CYBER-STRUCTURES FOR SUSTAINABLE DEVELOPMENT

POLITICAL DIALOG

Sustainable development is becoming a central tenet of legal international frameworks, agreements and recommendations. It is central to the Paris Agreement, which focuses on collective reductions of CO_2 emissions; the Nagoya Protocol, for access and benefit-sharing to protect biodiversity; and the vision to completely stop soil erosion and achieve Land Degradation Neutrality (LDN) by the year 2030. These three goals are based respectively on the United Nations (UN) Conventions for Climate Change (UNFCCC), Biodiversity (UNCBD) and Desertification (UNCCD), adopted in 1992 at the UN Conference in Rio de Janeiro. In addition to these conventions, the Sendai Framework also acts as an international non-binding agreement to improve the resilience of nations and communities to natural disasters.

The political discourse around sustainability is supported by evidence from the scientific community. This evidence stems from both ground and remote observations as well as numerical model simulations of the Earth. Although data for these observations and simulations is freely available, and despite dramatic computing advances, relatively few people have both the resources and skills to access and interpret this data. There is a risk for climate science to remain in the hands of a minority, denying large swaths of the population the benefits of evidence-based planning and decision-making.

BIG DATA PROBLEM

Independently of the political dialogue, the scientific communities attempting to understand climate change, biodiversity loss and desertification are experiencing a "Big Data" problem. The volume of scientific data is growing too rapidly for many research units to house and process them locally. The tools of data analytics need to evolve to face this challenge.

One solution to this big data challenge is to run part of the analysis remotely, on servers collocated with the data archives. Indeed, nowadays scientists typically download the full archive then perform the analytics locally. This approach puts pressure on data providers' bandwidth and local storage and compute resources. One idea that climate data and service providers are developing is to offer analytical services in addition to the raw data. Instead of performing analyses on local computers, scientists would run them on powerful servers close to the data. This setup lets scientists access data and analytics almost independently of their local computing resources, granting researchers in less and least developed countries access to valuable scientific information that can be customized to their needs and priorities.

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The current implementation of such remote analytical services builds on an international standard called Web Processing Services (WPS). Using a standard allows independent, heterogeneous organizations to offer their data and services through a common interface, facilitating access for users and *de facto* creating a loosely federated cyber-structure for climate services. Users are then free to compare and combine data and analytics from different providers to create novel, customized climate services and products. This service model has the potential to drastically change the knowledge-building landscape and enable new collaborations, leveling the playing field for scientists and policy makers everywhere.

To achieve the ambitious goals of keeping global warming in check, reverse land degradation, stop the loss of biodiversity and build resilience to natural disasters, there is a need for global planning, reporting or monitoring tools based on high-quality scientific data. Cyber-structures are one key aspect of the solution to support the creation of local, customized data and products necessary for evidence-based sustainable development.

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