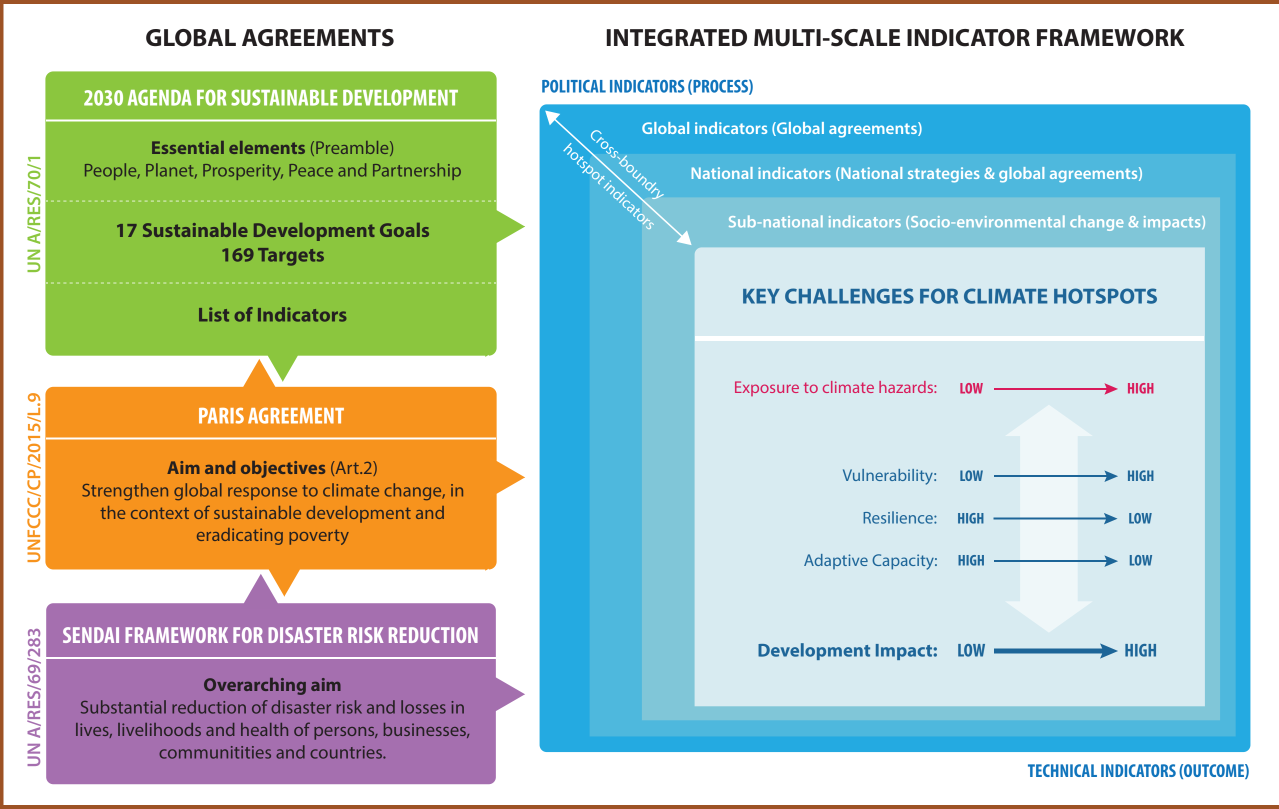
Semi-arid and arid lands of West Africa pose challenges for cotton cultivators.

Figure 2. Proposed multiscale SDGs framework for climate hotspots that aligns objectives of the UN 2030 Agenda for Sustainable Development, the UNFCCC's Paris Agreement, and the Sendai Framework for Disaster Risk Reduction.



Note. Key developmental challenges of climate hotspots and development progress are monitored through additional cross-boundary indicators. Political (process) indicators and technical (outcome) indicators are applied for measuring progress and developmental outcomes at different levels of analysis.

levels of analysis, including for cross-boundary regions (Figure 2). At the global level, the main indicators would reflect the key international priorities in terms of combating worldwide consequences of climate change; at the sub-national level, the framework would be tailored to the requirements of the country. Here, in addition to measuring such climatic and environmental phenomena as temperature rise, precipitation change, and sea-level rise, the developmental priorities should consider the needs of the least developed countries (LDCs) and allow for tracking of resources for development. National indicators should be linked directly to countries' poverty-reduction strategies and tie up with the SDG targets by either adding to the existing list of indicators or replacing some of the lower ranked indicators. Cross-boundary regional indicators should mirror the developmental priorities in the climate hotspots, which have critical implications beyond the areas where they are located. The development and monitoring of these indicators could be coordinated by regional intergovernmental organizations, such as the East African Community and the South Asian Association for Regional Cooperation.

Filling the Indicator Gaps

In order to fill the indicator gaps with regard to links and synergies between adaptation and resilience to climate change and sustainable development, we propose a maximum of five technical indicators that focus specifically on measuring environmental impacts for each of the three categories of climate change hotspots. These are indicators that are more detailed than some proposed for the SDGs[14] or that address new dimensions altogether. A suggested classification and proposed impact indicators are presented in Table 1. Thus, for populations living in delta regions, for example, the main threats are associated with relative sea-level rise reflecting a combination of a loss of elevation (subsidence) and climate-induced global sea-level rise. Subsidence, mainly due to human activities such as groundwater

Climate change induced sea level rise and subsidence contributes to flooding and tidal surges in delta regions. Photo shows flooded households in the Indian part of the Ganges-Brahmaputra Delta.

runoff. Modifications of current indices to account for the different time scales of seasonal water storage in snowpacks and behind dams, versus longer-term storage in glaciers and groundwater, can be used to capture changes. For all three types of hotspots, a composite checklist covering institutional, infrastructure, and informed decision making is needed to assess the overall water security of a region.[13]

For multiple climate change hotspots, such as mountainous semiarid areas, a combination of relevant indicators should be adopted. In regions where local populations may be affected by a range of hazards, analysts should examine which indicators are most relevant for the compound effects, and combine the indicators by applying appropriate weighting systems. Because the environmental impacts affecting climate hotspots are directly and indirectly associated with socioeconomic

pumping, oil extraction, oxidation of drained organic soils, and reduction of sediment from upstream, is in some areas more important than climate-induced sea-level rise.[8] The specific human-development challenges resulting from relative sea-level rise include salinity intrusion (soil and freshwater salinization), land erosion, increased risk of flooding, and increased incidence of waterborne diseases. For semiarid areas, changes in temperature are likely to lead to increased atmospheric evaporative losses, as well as heat stress, and together with changes in precipitation will result in greater land degradation and loss of water supply. For glacier- and snowpack-dependent river basins, both a decline in the amounts of seasonal snowpacks and glaciers and faster melting drive changes in the seasonality of essentially all components of the terrestrial water cycle. This includes earlier runoff and a longer growing season in mountains, potentially driving more evapotranspiration and less

Coastal embankments in the Indian part of the Ganges-Brahmaputra Delta region protect low lying land and vulnerable households.

Table 1. Key Challenges of Climate Hotspots, Resulting Developmental Impacts, and Proposed Technical Indicators for Measuring Cross-Boundary Environmental Impacts

Climate Hotspots	Key Challenge	Developmental Impacts and Proposed Impact Indicator(s)
Deltas	Global warming-induced sea-level rise Compaction and vertical land movement (loss of land elevation—subsidence) Changes in water and sediment flows	*Inundation by coastal storms* Indicators: Percent of delta inundated in a 1-in-100-year coastal flood event—under consideration of different adaptation levels and options. *Inundation by river floods* Indicators: Percent of delta inundated in a 1-in-100 year river flood event—under consideration of different adaptation levels and options. *Salinity intrusion* Indicators: Percent of delta area within the 4 ppt surface salinity isohaline.[17,18] *Erosion* Indicators: Percent of delta coastline and river network affected or threatened by riverbank and coastal erosion (allowing for accretion and deposition). *Water quality for aquatic ecosystems* Indicators: Percent of deltaic river and canal network area with dissolved oxygen <3 mg/L.[19]
Semi-arid areas	Rainfall variability and uncertainty Temperature rise	*Increased drought risks* Indicators: Drought risk index measured as percent change in future precipitation relative to the past; Palmer Drought Severity Index; Standardized Precipitation and Evaporation Index (SPEI). *Increased flood risk* Indicators: Area affected by a 1-in-100 year flood event (%); percent change in precipitation intensity-duration-frequency curves; percent change in runoff relative to the past. *Changing water supply/resources* Indicators: Relative magnitude of water supply and demand (including human and environmental needs); Multivariate Standardized Reliability and Resilience Index (MSRRI). *Land degradation* Indicators: Area (km^2) and percent of land area affected by land degradation; heat stress index—such at those used by the ETCCDMI or Alexander et al. (2006).[20]
Glaciers- and snowpack-dependent river basins	Decline in glacier extent and thickness Shifts in precipitation patterns Decline in seasonal snowpack extent and water content Changes in streamflow seasonality and flood frequency	*Insecure water supply* Indicators: Depletion indices for mass balance of glaciers; shifts in composition of total precipitation from snowfall to rainfall; monsoon onset, duration, and intensity. *Seasonality of river runoff* Indicators: Shifts in streamflow hydrographs and in monthly and annual total flows; increases/decreases in runoff from increased glacial melt. *Glacier melt-related risks* Indicators: Growth in number and extent of Glacial Lakes; occurrence of Glacial Lake Outburst Floods (GLOFs). *Increased flood risk* Indicators: Percent of land area affected by a 1-in-100-year flood event; percent change in precipitation intensity-duration-frequency curves.

development, for example, through changes in occupational structure and impacts on livelihoods and human health, it is critical to develop and adapt an approach that acknowledges the coupled climate and socioecological changes. Countries and regional organizations that focus on tackling developmental impacts of climate and environmental change, such as the Mekong River Commission and the International Centre for Integrated Mountain Development, should take leadership in coordinating efforts for monitoring and evaluating the developmental progress of their regions.

In addition, as some of the proposed indicators in the SDG framework are still flagged as "tier III" at the time of writing (i.e., in need of further development), we call for the international community of experts in climate, water resources, and environmental assessment who focus on quantifying change, and the Inter-agency and Expert Group on SDG Indicators, to work together to ensure that the indicators for climate hotspots reflect the cross-boundary challenges ahead. As some of the climate hotspots are interconnected (e.g., deltas belonging to glacier- and snowpack-dependent river basins, which might also contain a semi-arid region), it is essential to monitor indicators beyond national boundaries. Incorporating the challenges and priorities raised in climate hotspots within the wider SDG agenda and aligning the different global agreements will be critical to enabling inclusive human development and sustainable economic growth in the face of unprecedented climate and environmental change.

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Diminishing mountain snowpacks and forests impacted by climate warming threaten water and food security in multiple semi-arid regions. Photo shows drought impacts on snow and forests in the southern Sierra Nevada, California.

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Climate and environmental change is hard felt in drylands and semi-arid regions in West Africa. Photo shows a vulnerable household during the dry season which struggles to find sufficient water for all its needs.


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