Policy Paths towards Second-Generation Measurement, Reporting and Verification (MRV 2.0)

Actions needed for an MRV 2.0:

- Access to a centralized cloud service with decentralized multipurpose platforms and databases should be secured in the long-term (a minimum five-year time frame).
- A Global Forest Biomass Reference System for *in-situ* data collection should be supported and promoted.
- New standardized methods using Remote Sensing, Geostatistics, and Artificial Intelligence on the Cloud should be enhanced and promoted.
- Coordination and partnerships should be promoted among agencies, institutions, communities, and research groups to improve data and the sharing of know-how.
- A proof of concept should be developed to facilitate investigation of the technical viability and desirability of MRV 2.0 prior to scaling up.

WHAT IS THE ISSUE?

Limiting global warming to 1.5°C, in line with the Paris Agreement (PA), requires that global annual greenhouse gas emissions are cut by 50 percent of current levels by 2030, and reduced to net zero by 2050. This represents a net reduction target of 23 $GtCO_2e$/year by 2030 (Blaufelder et al., 2021). In order to reach this target, 5 $GtCO_2e$/year of Emission Reductions (ER) will have to come from reduced deforestation with 2 $GtCO_2e$/year of enhanced carbon sequestration (Taskforce on scaling voluntary carbon markets, 2021).

The importance of forests is recognized by the parties to the PA, 75 percent of whom have included forest sector targets in their first Nationally Determined Contributions (NDCs) (IUCN and Climate Focus, 2018). Forest sector targets are estimated to represent 25 percent of committed emissions reductions by 2030. This is equivalent to 0.2–2.4 $GtCO_2e$/year of ERs, and 0.5–1.6 GtCO2 e/year of carbon sequestration (Grassi et al., 2017) including conditional targets. These quantities would fall dangerously short of the above overall targets and would represent a deficit between 3.0–6.2 $GtCO_2e$/year of Emission Reductions and Enhanced Removals (ERER) by 2030.

Increased ambition will be needed in order to achieve current NDCs and bridge the existing gap. The relatively protracted nature of MRV processes (up to 21 months) translates into significant delays in finance mobilization. Moreover, MRV approaches may lead to estimates that incorporate significant uncertainties (Yanai et al., 2020) and these may erode confidence in the quality of Emission Reductions. Furthermore, MRV approaches vary across countries and markets, creating challenges for the fungibility and comparability of claims at different scales (Taskforce on scaling voluntary carbon markets, 2021; Streck et al., 2021). This lack of standardization, and the absence of spatially explicit estimates, tend to complicate the reconciliation of claims, not only at the level of programs and projects, but also at the national level. The consequence—when it is so difficult to attribute ERs or create an accounting framework that closely links performance to finance—is a diminution of incentives for investors (Streck et al., 2021).

A digital MRV that addresses these challenges is regarded as a vital way to speed up MRV processes, accelerate access to finance, improve the integrity of market supply, and thereby expand the entire market (Taskforce on scaling voluntary carbon markets, 2021).

WHY IS IT IMPORTANT NOW?

The world is currently facing a climate emergency—a crisis aggravated by the huge challenges that have accompanied the pandemic. Unprecedented and disruptive innovation is needed to enable a rapid economic recovery that attains climate change goals.

New technologies and unprecedented availability of satellite data are causing a paradigm shift in the way ERER in the forest sector may be monitored. They enable estimation of carbon stocks and dynamics from space across large areas, in a spatially explicit manner. Cloud computing technologies enable the processing of increasing volumes of data. Improvements in algorithms, including artificial intelligence (AI), enable the extraction of meaningful information from large volumes of data.

The combination of these innovative approaches and increased data availability is expected to overcome several serious challenges facing current MRV approaches, by:

- Enabling more frequent monitoring of carbon stocks;
- Decreasing the time needed to generate estimates (potentially from months to weeks);
- Decreasing the uncertainty of estimates;
- Standardizing estimates to render them comparable at different scales; and
- Providing spatially explicit estimates to facilitate straightforward attribution.

The implementation of these technologies is a crucial step to enable the digitization of the MRV system, i.e., MRV 2.0.

WHAT HAVE WE LEARNED?

The World Bank led a study (World Bank, 2021) to assess the readiness of innovative technologies for monitoring of carbon dynamics. To identify how these technologies can foster a second-generation MRV (MRV 2.0), the study considered four domains: Remote Sensing, Geostatistics, AI and cloud computing.

Remote Sensing: The datasets and technologies with the greatest promise for directly estimating biomass from remote sensing are a combination of LiDAR and L-band SAR data. However, MRV can never be conducted solely using Remote Sensing. Even with new sensors, access to field data (in-situ data) is essential for the calibration of satellite data. Small and sparse ground plots often limit the accuracy and precision of current satellite-based products. Current networks of scientific *in-situ* plots across the tropics (such as those under GEO-TREES) have not secured the long-term funding commitments that could guarantee consistency in terms of the design, location, and frequency of measurement. The lack of finance and adequate institutional arrangements for designing, creating, and re-measuring *in-situ* plots represents a significant constraint for directly estimating biomass from remote sensing. Free and open access to remote sensing data, reference data and algorithms are critical to ensure reproducibility, and to generate biomass estimates in a timely and cost-effective manner.

Geostatistics: This class of statistics enables the analysis and prediction of values associated with spatial and spatio-temporal phenomena. This could offer solutions to current limitations observed in the remote sensing domain. Geostatistical methods are mature technologies in the forestry sector, and common in mining and meteorology. The major challenge in using these technologies in an operational MRV context resides principally in the national and global application of these methods. To incorporate geostatistical methods within MRV, the process will need to include: (i) assisting in the design of *in-situ* plots; (ii) ensuring that *in-situ* plot networks are representative and protected against destruction by fires or illegal logging; and (iii) assisting with the creation of computationally efficient algorithms with AI support, so as to incorporate advances in computing technology, parallelization and cloud computing to enable implementation of complex geostatistical methods at a large scale.

Artificial Intelligence: The application of AI can bring significant improvements to different operations of the MRV process, such as data curation (for noise and uncertainties), data processing (including remotely sensed image processing). The current gap between two vital technical communities—those of AI and remote sensing respectively—could be closed by ensuring cross-communication between the two.

Cloud Computing: Cloud computing is a mature and developed technology. It is possible to manage resources to help users create a scalable product able to overcome various data processing issues—in both the Remote Sensing and Geostatistics domains—which cannot be addressed in non-integrated local systems. Harnessing the potential of Remote Sensing, Geostatistics and AI requires the use of a centralized cloud platform. Here users from different domains and countries will enjoy access to critical data and make necessary innovations to integrate *in-situ* and Remote Sensing data, serving a multiplicity of needs.

WHAT NEEDS TO BE DONE?

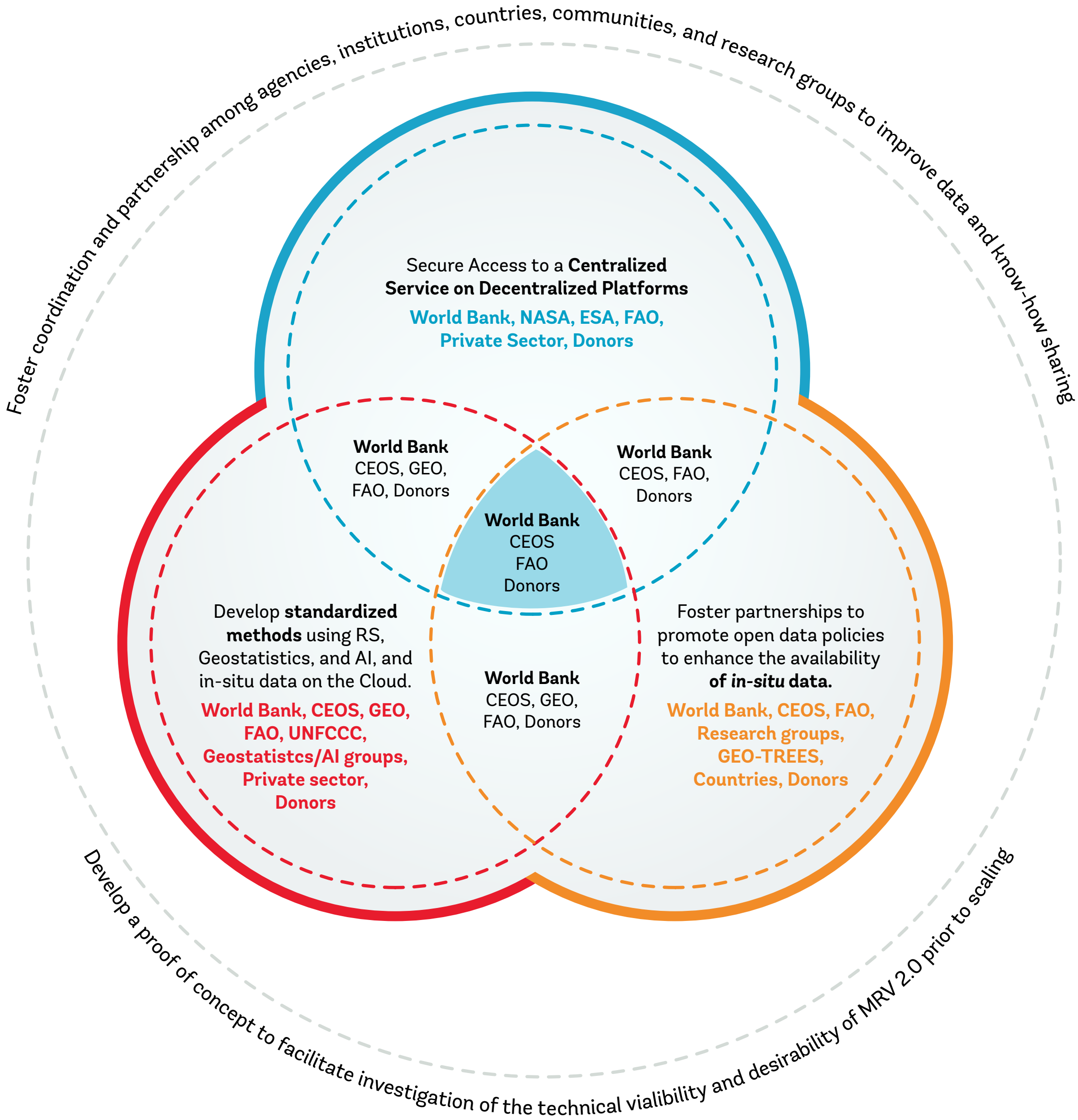
The synergistic application of these technologies would enable the development of a second-generation MRV system (MRV 2.0). A centralized cloud service would serve to collate an unprecedented volume of centrally or locally located remote sensing and *in-situ* data. This service would be connected to a set of decentralized multipurpose platforms, which could be customized by users according to their needs. This flexible multipurpose system would enable the use of MRV 2.0 at multiple scales and take account of different local circumstances and uses.

No single solution can deliver MRV 2.0. However, it could be accelerated through coordination, partnerships, and the use of current and future Remote Sensing technologies, as well as through a sophisticated combination of the three domains (Remote Sensing, AI, and Geostatistics) deployed to the cloud and anchored on traditional forest inventory datasets.

Different stakeholders and partners in development should work together in the implementation of the following actions conducive to the development of an MRV 2.0.

RELEVANT ACTIONS

Figure 1. Mapping stakeholders to relevant actions.



First, secure access to a centralized cloud service with decentralized multipurpose platforms and databases in the long term (five-year time frame). The centralized cloud service could be built on any of the cloud computing platforms currently in operation. This will enable harnessing of the capabilities of cloud computing, while providing open access to satellite and *in-situ* data to implement innovative solutions. This approach will enable countries to gain access to data; bring added computing power to Geostatistics and AI domains; promote fruitful collaboration with these two domains; and, foster collaboration among different communities.

Second, foster partnerships with research groups, institutions and agencies involved in the development and maintenance of *in-situ* plot networks, such as the recently created GEO-TREES. These partnerships would promote open data policies and engage in resource mobilization to ensure a sustainable base of financial support to enhance the availability of *in-situ* data (such as via the Global Forest Biomass Reference System). These partnerships would enhance data sharing by providing technical and financial support to allow countries to maintain national forest monitoring grids (such as multipurpose plots).

Third, enhance and promote new standardized methods using Remote Sensing, Geostatistics, and AI on the Cloud. In effect, combine *in-situ* data with the various remote sensing products, (e.g. LiDAR, SAR, and so forth) to create MRV 2.0 protocols through sustainable funding. This will represent a significant step towards the standardization and digitization of MRV processes.

Fourth, create the necessary enabling environment by fostering coordination and partnership among agencies, institutions, countries, communities, and research groups to improve data and the sharing of know-how. This could be achieved by; (i) improving data quality and availability; (ii) standardization of data collection, processing, archiving and security; (iii) cross-fertilization between different domains (namely, Remote Sensing, Geostatistics, and AI) for accelerated R&D and innovation; (iv) long-term financing for cloud services; and (v) focusing on priorities through the efficient overall use of resources—avoiding redundancy. Data sharing could likewise be promoted through the creation of regulatory frameworks which protect national sovereignty and intellectual property, the adoption of incentivization mechanisms to facilitate data sharing, and the implementation of innovative solutions, such as the use of local data centers, with edge computing (a distributed computing paradigm that brings computation and data storage closer to the location where it is needed, to improve response times and save bandwidth). Coordination mechanisms currently exist but they need to be further strengthened to expand their influence and capacity to secure resources.

Fifth, consider implementation of a proof of concept to investigate the technical viability and desirability of MRV 2.0 prior to scaling up. This would further strengthen understanding of the MRV 2.0 process and how it could be scaled up. It would not only lead to innovative approaches but would also accelerate the implementation of these actions. The implementation of this proof of concept could be conducted through public-private partnerships. Aim to establish financial sustainability mechanisms in the provision of different services to the public and private sectors, including through carbon finance, corporate social responsibility actions and traceability.

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