Digital MRV and Carbon Credit Integrity

Survey Summary

1. **Background**

The Digital Measurement, Reporting and Verification (DMRV) survey was organized by the Integrity Council on Voluntary Carbon Markets (ICVCM) to inform the scope of work for a dedicated Continuous Improvement Work Program (CIWP) on this topic. The program will look at how existing and nascent DMRV instruments can impact the environmental integrity of carbon credits and how high integrity can be ensured in these tools.

The survey ran in late December 2025 – early January 2026 and was circulated through the carbon market ecosystem and relevant groups. It received 137 responses, all of which were deemed relevant.

The survey produced deep insights into the state of DMRV as it relates to integrity. The summary provided here is high-level and identifies major themes across responses. Additional insights will be considered by the CIWP and in follow-up work.

This summary does not prejudge any discussions, technical work or outcomes of the CIWP and is provided for information only.
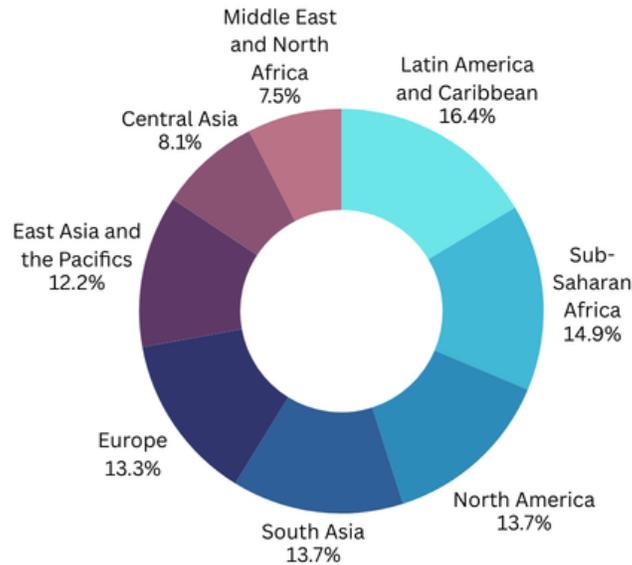
2. Survey respondents

Survey respondents by stakeholder type (n=137, multiple options allowed)

Respondents represent a mix of carbon market stakeholders, including a significant number of project developers (37%), infrastructure providers (financial, digital MRV and IT, data – 41%), consultancies (20%), as well as the NGOs and researchers (28%).[1] They are active across the world, with a fairly even spread across the regions. Many focus on Latin America & the Caribbean, North America and Sub-Saharan Africa.[2] Almost all respondents are active in the independent crediting space (85%).

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[1] Respondents could choose more than one stakeholder category.
[2] Respondents could choose more than one region.

Regions where survey respondents are active (multiple options allowed)

Respondents were overall familiar with digital technologies, with almost two-fifths of respondents listing them as a core part of their organization's work. Geospatial (72%), remote sensing tools (69%), and data management platforms (65%) were the most frequently mentioned instruments.[3]
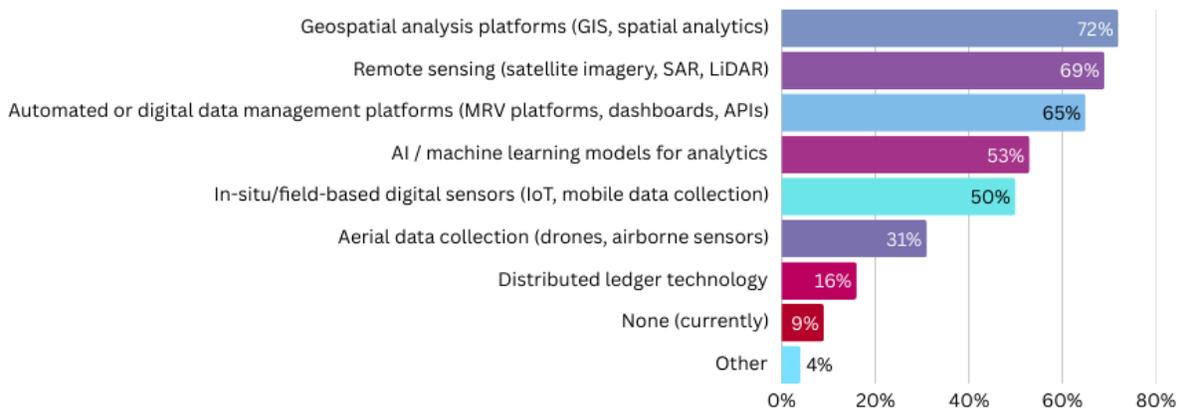

Digital DMRV tools and technologies used by respondents (n=137)

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[3] Respondents could choose more than one digital MRV tool/technology that they use.

The high use of geospatial and remote sensing tools reflects the fact that DMRV is most commonly used in the forestry sector (or nature-based solutions more broadly). Around three quarters of survey respondents use DMRV tools in the forestry sector, although agriculture, cookstoves and other energy products were also mentioned – albeit to a lesser extent (ranging between 7-16% of respondents).

The key criteria the vast majority of respondents (74%) look at when selecting DMRV tools is data accuracy and how uncertainty is managed, followed by alignment with standards, methodologies and regulatory requirements (58%) and cost (44%).
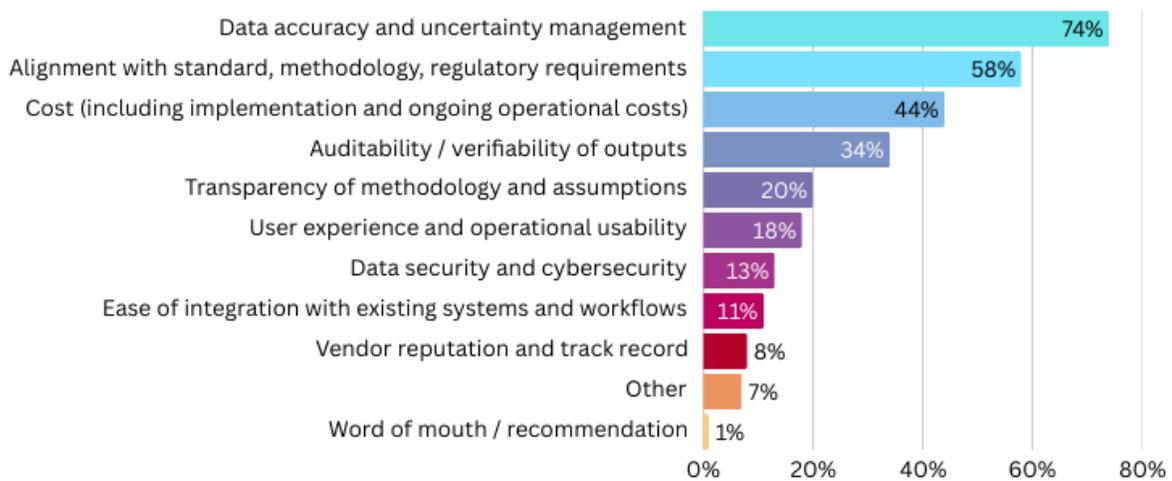
Key criteria considered when selecting a DMRV tool

3. Potential Benefits and Risks

Key takeaways: DMRV in carbon crediting presents both opportunities and challenges. It has the potential to increase transparency and accuracy at a lower cost but without the right guardrails, can raise questions about data quality and introduce biases, opacity and displace local knowledge.
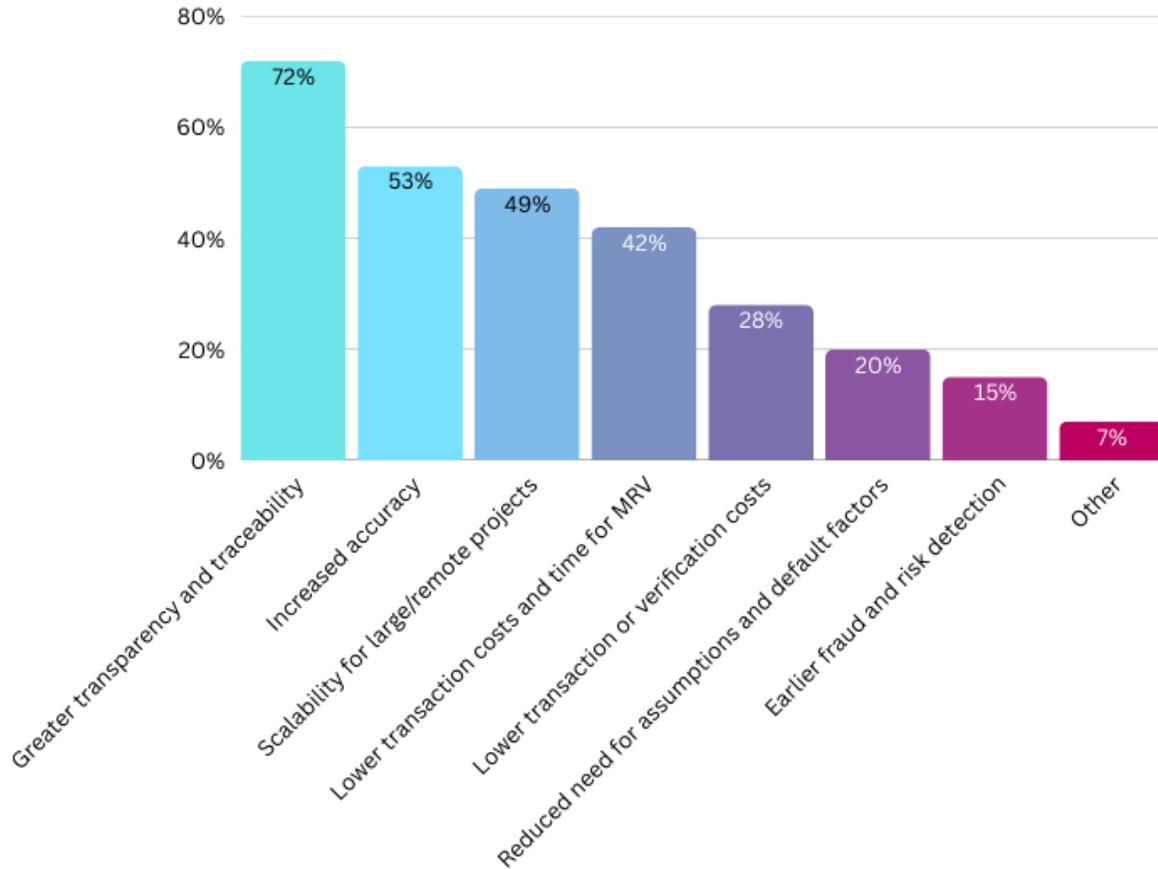
Potential integrity benefits identified by respondents related to DMRV for carbon crediting activities

Respondents see DMRV as bringing both integrity benefits and risks. On the one hand, DMRV can lead to increased transparency and accuracy at a lower cost. These are the top two integrity benefits cited by respondents with 72% and 53% respectively. In terms of accuracy, as data becomes more frequent, standardized - and with independently reviewable data (e.g., digital audit trails, sensors) - the risk of manual errors can go down. Near-continuous data may also lead to earlier fraud or risk detection (15% cite as a benefit). DMRV can also reduce the reliance on assumptions and default factors as well. Lowered costs and scalability to large and remote projects are also cited as benefits but are less directly related to environmental integrity (with 70% and 49% respectively).

However, without appropriate guardrails and governance frameworks, DMRV can also raise questions about data integrity and quality, which are the top concerns for respondents (cited by 58%).
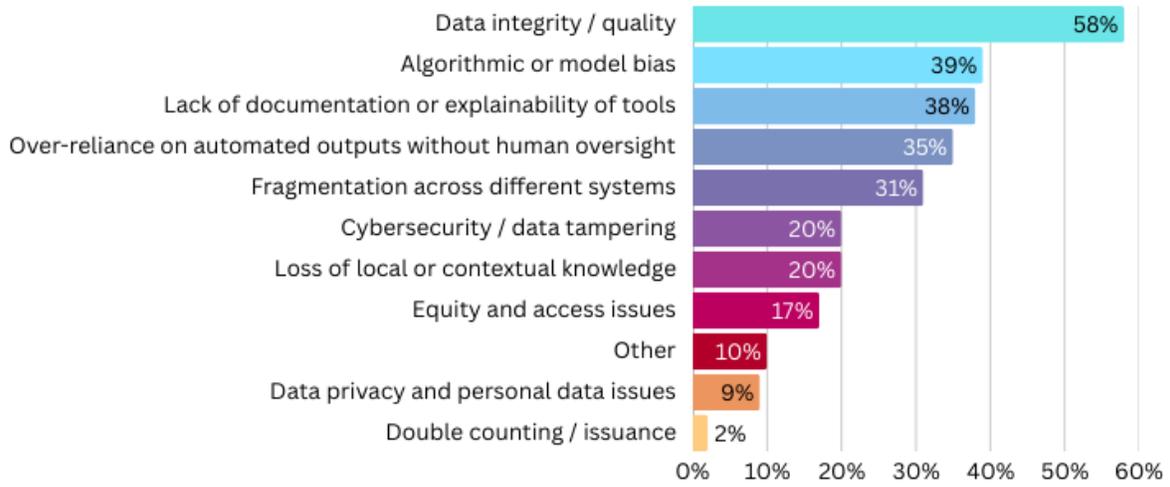
Potential integrity risks identified by respondents related to DMRV for carbon crediting activities

While both concepts are important to ensuring data is robust and reliable, data integrity looks at whether data is reliable and secure (e.g., Is it complete? Has it been tampered with?), while data quality looks at the accuracy and suitability of the data (e.g., Is it relevant, timely or consistent?). The second concern focuses on algorithmic or model biases (39%). This can range from geography, biome, project type to socio-economic context, and is particularly acute where models are trained in Global North contexts and applied elsewhere. "Black box" tools with limited documentation, transparency or reproducible methods (38%) were seen as potential risks, particularly relating to the inputs, assumptions and suitability of models and algorithms. As the trend towards increasing digitization and automated processes continues, the question of where and how human oversight is needed comes to the fore (35%) in order to ensure stakeholders do not end up overly reliant on digital outputs. Finally, how different types of data are treated and the risk of certain data being displaced or dismissed is also seen as a risk (20%), with respondents flagging the risk of losing local knowledge and context if those metrics are harder to quantify and/or digitize. For instance, the monitoring of co-benefits like sustainable development contributions or safeguard adherence may not be as straightforward but is equally important for impact integrity as emissions data.

4. Equity and Access

Key takeaways: Benefits and risks are context-dependent but equity and DMRV accessibility concerns are most acute for projects involving Indigenous Peoples as well as local communities and smallholders in remote and heterogenous landscapes. DMRV capacity building efforts need to be paired with infrastructure development, should be adapted to the local context, and be designed inclusively.

Benefits and risks are context-dependent, though many respondents see integrity and equity concerns most acutely for projects involving smallholders, heterogeneous landscapes in remote/data-sparse regions. DMRV tools appear to be more easily utilized – and thus more beneficial – for larger scale, highly capitalized projects in well-studied environments. These projects inherently have better infrastructure, IT capacity, and the ability to pay for high-resolution data and expert benchmarking. The survey noted that the successful use of DMRV in specific sectors, especially in developing countries, will require tailored approaches and specific attention to equitable access and context adaptability to ensure technology diffusion is not concentrated to high-income countries and/or well-resourced projects.

Most respondents cite as the top equity concern the risk that local knowledge and/or community roles and agencies are displaced in the MRV process as digital tools and automation is introduced. Some capacity-building efforts are emerging to address the digital divide and equity concerns, but they remain ad hoc.

Alongside practical capacity-building efforts, respondents stress the need to make DMRV tools affordable (open access or low cost) and accessible (usable, adapted to the local context, paired with infrastructure development). An explicit consideration of digital divides, traditional and local knowledge, as well as participatory design and rules by carbon-crediting programs, governments and other bodies were the top recommendations to address equity concerns.

Finally, some respondents also flag that DMRV could help lower barriers for smaller projects and Indigenous-led projects by reducing the need for expensive, third-party experts and by enabling community access to data and tools. However, additional governance frameworks would be needed to encourage this.

5. Roles and Responsibilities

Key takeaways: VVBs are particularly concerned about the division of roles and responsibilities of MRV stakeholders when digital tools and technologies are introduced, particularly in relation to model or data errors.
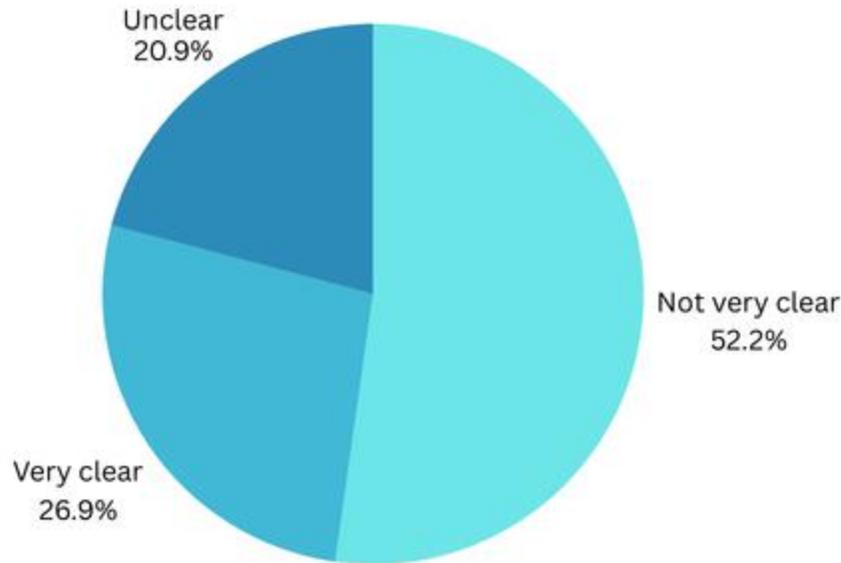

Respondents on the introduction of DMRV; how clear are roles and responsibilities across the MRV cycle (e.g., project developer, verifier, technology provider, standard, regulator)?

With DMRV, there is a lot of uncertainty about the roles and responsibilities among project developers, technology providers, registries, buyers, and validation and verification bodies (VVBs). 74% of respondents indicated they felt unclear or not very clear on how responsibility is allocated, especially when it relates to model or data errors. Inconsistent and fragmented expectations from the carbon-crediting programs and standards also add to this confusion. This is of particular concern from VVB respondents. Though updates to ISO 14064-3/-5/-65 are in progress, the standard still lags behind the realities of DMRV application and use currently seen in the carbon market.

6. DMRV Guidance and Regulation

Key takeaways: Most respondents follow carbon-crediting program guidance though this tends to very across the various programs. Principles-based guidance that focuses on minimum expectations on accuracy, transparency and uncertainty quantifications would be a welcome development.

Given how nascent the DMRV field is, many respondents are not subject to DMRV regulations, though more than half the respondents follow guidance from carbon-crediting programs and standards (53%), and a third of respondents have internal guidance (36%).
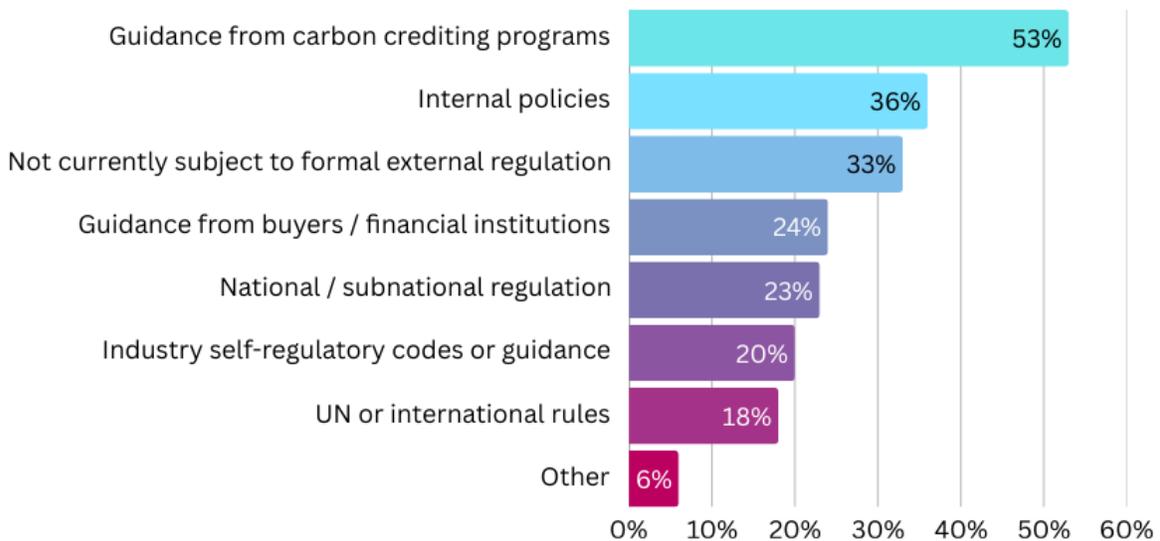
Respondents share if their DMRV activities are subject to regulation

While the lack of guidance and fragmented standards has caused confusion and is a concern for many survey respondents, they see that the establishment of DMRV guidance needs to be developed carefully in order to balance the need for high integrity without being overly prescriptive as to specific technologies, vendors and/or systems in order to encourage innovation and improvements.

The consensus from the survey focuses around developing principles-based frameworks or guidance that put in place minimum expectations on accuracy (e.g., quantifying uncertainty, conservative measurements), transparency and auditability. These are suggested to be

regularly reviewed to keep pace with real world developments. A tier-based approach could also provide more flexibility than uniform regulation. These frameworks can be developed with input from stakeholders along the MRV cycle and could be tailored to specific sectors, focusing on those that are more advanced in their DMRV application, like forestry and cookstoves. This could be done by the standards and the methodologies, with the ICVCM taking on a more holistic role to assess whether these thresholds meet conservativeness and transparency requirements.

7. Priority topics and role for ICVCM

Key takeaways: Survey respondents see ICVCM as an effective convenor in the carbon markets space that can set minimum expectations on integrity. Possible topics for ICVCM to focus on include data quality, algorithm/model bias, as well as assurances and the role of the VVBs.

There is a strong consensus for ICVCM to act as a convenor and to set the bar on integrity, focusing on outcomes (e.g., in terms of transparency and traceability, equity, how uncertainty is treated), while other actors, such as carbon-crediting programs and standards can focus on the process and sector specific thresholds.

Respondents identified a number of priority topics for ICVCM that focus on where DMRV creates new integrity risks. These include:

Data & model quality. Ensuring that digital data, models and algorithms produce accurate, transparent and explainable results across project types and geographies, rather than becoming "black boxes" that undermine integrity.

- Definitions of minimum digital evidence and data quality standards: what counts as verifiable, auditable digital data; uncertainty quantification; sensor calibration; cybersecurity and data integrity requirements.
- Establishing expectations for algorithm and model governance: transparency of logic and assumptions, training data, uncertainty treatment, documentation and version control, performance benchmarks, independent validation/audits, and clear change management rules for systems that update over time.

Integrity guardrails. Requiring regular and independent verification on DMRV tools. Encouraging independent benchmarking, hybrid approaches and minimizing conflicts of interest.

- Guidance to programs on what is needed for an MRV regime to be validation and verification ready if digitized (e.g., materiality, uncertainty, sampling, model validation expectations).
- Independent benchmarking of DMRV providers against neutral, well-characterized reference datasets (e.g., multiscale LiDAR, robust soil datasets), rather than each program or developer running their own ad hoc comparisons.
- Guardrails against self-review and conflicts of interest when registries or DMRV vendors both "do the math" and set/interpret the rules.
- Strong support for a hybrid approach (digital tools grounded with field samples), particularly in high-risk, complex or low signal to noise contexts like soil carbon.

Clarifying roles and expectations: Clarifying who is accountable for DMRV systems and outputs: project developers, technology providers, programs/registries, VVBs, accreditation bodies, and how assurance should adapt.

- Clarifying assurance expectations for VVBs, in particular over digital systems: how to audit pipelines, models, and controls; when and how to combine digital evidence with mandatory field checks; risk-based sampling for automated outputs.

8. Areas for Improvement

Key takeaways: ICVCM's CCP Assessment Framework could be complemented with guidance on integrity in DMRV around areas like transparency, models and algorithms, security and privacy, interoperability, as well as VVBs roles and competencies.

Survey respondents suggested that the ICVCM focuses on non-binding DMRV guidance that translate the Core Carbon Principles into expectations around DMRV integrity on topics like:

- Transparency (evidence traceability, digital audit trails).
- Models and algorithms (transparency, validation, bias testing):
    - Documentation and disclosure for any material model use (inputs, assumptions, training data, performance metrics, applicability limits, version history).
    - Evidence retention, audit logs, and reproducibility of issuances from stored data and documented logic.

- Security and privacy:
    - Cybersecurity and data integrity controls referencing recognised frameworks (e.g., ISO27001, NIST, CIS Controls) as acceptable baselines
    - Basic data governance protections (consent, privacy, data rights) where household or community-level monitoring is used
- Interoperable data fields and standards to reduce fragmentation.
- Roles and responsibilities:
    - VVBs competency expectations for working with digital systems (remote sensing, data pipelines, algorithm review).

Conclusion and Next Steps

The survey reflects the rapidly evolving developments in the DMRV space in carbon markets. While it is clear that these tools have the potential to strengthen environmental integrity in the market by increasing accuracy and transparency, it could also challenge those very same benefits by introducing biases and opacity. This also varies across sectors, geographies and specific digital tools or technologies and any emerging guidance will have to consider this diversity.

While steps are being taken by carbon-crediting programs and ecosystem players to put in place minimum requirements around accuracy, transparency and accessibility, as part of the CIWP, the ICVCM will convene stakeholders to discuss potential evolution of the CCP Assessment Framework integrity threshold and how it interfaces with DMRV.

The outputs and key topics identified in this survey will inform the discussions of the CIWP on DMRV in 2026.