Use of weather and climate information essential for SDG implementation

David Griggs¹,², Mark Stafford-Smith³, David Warrilow⁴, Roger Street⁵, Carolina Vera⁶, Michelle Scobie⁷ and Youba Sokona⁸,⁹

Owing to a lack of understanding, and data being unavailable, unusable or unsuitable, weather and climate information is currently underutilized in Sustainable Development Goal implementation. Improvements are essential in knowledge brokering, clarifying responsibilities, multi-institutional and multi-stakeholder governance arrangements and research on systemic risks and decisions.

The United Nations’ 2030 Agenda for Sustainable Development is an ambitious plan for “people, planet and prosperity”, aimed at achieving a sustainable future for all. At its core are 17 Sustainable Development Goals (SDGs), the achievement of which is widely affected by weather and a changing climate. To that end, emphasis has been given to delivering weather and climate services, such as identified through the Global Framework for Climate Services’, with information packaged in ways that support timely decision-making.

Decision-making contexts

It is not just the nature of the weather and climate risk matters, but also the decision process and whether decision-makers are resourced, experienced and able to interpret and use the data. Weather and climate impacts deliver various levels of complexity for decision-makers. For example, weather and climate impacts can be relatively direct and simple for decision-makers to interpret and take action on, such as heat waves requiring health warnings (SDG 3) or extreme snow and ice conditions requiring road gritting (SDG 11). Conversely, the impacts can be indirect and harder to infer, such as rainfall and evapotranspiration affecting soil moisture for farming and food security (SDG 2), or changing climate zones affecting insect-borne disease distributions (SDG 3). The impacts can also be systemic, which are usually harder to predict than indirect impacts, such as seasonal effects on the spread of a pandemic such as COVID-19 and consequent economic impacts (SDGs 3, 8).

Considering the state of knowledge and praxis, four categories of decision-making contexts and related responses to the information about weather and climate conditions can be identified, although in practice they do not have hard boundaries (Table 1).

Short term reactions to weather forecasts requiring little processing: where the direct effects of weather are readily understood, there are mature relationships between providers and decision-makers, and decision-makers have the capacity to respond. The short term nature of forecasts and early warning systems allows relatively rapid feedback and learning.

Long term responses to climate change projections requiring limited processing: where adaptation and resilience design and implementation decisions are in sectors that have the capacity to analyse the impacts of longer-term climate change risks, and there is a mature relationship between providers and decision-makers, who may have their own embedded processing capacity. However, the longer timeframes increase uncertainty and the complexity of issues, and the resulting decisions are often plagued by limited learning feedback.

Long term responses to climate change projections requiring substantial further processing: where the relationship between providers and decision-makers is less mature, and decision-makers are less able to use the weather or climate data directly, although in principle it is often known what processing is needed and how to
Table 1 | Engagement and processing needs for climate data in different decision-making contexts

| Decision-making context | Description | Examples | Implications | Need for 2-way engagement, knowledge brokering, data processing | Readiness of technical climate data for use in decision-making | Clarity of roles and responsibilities |
|-------------------------|-------------|----------|--------------|---------------------------------------------------------------|---------------------------------------------------------------|--------------------------------------|
| Short term reactions to weather forecasts needing little processing | Actions on weather forecasts that are easily interpreted by decision-makers with little processing; or processing is well understood and adopted, with quick feedback | Early warning on hours-to-days time frames for cyclones (SDG 11), or processed forecasts of UV or air quality risk (SDG 3); seasonal forecasts of droughts or ocean warming, or processed for famine risks (SDGs 2, 6) | Useful forecasts can be created by meteorologists; engagement aimed at accessibility. | Low | Very high | High |
| Long term responses to climate change projections needing limited processing | Climate change responses where climate outputs are either directly useful to decision-making, or the target sector is sophisticated in its own analysis of raw climate data | Heatwaves where the climate data makes sense directly (e.g. days over 40 °C per year) (SDG 3); or decisions in sectors that are good at processing climate data, such as agriculture and water (SDGs 2, 6), insurance (SDG 8) or energy (SDG 7) | Climate projections can be provided by climate scientists, though guidance on their use in adaptation may be needed. | Medium | High | High |
| Long term responses to climate change projections needing much more processing | Longer term climate change responses where much more processing is needed to fit the target sector’s normal decision-making and business practices | Data on extreme events for infrastructure design where engineers need flood return times or peak flow rates (SDG 9); or in health where vector transmission must be modelled (SDG 3), for cities (SDG 11) or circular economies (SDG 12) | Needs close engagement and (new) bridging institutions everywhere to co-design the research, processing and delivery of useful information, as well as institutions for processing. Support sectoral best practice in lower income countries | High | Low | Low |
| Responses to changing systemic risks needing new forms of information | Decisions on systemic risks where climate data needs major, often poorly understood, processing to help decision-makers see how climate affects diverse sectors, places and times systemically | Acting on changing correlations in space and time, such as crop failures and flooding across continents driving social unrest (SDG 16), or systemic action on climate adaptation and mitigation affecting industry and jobs (SDGs 13, 9, 8), or disasters increasing poverty and inequality (SDGs 1, 10) | Complex, cross-sectoral, local and global institutional partnerships needed to research, project and act on systemic risks from climate and other interacting drivers. Ensure analysis for lower income countries | Very high | Very low (or unknown) | Low |

Table 1 continues...
Enabling action

To improve integration of weather and climate data into SDG-related decision-making, we highlight three key action areas that should be addressed.

Knowledge brokering and engagement: data production and processing capability remains a challenge in many policy spaces, particularly in lower income countries where increased financial and capacity support for meteorological services is needed. However, there additionally needs to be better knowledge brokering, knowledge exchange and engagement between data providers, researchers and decision-makers, for example by utilizing boundary organizations. Levels of engagement depend on context from mostly consultative (where considerable capacity exists), to a greater level of collaborative co-production (of information and interfaces) and deep co-design (to understand the decision needs and define and deliver research on addressing existing and emerging requirements). Issues of equitable access to information and decision-making are crucial to avoid entrenching power imbalances. We therefore recommend that governments and international funding agencies should promote context-appropriate knowledge brokering and boundary organizations and invest strongly in them, building on existing national and international efforts.

Institutions and governance: institutional requirements are also differentially important across decision contexts. Governance and institutional arrangements, even where data provision is mainly by public meteorological services and is relatively simple, are challenging the provision and delivery of effective climate services. The lack of necessary institutional capacity, especially in some lower income countries, is adding to this challenge. Where substantial data processing and tailoring is required, the challenge is the so-called ‘valley of death’ whereby national providers, governments and business each see it as someone else’s responsibility to convert the data into decision-ready form, and so it fails to be converted and fails to be used. The responsibility for undertaking this task is unclear, especially where the benefits are both public and private and there are no accepted standards. Here, new public–private–citizen partnerships could fill this gap, and may or may not also play a knowledge brokering role. Systemic risks are even more challenging, where the crucial task of preparing for these is undermined by a lack of policy and practice coherence among disciplinary and sector-based silos in both public and private bureaucracies. We therefore recommend that governments and international bodies should take the lead in facilitating the establishment of, and investing in, multi-stakeholder institutional and governance arrangements that better integrate knowledge and evidence across the SDG framework and, once roles and responsibilities for such are clearly defined, to ensure the development, processing and availability of decision-ready information for users.

Knowledge needs and research: there are many areas where weather and climate-related risks and how to integrate them in policy and decision-making remain poorly understood. These limits to knowledge and capacity, especially for systemic risks, increase as the impacts become longer term and more system-wide. In all types and in both higher and lower income countries, care must be taken to ensure that weather and climate services do not entrench inequities (SDG 10) and power imbalances. We therefore recommend investment in interdisciplinary research and innovation on systemic climate and weather-related risks and on which forms of cross-temporal and cross-spatial data analysis is needed to inform policy responses in different contexts. Research funders should promote in depth engagement with users and other research funders in setting such research and innovation agendas.

Though not a panacea, weather and climate information is an important component of achieving the SDGs. But current services fail to be sensitive enough to the different decision-making needs; in particular, they fail to deliver information in the right form for long term responses to climate change by sectors that are unused to processing weather and climate data, and fail even more to support decision-makers faced with systemic risks, where co-designed research is needed to understand needs. Improvements in institutional arrangements that assist with knowledge brokering, and a greater focus on tailoring information to decision-making processes, are essential steps towards better SDG outcomes. Special attention must be paid to building the right capacity in lower income countries, in order to avoid entrenching an inequitable status quo.

1. UN. Transforming our world: the 2030 Agenda for Sustainable Development. (United Nations, 2015).
2. Machungu, F., Nyamwana, A., Huime, D. & Stuart, E. Climate information services, integrated knowledge systems and the 2030 Agenda for Sustainable Development. Sustainable Earth 1, 1 (2018).
3. WMO. Global Framework for Climate Services: Progress Report 2009–2019 (World Meteorological Organisation, 2020).
4. Lourenço, T. C., Swart, R., Goosen, H. & Street, R. The rise of demand-driven climate services. Nat. Clim. Chang. 6, 13–14 (2016).
5. Scobie, M. Sustainable development and climate change adaptation: goal interlinkages and the case SIDS. in Dealing with climate change on small islands: towards effective and sustainable adaptation (eds Klöck, C. & Fink, M.) 101–122 (Gottingen University Press, 2019).
6. Scobie, M. Policy coherence in climate governance in Caribbean Small Island Developing States. Environ. Sci. Policy 58, 16–28 (2016).
7. Buzier, J., Jacobs, K. & Cash, D. Making short-term climate forecasts useful: linking science and action. Proc. Natl Acad. Sci. U.S.A. 113, 4597 (2016).
8. Meadow, A. M. et al. Moving toward the Deliberate Coproduction of Climate Science Knowledge. Weather Clim. Soc. 7, 179–191 (2015).
9. Daly, M. & Dilling, L. The politics of “usable” knowledge: examining the development of climate services in Tanzania. Clim. Change 157, 61–80 (2019).

Competing interests
The authors declare no competing interests.