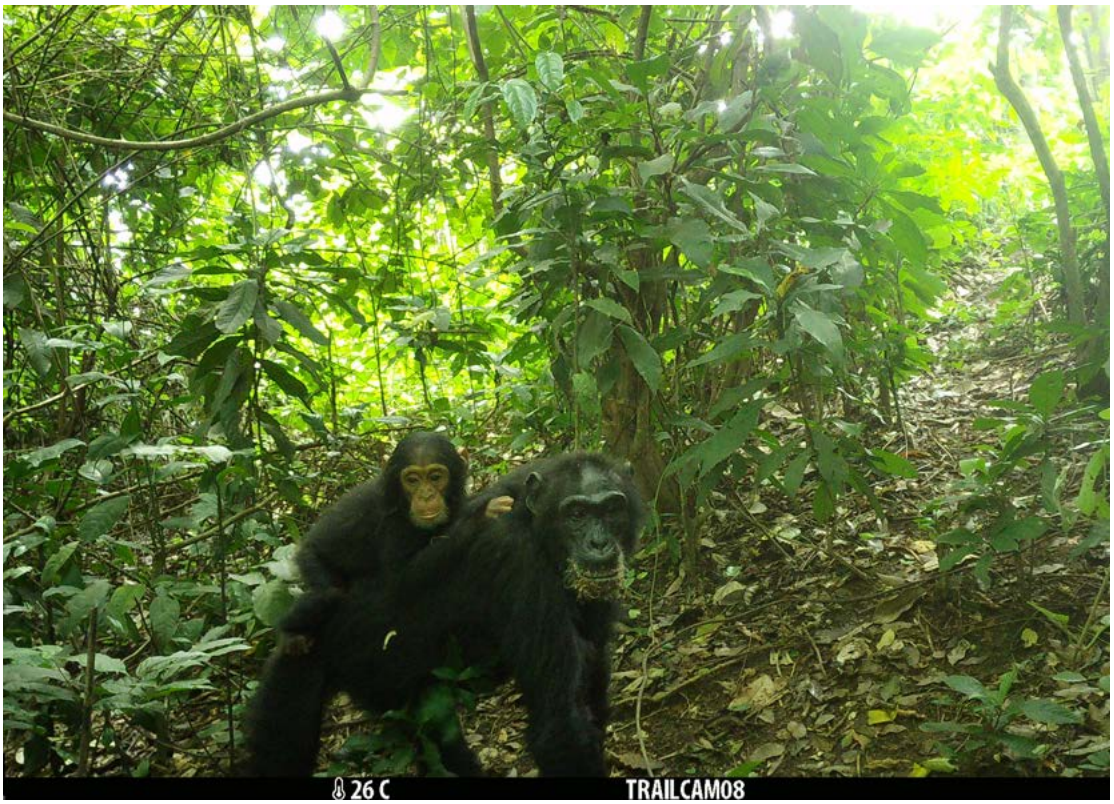
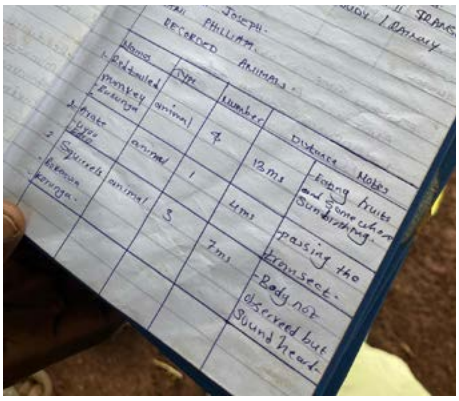
Indigenous data in nature markets

An Indigenous data economy to generate value for nature and people

Anna Ducros, WarīNkwī Flores, David Hall, Richard Field, Tambudzai Matenga and Paul Steele





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Contents

Boxes

Figures

Tables

Project partners

Conserve Global manages large conservation wildscapes for the benefit of people and nature, forging solutions together with local communities.

CreditNature is a B Corp-certified nature fintech company that develops the Natural Asset Recovery Investment Analytics Framework (NARIA), which includes the independently accredited Ecosystem Condition Index (ECI) for measuring ecosystem condition. They have built the commercial products that turn verified nature recovery into investable, tradeable assets, enabling private capital to flow into ecosystem restoration at scale.

ECOTRUST Uganda is a not-for-profit conservation organisation established in Uganda in 1999 to conserve biological diversity and enhance social welfare.

NatureAnalytics GmbH is a science-driven ecological intelligence company headquartered in Starnberg, Germany. They leverage AI, remote sensing and in situ monitoring to deliver scalable, high-integrity impact assessments for nature-based projects. Their solutions support validation, verification and transparent reporting of biodiversity outcomes across diverse ecosystems.

Abbreviations

AI	Artificial intelligence
API	Application programming interface
BCA	Biodiversity Credit Alliance
CBD	Convention on Biological Diversity
DSI	Digital sequence information
eDNA	Environmental DNA
ESG	Environmental, social and governance
FPIC	Free, prior and informed consent
GALS	Gender Action Learning System
GDPR	General Data Protection Regulation
GIS	Geographic information system
IAPB	International Advisory Panel on Biodiversity Credits
ICIP	Indigenous Cultural and Intellectual Property
ILK	Indigenous and local knowledge
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCA	Inclusive Participatory Community Assessment
LLM	Large language learning models
ML	Machine learning
MRV	Monitoring, reporting and verification
SDGs	Sustainable Development Goals
SMEs	Small and medium-sized enterprises
TEK	Traditional ecological knowledge
TNFD	Taskforce on Nature-related Financial Disclosures
UNDRIP	United Nations Declaration on the Rights of Indigenous Peoples
VCM	Voluntary carbon markets

Glossary

Artificial Intelligence (AI)	A machine-based system that infers, from input it receives, how to generate outputs such as predictions, content, recommendations or decisions by performing tasks that normally require human intelligence, including learning, pattern recognition, prediction and decision support. AI systems vary in their levels of autonomy (OECD, 2024).
Assetisation	The process of transforming something physical or digital into an asset that can be valued, traded, invested in or monetised.
Biocultural asset	An asset that reflects the interconnected relationship between biological and cultural systems.
Biocultural data	Data that captures co-constituted relationships between biological and cultural systems, aiming to treat nature and people as interconnected rather than separate.
Biodiversity credit	A tradable unit representing measurable positive biodiversity outcomes generated through conservation, restoration or improved ecosystem stewardship (Biodiversity Credit Alliance, 2024).
Biodiversity Credit Alliance (BCA)	The Biodiversity Credit Alliance (BCA) is a voluntary international alliance working to shape a credible market for biodiversity credits (see definition above). Its aim is to create guidance, principles and safeguards so that biodiversity credit markets become an effective way to invest in nature and nature stewardship.
Biopiracy	The unauthorised commercial or other use by third parties of Indigenous knowledge, genetic resources or biodiversity without consent or equitable benefit-sharing (Convention on Biological Diversity, 2011).
CARE Principles	Indigenous data governance principles: Collective Benefit, Authority to Control, Responsibility and Ethics (Carroll et al., 2020).
Carbon Credit	A tradable certificate representing one metric tonne of carbon dioxide equivalent reduced, avoided or removed from the atmosphere.
Chakana	An Andean framework for organising knowledge and relationships, emphasising reciprocity and balance.
Data	Information in any form collected, generated, managed or shared for monitoring, research, governance, reporting or decision making.
Data arbitration	The process through which decisions are made about what counts as data, how it is represented and how it is governed.
Data economy	An economic system in which data is exchanged, creating monetary and non-monetary value, including by informing decision making.
Data ethics	Principles governing the responsible collection, use, management and sharing of data.
Data genealogy	The practice of documenting the origins, transformations, obligations and relationships associated with data throughout its lifecycle.
Data governance	The institutions, rules and processes that determine how data is collected, accessed, stored and used.

Glossary continued »

Data lifecycle	Sequences of stages that data goes through from the moment it is created or collected to when it is archived, deleted or re-used. Typically, stages are considered as data collection, when data is generated, captured or received; data storage and aggregation, when data is saved in databases, files, cloud systems or other repositories; data processing and analysis, when data is transformed for decision making; data sharing and retention; and data deletion or re-use.
Data management	The process of collecting, storing, processing and deleting data.
Data provenance	Documentation of the origin, custody and transformation history of a dataset.
Data stewardship	The responsible care and governance of data throughout its lifecycle.
Data sovereignty	Managing data and information in a way that is consistent with the laws, practices and customs of the nation-state in which the data is located (Kukutai and Taylor, 2016).
Data value chain	The sequence of activities through which observations are transformed into intelligence and value.
Digital asset	A digital resource that has identifiable ownership, governance or economic value.
Digital public infrastructure	Foundational systems and platforms that enable secure, trusted digital interactions across society. Such as online payment systems or digital identification (Clark et al., 2025).
Digital sequence information (DSI)	DSI is a term commonly used in policy, and therefore the definition is often debated, but it broadly refers to digital data that provides a representation of genetic resource information, such as DNA sequence data (Muñoz-García and DSI Scientific Network, 2025).
Digital twin	A virtual representation of a physical ecosystem, process or asset.
Environmental data	Measurements, observations or records that describe or quantify the state of the environment; the human and natural drivers and pressures causing environmental change; the resulting impacts on people and ecosystems; and the effectiveness of societal responses (International Organization for Standardization, no date).
Environmental, social and governance (ESG)	A framework used by investors, consumers and regulators to measure a company's sustainability (environment), ethical considerations (social) and operational transparency (governance). For example, a company may commit to disclose their carbon footprint each year, due to its ESG commitments.
FAIR Principles	Data stewardship principles requiring data to be Findable, Accessible, Interoperable and Reusable (Wilkinson et al., 2016).
Free, Prior, and Informed Consent (FPIC)	The right of Indigenous Peoples to give or withhold consent to activities affecting them, their territories or resources (United Nations, 2007).
Financial data	Data that carries information on the cost, revenues and profits of the financial mechanisms, including how the costs or benefits are distributed amongst stakeholders.
Indigenous Cultural and Intellectual Property (ICIP)	All aspects of Indigenous Peoples' traditional knowledge and cultural expression, a definition originally developed by the Aboriginal and Torres Strait Islander peoples of present-day Australia (Arts Law Centre of Australia, 2011). See Section 3.1.3, page 27.

Glossary continued »

Indigenous data sovereignty (IDS)	The right of Indigenous Peoples or nations to govern the collection, ownership and application of data relating to them, their communities, their territories and resources. The right rests on Indigenous Peoples' right to autonomous government, and is supported by the UN Declaration on the Rights of Indigenous Peoples (Mukunda, 2025). IDS extends self-determination to the digital realm, meaning that Indigenous nations can make decisions about data about their people and territories, including how it is governed. It often embeds principles of collective ownership, meaning that Indigenous data belongs to the community as a whole, rather than centralising ownership to the subject or to a single organisation. Data management practices that align with Indigenous data sovereignty must respect and uphold local customs, laws and traditional knowledge. The Indigenous data sovereignty movement is the joint effort of Indigenous groups, non-governmental organisations and other stakeholders to uphold and implement Indigenous data sovereignty. See Box 4, page 31, for more details.
Indigenomics	A framework in which Indigenous Peoples can participate, own and create value within economic systems (Hilton, 2021).
Indigenous data	Data generated by, about or relating to Indigenous Peoples, their territories, resources and knowledge systems. This data may be representative of any form, medium or expression of Indigenous and local knowledge (ILK) as well as traditional ecological knowledge (TEK) (see definitions in this glossary). There are varying degrees of sensitivity to this data that are highly context-specific.
Indigenous data economy	A system of value generation, circulation and governance in which Indigenous Peoples exercise authority over data derived from their territories, knowledge systems, communities and themselves. This ensures that such data creates collective benefit, collective privacy and rights, reinforces data equity shares (shareholdership) in ecological stewardship, territorial and biocultural assets, and advances Indigenous self-determination and FPIC across all stages of the data lifecycle.
Indigenous and local knowledge (ILK)	The place-based understanding, skills and philosophies developed by societies with long histories of interaction with their natural surroundings (IPCC, no date).
Interoperability	The ability of different systems, datasets or technologies to exchange and use information effectively (Wilkinson et al., 2016).
The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)	An independent global body that connects scientific communities with political decision makers to protect nature and human wellbeing (British Ecological Society, 2026).
International Indigenous Data Sovereignty Interest Group	A global network dedicated to ensuring Indigenous Peoples govern the collection, ownership and application of their own data (Research Data Alliance, 2026). This group developed the FAIR Principles (see definition above).
International Advisory Panel on Biodiversity Credits (IAPB)	An independent global initiative established by France and the UK in June 2023 to facilitate the creation and growth of high-integrity biodiversity credit markets and encourage enabling policy and regulatory mechanisms in ways that are credible, timely, and coherent at the international level (International Advisory Panel on Biodiversity Credits, no date).
Khipu	An Andean information and record-keeping system using cords and knots.

Glossary continued »

Majority world	A collective term for nations in Africa, Asia, Latin America and the Middle East, along with Indigenous Peoples around the world. It is a term that deliberately reframes and shifts the focus away from what these areas and societies lack, to what they have.
Metadata	Data that describes other data, including its origin, format, ownership or purpose.
Monitoring, Reporting and Verification (MRV)	Processes used to measure, document and verify environmental outcomes.
Nature finance	Financial flows supporting the conservation, restoration or sustainable management of nature (see Box 1, page 16).
OCAP® Principles	Ownership, Control, Access and Possession principles developed by First Nations in Canada (First Nations Information Governance Centre, no date).
Ontology	The philosophical study of being.
Open access	The principle that information, data and research outputs should be freely available to anyone to access and use. Open-access data refers to data that is available and accessible to anyone, at all times.
Payment for Ecosystem Services (PES)	A mechanism through which beneficiaries of ecosystem services compensate those who conserve or manage them.
Provenance	The origin, source or complete history of ownership of a location or an object. See also the definition for data provenance.
Relationality	The concept by which everything in the world does not exist in isolation but is defined by its connections and relationships to other things. For example, data, specifically Indigenous Data, is relational in that it is generated within specific territory-community-protocol relationships that are integral to its meaning and its governance.
Rights of Nature	A framework that recognises that nature, including trees, oceans, animals and mountains, has rights just as human beings have rights (Global Alliance for the Rights of Nature, no date).
Shareholder	A shareholder is a person, company or institution that owns one or more shares (fractions) of a company or asset, and because of this, they are considered part-owners of the corporation or asset. A shareholder has shareholdership. In this report, we use the term shareholder in relation to partially or fully owning data as an asset.
Sovereign Data Supply Chain	A decentralised governance and technical framework that operationalises Indigenous data provenance and shareholdership by linking digital assets to physical assets. It proposes to transition Indigenous Peoples from passive 'subjects' of data extraction to active Source Domain Authorities who exercise 51% or greater majority control over the lifecycle of their high-integrity biocultural assets.
Sumak Kawsay	An Andean philosophy of good living based on harmonious relationships among people, communities and nature.
Sustainable finance	This term can mean various things, but in the context of this report, it refers to financial decision making that incorporates environmental considerations.

Glossary continued »

Taskforce on Nature-related Financial Disclosures (TNFD)	An initiative providing organisations with tools to act on nature-related issues. TNFD most commonly refers to the set of disclosure recommendations and guidance that the taskforce has created, which encourage and enable businesses to assess, report and act on the nature dependencies, impacts, risks and opportunities of their company (Taskforce on Nature-related Financial Disclosures, no date).
Tokenisation	The process of converting knowledge or data into a digital asset with unique identifiers.
Traditional ecological knowledge (TEK)	A subset of Indigenous and local knowledge (ILK, see definition above), TEK refers to the ecological knowledge and practices of Indigenous and local cultures. Often highly place-based and effective for environmental and resource management, TEK is passed from generation to generation and informed by a long-standing relationship with the surrounding environment.
United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP)	Adopted in 2007, it is the most comprehensive international instrument addressing the individual and collective rights of Indigenous Peoples (United Nations, 2007).
Yupana	Traditional Andean computational device used for calculation and record-keeping.

Summary

Target 19 of the Kunming-Montreal Global Biodiversity Framework aims to mobilise US$200 billion per year for biodiversity from all sources. This is spurring growing interest in nature makets that promote investment in nature and peoples, including biodiversity credits and other forms of nature finance (Convention on Biological Diversity, 2022). To promote transparency, accountability and ultimately, socioeconomic and biological outcomes, nature markets are information-intensive services and rely on the collection of environmental and socioeconomic data. In many ways, value in nature markets emerges from the exchange of information: value is created when the required information is received, proving whether protection or restoration of nature has occurred or not. This exchange and use of information is emerging in a wider global context, where information-intensive services are becoming increasingly relevant in data-rich global economies

This report discusses the need for effective and equitable data management pertaining to Indigenous Peoples and their territories in nature markets (hereafter referred to as 'Indigenous data'). We aim to promote an understanding of how to practically and ethically collect, manage, analyse and use Indigenous data in the context of nature markets. Indigenous data here includes, but is not limited to, all forms of media, or expressions of traditional ecological knowledge (TEK) and Indigenous and local knowledge (ILK). Section 2 explores what constitutes data, and key principles of data access and use. Section 3 takes stock of the current state of Indigenous data management in nature markets, examining the challenges of managing such data and current principles, legal frameworks and guidelines for working with Indigenous data.

We provide a non-exhaustive list of common technologies used in nature markets. Indigenous Peoples have a long history of engaging proactively with new technologies on their own terms. The question needs to be asked: when is adding more technology adding value, and for whom? By whom must this technology be developed? How can monetary and non-monetary benefits be returned to the owners of the data? A technology-led approach may neglect the trade-offs and risks for Indigenous Peoples. Navigating these trade-offs requires seeing both the risks and opportunities of technology, rather than treating new technology as unambiguously good.

In Section 4, we propose an Indigenous data economy as a new way to conceptualise how Indigenous data can flow through a sovereign data supply chain and create monetary and non-monetary value for both nature and peoples. We define an Indigenous data economy as:

> A system of value generation, circulation and governance in which Indigenous Peoples exercise authority over data derived from their territories, knowledge systems, communities and themselves. This system ensures that such data creates collective benefit, collective privacy and rights, reinforces data equity shares (shareholdership) in ecological stewardship, territorial and biocultural assets and advances Indigenous self-determination and the negotiation diligence of free, prior and informed consent (FPIC) across all stages of the data lifecycle. This economy is embedded within, not above, the living territory from which the data derives, and is governed by Indigenous customary laws and protocols, collective ownership, relational goods and services and intergenerational responsibility.

An Indigenous data economy does not mean inserting Indigenous data into existing markets or adopting external market language. Rather than treating Indigenous data governance as an external ethical requirement, an Indigenous data economy frames data governance as economic infrastructure. In this framing, we extend alternative solutions with Indigenous data economy to the issues raised by the High-level Principles to Guide the Biodiversity Credit Market on the poor treatment that voluntary carbon markets (VCM) give to Indigenous data and their rights. This reframing enables negotiation over system design, obligations and long-term value retention, rather than oneoff consent or downstream benefit-sharing. Data trade becomes the mechanism through which Indigenous sovereignty, governance and authority are translated into durable economic participation. For nature markets, this shift is foundational: financial mechanisms risk instability, contestation, lack of insurability and loss of legitimacy if they depend on Indigenous data without sovereignty of the data. VCM offer concrete examples for the need of this foundational shift as the market development has suffered low quality, low integrity, and doubts on the fundability of VCM projects. Additionally, aligning

financial returns and data management with existing principles regarding Indigenous data and Indigenous stewardship enables nature markets to function as systems of regeneration finance and reduces the risk of eroding cultural and spiritual values. Investment in these practices is, therefore, not adjacent to nature markets or an additional cost, but a key step that promotes credibility, durability and capacity to attract investment. In this way, Indigenous Peoples are not being invited into a data economy but are articulating the terms of a different political data economy (Hilton, 2021; Trosper, 2022).

In short, the data ethics frame asks 'How should data obligations regarding Indigenous data be fulfilled?'; the data sovereignty frame asks 'Who has the right to own, benefit from and govern Indigenous data?' and the data economy frame asks the generative question 'Given sovereignty, how can data create value that flows to and is governed by Indigenous communities?' This addresses how value persists over time, and how data and the value derived from data return to the original peoples and places where it was generated. An Indigenous data economy leads to trusted nature markets and biocultural resilient outcomes.

Along with the development of the Indigenous data economy as a conceptual framework, Section 4 provides practical considerations for nature market practitioners to consider while designing, implementing and managing nature finance mechanisms. This includes outlining how partnerships can support the mitigation and management of risks to the market, nature and Indigenous Peoples.

We conclude in Section 5 with three key recommendations:

- Data management plans should be created from the outset of a project to ensure that they are fully integrated into project design and implementation. This includes ensuring the data management plan is cost effective and resourced. We recommend incorporating Indigenous and traditional knowledge alongside Western scientific approaches, where appropriate, through a multiple-ontology framework. This approach supports the integration of diverse knowledge systems and promotes evidence-based leadership and decision making by Indigenous Peoples.
- The data management plan and implementation should align with obligations of data ethics and legal frameworks, especially free, prior and informed consent (FPIC). This includes aligning the data management plan with national and regional legislation. Data management practices should embed the principle of Indigenous data sovereignty and application of an Indigenous data economy, ensuring that data generated within Indigenous territories is governed, accessed and used in accordance with the rights, interests, and protocols of Indigenous communities.
- Effective partnerships can strengthen, and be strengthened by, a data management plan when the plan outlines the various roles, responsibilities and resources of each partner. Being practical about what each partner can do with the time and resources available to them will allow the consortium to identify any gaps that may affect the successful implementation of the data management plan and adapt accordingly. Trust-building among project partners and with market actors may also provide a way to reduce the quantity of data required, and hence, reduce the data costs, the risks to Indigenous rights and the potential burden of top-down data requirements for Indigenous Peoples.

Throughout this report, we use the terms 'Indigenous Peoples' and 'Indigenous' to refer to all those who self-determine as Indigenous, recognising that this status may not be recognised by the governing nation-state or jurisdiction in which such people and peoples exist (see Section 1, page 15, for more information).

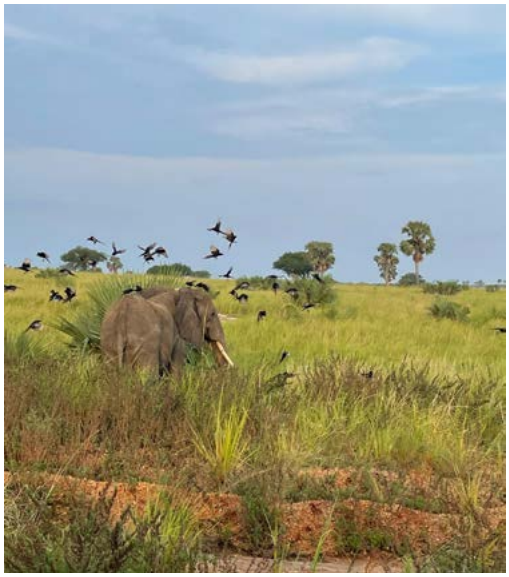
The target audience for this report is nature market practitioners with an interest in and working knowledge of nature and conservation finance, such as project developers, potential buyers and governments. It is also aimed at Indigenous Peoples and organisations who are engaging in nature markets and are looking to build a deeper understanding of data sovereignty and ethics to benefit from nature markets while better protecting their intellectual and cultural rights.

The findings and recommendations in this report have benefitted from biodiversity credit pilots in Uganda and Zambia, complemented by reviewing existing literature related to Indigenous data. Engagement with Indigenous Peoples has fed into the methodology and design of this report, with the text co-authored by an Indigenous scholar from Latin America and the report peer-reviewed by additional Indigenous practitioners from Africa. We use some technical language where necessary but aim to make the report as accessible as possible by providing definitions of key terms and avoiding overly technical jargon (see Glossary, page 8).

1 Introduction

Globally, nature markets (defined in Box 1, page 16) are growing, presenting both opportunities and challenges for nature and people. Like many markets in today's increasingly digital world, nature markets are underpinned by data. A 'nature market' is essentially a set of financial mechanisms: information-intensive services that leverage biological, financial and social data to facilitate investment in nature. Traditional record-keeping, including non-digital or semi-digital methods, cannot provide the transparency, verification, comparability and auditability that are required to build high-integrity[1], trusted and scalable nature markets (Biodiversity Credit Alliance, 2026). Further, nature markets themselves are emerging in a wider global context where the 'big data economy' and artificial intelligence (AI) use are growing, and where information-intensive services are becoming increasingly relevant in data-rich global economies (Lim et al., 2018). Value in the market is, in part, related to informational interactions rather than physical and interpersonal interactions between information users (standard setters, buyers and others) and the implementers (Lim et al., 2018). Therefore, a fundamental starting point for this report is that monetary value in nature markets is not created until the information user receives the information for a specific purpose, in this case the information proving that there have been positive outcomes for nature (for example, conservation or restoration of nature has occurred).

Nature-related data itself is increasingly in demand by financial institutions and non-financial corporates for reporting and disclosure purposes. This demand gives monetary value to nature data because entities need to procure data for reporting purposes, and that data needs to have sufficient integrity to mitigate operational and reputational risks (for example, allegations of greenwashing). In certain cases, this data is also Indigenous Peoples' data, because it represents ecological and sociocultural states or trends on Indigenous territories or related to Indigenous territories. In this sense, nature finance tools often draw upon Indigenous data on the supply side, but the value of the data might be captured mainly by other entities and intermediaries along the value chain — such as data aggregators, data analysts and brokers or final users of the data, as experienced in early carbon market interventions. This raises ethical issues, particularly where nature-related data includes Indigenous or traditional knowledge, and requires appropriate safeguards to ensure FPIC (see Section 3) and benefit-sharing. Digitalisation of data brings increased risks to the intellectual property rights of Indigenous Peoples over their traditional knowledge and has contributed to growing attention to ensuring Indigenous data sovereignty and preventing biopiracy (unauthorised commercial use of traditional knowledge and biodiversity resources of Indigenous Peoples, for example, for developing new crops or medicines).



Birds flying around an elephant, Murchinson Falls Park, Uganda. Photo credit: Anna Ducros/IIED

[1] High integrity, in the context of biodiversity credits, refers to when interventions are aligned with the High-level principles to Guide the Biodiversity Credit Market, developed by the Biodiversity Credit Alliance, International Advisory Panel on Biodiversity Credits and the World Economic Forum (Biodiversity Credit Alliance, 2025)

Box 1. What are nature markets?

The term 'nature market' takes many meanings, and in a practical sense is still being defined. For the purposes of this report, nature markets are defined as market-based mechanisms that channel investment into natural capital (or other aspects of nature) and the socioeconomic systems that sustain it (Taskforce for Nature Markets, 2023; UK Department for Environment, Food and Rural Affairs, 2023). This includes investments associated with Indigenous territories and lands, waters, and resources traditionally managed by Indigenous Peoples. Nature markets include:

- **Asset markets**, where the rights to use ecosystem assets with long-lived value are traded. This is the buying and selling of real assets, and the rights to use an entire ecosystem asset and resulting services (for example, agricultural land, timberland and water rights).
- **Intrinsic markets**, in which provisioning, regulating or recreational ecosystem services are traded. These include the tangible, consumable goods and materials that are derived from nature, access to and use of cultural services (for example, wildlife tourism), and the conservation of nature for direct economic or altruistic value (payment for ecosystem services, overseas development aid, philanthropic grants and sustainability-linked debt).
- **Credit markets**, in which credits that reflect efforts to enhance or conserve nature are traded. This includes both nature-specific credits (for example, biodiversity credits, water credits and mitigation banks) and nature-related carbon credits.
- **Derivative markets**, which are markets for financial products that directly reflect ecosystem values or risks, for example, nature-related insurance, water futures and commodity derivatives.
- **Biocultural asset markets**, in which markets capture mutual relationships between biological and cultural systems, which offer a more appropriate way to handle genetic code (digital sequence information) and virtual models (digital twins).

All markets, and in fact the whole global economy, depend on nature, but nature markets and the financial tools that drive them work to internalise the value that nature provides to economies and people — value that has historically been 'off the balance sheets'.

It is also worth distinguishing between data markets (specifically markets in environmental data) and nature markets. In environmental data markets — which have quite a long history — businesses and government agencies procure data for purposes such as financial disclosures, risk analysis, project evaluation and credence attributes for goods and services. What is exchanged is simply data: the value of information, not the value of nature itself. There is an overlap with nature markets, in which data often underpins the goods and services (for example, agricultural goods or ecosystem services) being exchanged, as outlined above. This is particularly true in credit, derivative and biocultural asset markets, where exchange is in the form of bundles of data. However, a crucial difference is in the alignment to nature-positive outcomes. Data markets tend to be indifferent to nature; environmental data is often used to enable extraction and destruction, rather than restoration or protection. In contrast, a nature market that exchanges data does so to improve biodiversity through stewardship payments, or payments for ecosystem services or biodiversity credit sales. With respect to assets, we can also distinguish between a market exchange that sustainably trades fruit in order to economically support the community that protects the ecosystem (a nature market) and a market exchange that depletes the fruit supply, then chops down the trees, extracts the minerals underneath and displaces the community (a pure asset market). A defining feature of nature markets is that they are aligned to nature positivity.

1.1 Who are Indigenous Peoples and local communities?

There is no universal definition for 'Indigenous Peoples'. Instead, 'Indigenous' is based on a number of criteria, with the fundamental criterion being self-identification. An important criterion is historical continuity with pre-colonial or pre-settler societies. Indigenous Peoples have strong links to their ancestral territories and natural resources, practise unique traditions, and retain social, cultural, economic and political characteristics that are distinct from those of the dominant societies in which they live. They hold unique knowledge, practices and solutions related to the conservation and sustainable management of natural resources, administering a significant portion of the world's biodiversity.

The Convention on Biological Diversity refers to Indigenous Peoples as embodying traditional lifestyles relevant for the conservation and sustainable use of biodiversity (Article 8(J)) (Convention on Biological Diversity, 2026). Other terms are sometimes used that align to varying degrees with Indigenous Peoples, including Tribal Peoples, First Peoples/ Nations, Aboriginals, ethnic groups, pastoralists, nomads, peasants, Hill peoples, and so on (United Nations Permanent Forum on Indigenous Issues, no date; World Bank, no date). Throughout this report, Indigenous Peoples are referred to in the plural to recognise the diversity and distinctiveness of the many Indigenous populations around the world. Each group has its own unique culture, language, history, governance systems, spiritual traditions and ways of life. The plural form is a way to honour and acknowledge heterogeneity within and across different Indigenous nations, either recognised under nation-state or international law or not.

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) defines a local community as: "a group of individuals that interact within their immediate surroundings and/or direct mutual influences in their daily life". In this sense, a rural village, a clan in transhumance or the inhabitants of an urban neighbourhood can be considered a 'local community', but not all the inhabitants of a district, a city quarter or even a rural town. A local community could be permanently settled or mobile (IPBES, 2016).

Notably, some Indigenous Peoples are not formally recognised by law or politically, and therefore are referred to as local communities, meaning that there is overlap of the two terms. For example, in many African countries only mobile peoples are recognised as Indigenous, while settled peoples are not, even though they are also Indigenous to these countries. We recognise that where the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) is not formally applied, where self-determined Indigenous Peoples are not recognised, there may be other legislation that can provide additional support to international instruments, such as the African Charter on Human and Peoples Rights in an African context.

We use the terms 'Indigenous' and 'Indigenous Peoples' to refer to all those who self-determine as Indigenous (including a range of local communities in Africa and elsewhere). We understand that this status may not be recognised by the governing nation-state or jurisdiction in which such people and peoples exist.

Botanist assisting community scout with plant species identification during a vegetation survey in Tondwa Game Management Area, Zambia. Photo credit: Conserve Global

2

Data underpinning nature markets

The importance of transparent, accessible and trusted information in nature markets is paramount to ensuring their integrity and generating environmental and economic value, in turn providing positive impacts for both nature and people. In this section, we break down what data is and how data moves through a supply chain in nature markets. We introduce the key dimensions of data that need to be considered in nature markets, that we later build on.

In nature markets, biological data, financial data and human data generate value by informing verification and validation processes. Various data types can also be used for marketing purposes. More broadly, data that is accessible for all parties (in both readability and in a literal sense) and is in conformity with the rights of Indigenous People is key for creating a transparent and accountable market mechanism.

2.1 What is data?

The word *data* derives from the Latin verb *dare* (to give) — *datum* means 'a thing given'; the plural *data* means 'things given', though today the word is often used (as herein) as a singular noun to mean a set of information. But what information is given, by whom, from what, to whom and under what conditions of accountability? These foundational questions determine the architecture of any data economy. In the computational tradition, which has become dominant, data is defined functionally: any information that can be collected, stored, processed and transmitted in a structured form; data is treated as 'neutral raw material' that gains meaning only through analysis.

The decision that something is data is an act of arbitration, in that it is a judgement that something is worth recording, that it constitutes evidence and/or that it has standing in a governance framework. Something becomes data when a social process declares it to be so, for instance when a regulator writes it into a monitoring protocol, when a scientist decides to measure it, when a community chooses to document it or when a platform is designed to capture it. These are not neutral technical choices: they are determinations of what counts, and therefore of what is governed. For Indigenous People, their rich ancestral knowledge about nature may be considered as 'data' by external data actors, but for them, this system of knowledge is not 'neutral raw material' but has related biocultural and spiritual values and customary laws. ILK systems govern the use of different types of ILK and must be respected even when Indigenous data leaves the community.

In Euro-western societies and nature markets, data is recognised as such in various ways:

- Technically, something becomes data when it is encoded in a format that a computational system can process, such as an indicator, number, label, coordinate or sequence.
- Institutionally, something becomes data when it is recognised by an authoritative framework as a valid input, for example, when a biodiversity standard accepts a field observation for monitoring, reporting and verification (MRV), or when a court accepts a genetic sequence as evidence of biopiracy, or when an Environmental, Social, and Governance (ESG) rating agency accepts a community biodiversity assessment in a disclosure.

- Politically, something becomes data when it is made legible to external systems. This carries risks, because once in external systems, data circulates beyond the originating entity's control and outside the original knowledge system. This is referred to as the 'threshold decision' of the data lifecycle (Flores, 2025a), because externalising knowledge as data is an irreversible act that requires consideration of the knowledge system in which the data originated, and the full weight of who has sovereignty of this information needs to be considered before the data is circulated beyond the original context.

For the purposes of this report, data refers to information in any form (including quantitative measurements, qualitative observations, spatial information, images, recordings, documents and knowledge records) that is collected, generated, managed, or shared for the purposes of monitoring, research, decision making, governance and reporting. This includes information derived from scientific methods as well as ILK systems.

The power to define what constitutes legitimate data and knowledge, what gets measured, how it is managed, who gets to monetise it, which knowledge types are accepted and what thresholds trigger regulatory action are inseparable from the power to govern (Barrett et al., 2025; Flores et al., 2026). Table 1 breaks down key dynamics of data arbitration.

Table 1. The dynamics of making decisions around data

Type	Application in an Indigenous data economy
Ontological and technical arbitration	Determines what phenomena can become data, how they are represented, and whose realities are legible within data systems. Technical architectures are not neutral: schema design, supported formats and metadata structures establish the costs of data production and determine whether ILK systems can enter the data economy without distortion or loss of associated rights and responsibilities. Emerging standards such as IEEE Std 2890 2025 and the Sovereign Data Supply Chain Framework (IEEE Std 2890, 2025; Kinray Hub et al., 2026) offer emerging frameworks that shift technical arbitration from discretionary design choices to enforceable conditions of platform legitimacy.
Methodological arbitration	Determines which methods, indicators and forms of evidence are recognised as valid, shaping how data is aggregated, analysed and transformed into insight and foresight. This dimension governs how data is weighted within decision making systems, and whether Indigenous systems must conform to external standards to be recognised.
Legal and institutional arbitration	Determines how data can be owned, protected, licensed or excluded from circulation, particularly in contested domains such as TEK and associated genetic resources commonly referred to as digital sequence information (DSI) (human and non-human). Existing international regimes partially recognise the rights of Indigenous Peoples but often lag in regard technological extraction methods and tools (for example, digital sequencing, AI) and fail to protect Indigenous data in the public domain. Emerging legal instruments seek to realign legal arbitration with Indigenous data sovereignty and close governance gaps.
Indigenous governance and protocol arbitration	Determines how data does, or does not, move according to Indigenous laws, protocols, customs and relational obligations. This dimension expresses Indigenous data authority by deciding who can access data, for what purposes, under what conditions and for how long. It includes the authority to monetise data through allocating shareholders to the data and/or data licensing agreements and licensing, as well as the authority to withdraw or retire data to prevent perpetual extraction and ensure intergenerational accountability.

2.1.1 Indigenous data in nature markets

In conventional nature markets, methodologies define what data is needed, such as when a standard-setting body has determined that a particular indicator is necessary for credit issuance. However, importantly for Indigenous data, that knowledge does not come before the relationships that generate it: knowledge is not something that is collected and stockpiled but something that exists in relationships (Wilson, 2008). There are minimum necessary conditions for something to function as data in each methodology: it must be captured, formatted, stored and interpretable within

an institutional framework. Each of these conditions is a point of potential exclusion or isolation. This can result in Indigenous data failing to qualify as data in the technical sense, even if it contains more relevant information than an indicator that does qualify.

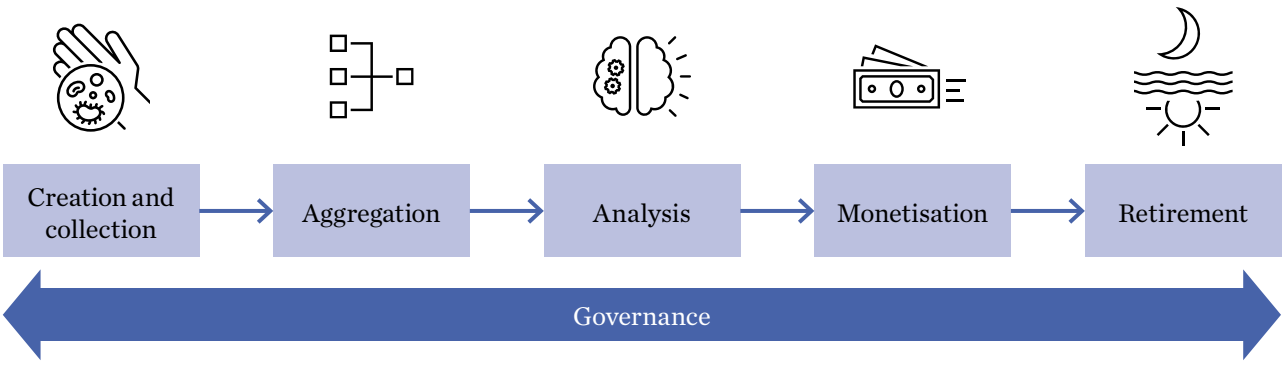
Indigenous data may become part of nature markets in several ways, yet the incorporation of Indigenous data is sometimes done without the knowledge or approval of Indigenous Peoples. For example, when a data actor decides to extract the data from a territory and use it for their own purposes, an AI tool ingests the publication that Indigenous knowledge was cited in without accreditation, or because an eDNA sample captures the genetic signatures of a community's agrobiodiversity without anyone's knowledge. The 'Indigenomics' framework[2] argues that such structural asymmetry is the economic root of Indigenous exclusion from data markets, and that Indigenous Peoples should control the initiation of the data creation process and collection of data on their territories, and not only the conditions of subsequent use (Hilton, 2021). Treating Indigenous knowledge as data to be harvested, rather than as knowledge systems, has been foundational to colonial epistemology and misinformation (Smith, 2021).

It is useful to consider the data value chain: how data flows through a value chain over time to generate a product that is the basis of a nature finance mechanism, joining up supply and demand for data (see Figure 1). The data value chain is the sequence of activities through which observations are transformed into intelligence and monetary value (for Indigenous People and potentially others). It begins with data generation and collection: sensors, surveys, satellite imagery, administrative records, on-the-ground monitoring of lands and waters and, in the Indigenous context, TEK. From there, data moves through stages of aggregation (for example in databases, cloud platforms), cleaning and storage, then on to analysis (using models, AI and statistical methods, and Indigenous systems of analysis), application to policy, disclosure and market instruments, before being distributed to users in the form of dashboards, indices, certifications or embedded inputs into other products — involving monetisation through means such as licensing, application programming interface (API) fees, data products and financial instruments. Finally, data retirement is an important step that is often required under data legislation, though compliance can be challenging.

Each step can add value to the data, and at each step the question of who captures that value, and on what terms, is consequential. The further data travels along this value chain, the more it is abstracted from its source, and the more the value tends to concentrate in the hands of those who control the analytical and distribution layers, rather than those who generated the underlying observations.

Transforming the data value chain requires intervention at each node. As proposed by the emerging Sovereign Data Supply Chain Framework[3], Indigenous communities shall have: (a) visibility — knowing where their data is; (b) veto authority — the right to halt processing that violates community protocols; and (c) binding return on investment (ROI)

Figure 1. Key nodes in the data value chain



Source: Adopted from Open Data Watch (Open Data Watch, no date)

[2] The Indigenomics framework is a framework developed by Carol Anne Hilton in which Indigenous Peoples can participate, own and create value within economic systems (Hilton, 2021). As an economic system, Indigenomics does not solely focus on profit maximisation, it also prioritises stewardship and sustainability of environmental resources, reciprocity, mutual responsibility rather than individual wealth accumulation and blending traditional subsistence activities with market enterprises.

[3] The sovereign data supply chain is a decentralised governance and technical framework that operationalises Indigenous data provenance and shareholdership by linking digital assets to their Living Territories. It offers an example of a framework to transition Indigenous Peoples from passive 'subjects' of data extraction to active Source Domain Authorities who exercise 51% or greater majority control over the lifecycle of their high-integrity biocultural assets. Bridging the the digital market and the origin of the information, ensure that digital representations remain connected to the physical territory and that value generated downstream returns to regenerate the biocultural source. (Kinray Hub et al., 2026).

— receiving economic returns proportional to value generated at that node (Kinray Hub et al., 2026). Some frame this as an economic design problem, highlighting that "Indigenous Peoples have been left out of the value chain, not by accident, but by design" (Hilton, 2021). A transformation of the data value chain should therefore follow Indigenous economic logic rooted in relationality and reciprocity: value created within a relationship must be returned to all parties in that relationship (Trosper, 2022).

The data supply chain transformation required is a varied system of decision making around data (data arbitration): not one global standard that all knowledge must meet, but a co-created framework of mutual recognition in which Indigenous governance protocols and non-Indigenous technical/legal standards each respect the other's authority at each step of the value chain. Africa data ethics scholarship frames this as the condition for genuine data justice in postcolonial contexts — applicable globally wherever ILK systems interact with external or internal data economies (Barrett et al., 2025).

2.1.2 Five dimensions of data

To enable discussion of generating monetary value through data and its associated information, we define 'data' in terms that are hospitable to Indigenous data, rather than by importing definitions designed for existing computational economies. These dimensions (outlined in Table 2, page 22) of data emerge from reviewing decades of Indigenous and non-Indigenous literature and authors' lived experiences of participating within movements around Indigenous data sovereignty, governance, authority and digital transformation. We propose that all data exists simultaneously across five dimensions (see Table 2), and that understanding data requires attention to all five.

Once data is recognised as having the five dimensions set out in Table 2, the conventional data value chain (see Figure 1, page 20) becomes a specific political-economic arrangement, not a technical inevitability. At each stage, data value is transformed from the original data source and accumulated by the entity controlling the next processing stage. Indigenous Peoples, who tend to be positioned (both currently and historically) as data sources at the collection stage, receive the least value transformation and therefore the least ROI from the data value chain, while bearing the greatest risks (including the cost of making data exist, from some downstream applications and threats to intellectual property rights).

2.2 Data genealogy

Data should retain the relationships from which it was generated: relationships of accountability, protocol, reciprocal obligation and governance (see Box 2, page 24). 'Data genealogy' is the practice of making these relationships explicit, documented and enforceable across the full lifecycle of a data system. It is foundational to data governance, not an add-on. Data without a genealogy is data whose relationships have been severed: it may carry ecological information while containing no record of who generated and curated it, under which protocols, with what obligations or through what transformations.

The temporal dimension of data means that genealogy is not a snapshot but a living record. Data about an ecosystem in one season, generated under one governance framework, translated through one set of methodological choices, is not the same data if any of these parameters change. The genealogy should track not only the origin of data but transformations such as processing steps and format conversions. The genealogy also extends into the future, including downstream inferences that are derived from it and models using the data for training (for example, AI agents). From an Indigenous perspective, the integrity of Indigenous data over time requires that its genealogy remains legible across generational timescales, not merely across a project cycle.

Table 2. Five key dimensions of Indigenous data, with application to an Indigenous data economy

Dimension	Guiding questions	What
Ontological	What is the data? Does it represent physical quantities, relational states, ceremonial obligations, ecological memory? Data can represent phenomena that some knowledge systems, but not others, recognise as real.	Data typologies must be broad enough to accommodate biocultural data, relational indicators and non-material ecological knowledge. Multiple ontologies can be linked through the Multiple Evidence Base (Tengö et al., 2014) approach to accommodate territories' data. From a multiple-ontology science perspective, theories such as Sumak Kawsay (Hidalgo Capitán and Guillén García, 2014) and Kincentric Ecology (Salmón, 2000) and Rights of Nature (Global Alliance for the Rights of Nature, no date) frameworks have different types of data that current databases within environmental markets may not support (Malo Larrea et al., 2024).
Relational	From what relationship did this data emerge? The relationship — between observer and observed, community and territory, researcher and knowledge-holder — shapes what can be seen and what remains invisible. No relationship is neutral.	Indigenous data is usually generated within specific territory-community-protocol relationships that are integral to its meaning and its governance. Stripping away relational context to produce 'generalisable' data breaks the chain of obligation that gives the data its integrity. CARE Principles (Carroll et al., 2020), OCAP® (First Nations Information Governance Centre, no date) and the Kara::Kichwa Data Sovereignty Framework (Flores et al., 2026) all ground data governance in the primacy of relationships.
Temporal	When was the data generated, under what conditions, and for how long does it remain valid? Data has a temporality: it carries the conditions of the moment of its production and has a lifespan of ecological, cultural and political relevance.	Indigenous data is often temporally embedded in seasonal, generational and cosmological cycles. An Indigenous data economy requires temporal bounds to when data can be used, and for what, including built-in mechanisms for communities to withdraw data from mechanisms when they choose to. Intergenerational governance requires that data stewardship persists across multiple human lifetimes (IEEE Std 2890, 2025; Kinray Hub et al., 2026).
Informational	What information does data carry? This is the classical definition: data as a structured carrier of information that reduces uncertainty. But what counts as information is a cultural and political choice: what signal is extracted from what noise is not technically neutral. Thus, data is never neutral.	Indigenous knowledge systems extract information from phenomena that Western science typically treats as noise, such as the behavioural patterns of individual animals as ecological indicators, the cultural significance of particular species combinations or the spiritual state of a watershed as understood through ceremonial knowledge. Expanding the definition of 'information' to include these signals requires epistemic pluralism at the level of data architecture (DePuy et al., 2022; Flores et al., 2026; Kovach, 2009).
Political and governance	Who benefits from the production of this data? Who is harmed? Who decides what counts as data and what does not? Data is never apolitical; it is produced within power relations that shape what is visible, valued, measured, managed or monetised, and what is governable.	The political dimension is where Indigenous data sovereignty, governance and authority begin. Control over data definition is bound up with control over territory. The powers to ensure recognition of customary laws and protocols relating to different types of Indigenous data and ILK, to determine which indicators count as valid MRV, which knowledge formats are accepted as evidence, and which communities are recognised as data curators, are integral to the power to govern nature finance equitably (Carroll et al., 2020; Flores et al., 2026; Convention on Biological Diversity, 2011).

Indigenous data genealogy systems have a very long history, some dating back millennia before the term 'data' entered the vocabulary of Western science[4]. For example, Khipus (or quipus) are information and record-keeping devices long used in Andean:Amazonian civilisations. Each Khipu comprises a horizontal string (or cord) with knotted strings hanging off it, the knots denoting numbers and relational, narrative and administrative information across a variety of cords. Computational analysis of 650 Khipus has demonstrated rigorous logic and tracking (Medrano and Khosla, 2025). Yupanas (Andean computational devices) perform arithmetic, in line sequences identified within Western mathematical theory such as the Fibonacci sequence, while maintaining the contextual relationship to the quantities being calculated (Pilgaonkar, 2014). These were therefore not merely counting tools, but architectures of relational accountability: data that knew its lineage, its obligations and its governance context. Chakanas are mapping frameworks based on the Andean sacred cross that place elements of knowledge into four quadrants, emphasising the balance of opposites and reciprocal relationships between peoples and nature. They provide an architecture for understanding how data generated at different levels of an ecological scale related to one another (for example, connecting information on seeds to decision making on land use) and what governance obligations flow across those relationships.

In present-day nature markets, data genealogy operationalises three critical functions:

1. **Provenance:** every data set used in a nature finance mechanism, an MRV system, an ESG disclosure or in the Taskforce on Nature-related Financial Disclosures (TNFD) should be traceable to the community where it was generated, the protocols governing its collection and the ongoing consent framework authorising its use. The IEEE Standard is an example of a technical architecture for tracing across digital systems that is explicitly designed to enable relational dimension of Indigenous data, one of the first of its kind (IEEE Std 2890, 2025).
2. **Transformation audit:** as data moves from systems knowledge to field observation to statistics to geographic information system (GIS) layer to AI training dataset, each transformation should be documented to maintain the relational integrity of the original data. Each transformation that strips cultural context, simplifies ecological complexity or removes community attribution breaches an aspect of data genealogy. Often, such violation of the relational dimension of data is not recoverable after the fact (Audit and Assurance Services Branch, 2023). The sovereign data supply chain framework offers a solution by specifying audit requirements at each node of the transformation of data value chains, providing a functional standardised protocol (Kinray Hub et al., 2026).
3. **Obligation inheritance:** Indigenous data carries obligations that travel with it — obligations to the originating community, to future generations and to the non-human entities represented in the data. These obligations do not disappear when data is licensed, aggregated or monetised. The 'Responsibility' dimension of the CARE Principles (see Section 3.1, page 25) and 'Biocultural Integrity' of the Sovereign Data Supply Chain protocols make this a governance standard: data actors using Indigenous data inherit responsibility for nurturing the relationships from which the data derives (for example, data actors must maintain management in line with agreed management plans) (Carroll et al., 2020). When data extraction without community governance occurs, the result is accumulation of research and commercial capital from local knowledge without return and the risk that data/knowledge is used in ways that go against the customary laws and spiritual values of Indigenous Peoples (Barrett et al., 2025). Some frameworks, such as the Sovereign Data Supply Chain, make it an obligation that any dividends from the data must return to the data source, and hold data actors responsible for fulfilling data shareholdership agreements. However, such frameworks are not legally binding, and it is very difficult for communities to control the use of their data/knowledge once it has been documented and left their community — therefore, it may be best for communities not to include data/knowledge which they consider sacred or which could be used for biopiracy (for example, knowledge about medicinal-plant uses or traditional crop properties) in data sets for nature markets. Upholding shareholdership and relationship context of data is also of interest to private sector actors, to mitigate risks of extractive practices, misconduct and ensure their own objectives of conservation or restoration are met.

[4] We use the term Western Science here loosely, referring to science from Western, Educated, Industrialised, Rich and Democratic jurisdictions, commonly referred to as 'WEIRD' Science.

Box 2. Can we separate data on nature and data on people?

Crucial to the ontological dimension of data (in other words, what it represents) is the question of whether 'nature data' and 'peoples' data' can be separated. A foundational assumption in mainstream nature market data architecture is that nature data (ecological, biological, environmental, material) is categorically distinct from peoples' data (social, cultural, economic, political, ways of life). This separation is not neutral: it reflects a worldview that separates nature from peoples and views the world as understandable through rational analysis and mathematics. It is reproduced in the regulatory and financial architectures of environmental markets.

From the perspectives of many Indigenous knowledges and worldviews, this separation is a paradox. For example, in the Ecuadorian and Peruvian Amazon, the Kichwa governance of 'Mother Earth' (Pacha Mama) does not position the natural world as an object separate from human communities, but instead positions human communities as relatives with and within a living Earth system. Sumak Kawsay (the Andean philosophy of 'Buen Vivir' or Good Living) considers flourishing as an inherently relational state: the health of a community is inseparable from the health of its watershed, soils, seed networks and biocultural practices and sacred mountains. The Anishinaabe concept of manoomin (wild rice) as a relational being, not merely a plant species, is another example that contradicts the notion of a nature/culture distinction (Panek et al., 2025).This is not merely a philosophical matter: transcending the nature-society dichotomy (for example through dialogue between Sumak Kawsay and non-Indigenous scientific understanding of complex systems) has direct implications for how ecosystem governance is structured (Panek et al., 2025). In practice, this means moving away from treating nature as an external object to be managed by society, and instead recognising ecosystems, peoples, knowledge and governance as part of a whole, relational system, with shared responsibilities and consequences.

Consequences of disaggregating data into separate nature and people categories include:

- Different aspects of Indigenous data may be classified as either 'nature' data or 'peoples' data, placing them under different governance regimes that may not reflect the integrated, biocultural nature of the data.
- When re-aggregated for AI model training or national biodiversity assessments, the contextual relationships that make the data ecologically meaningful are likely to be stripped away, producing datasets that encode ecological dynamics without the underlying ILK.
- AI systems trained on disaggregated data produce outputs affecting Indigenous territories without any mechanism for the communities who originated the data to recognise, contest or govern those effects. This is what has been called the 'central dogma of AI' risk: data is perpetually recombined through AI retraining without community control over downstream uses (Flores et al., 2026).

A possible solution to this 'disaggregation problem' is the emerging category of 'biocultural data products' (biocultural assets). Data in this category captures co-constituted relationships between biological and cultural systems. The 'biocultural conservation' framework (Rozzi et al., 2019), the biocultural literature, and data governance on the United Nations Nature ID ecosystem (Flores, 2025b) are all consistent with this integrated data architecture. Nature markets that do not allow integration of 'peoples' data' and 'nature data' through considering both types as biocultural data will systematically undervalue Indigenous territories and undercount Indigenous Peoples' role in nature asset management and biodiversity conservation.

3

Indigenous data in nature markets: current conditions for nature and people

3.1 Existing legal frameworks and principles

There are principles that apply directly to data derived from Indigenous Peoples and their territories, as well as broader principles that apply to all data, such as the General Data Protection Regulation (GDPR) in the UK. Here, we focus on the primary principles that apply specifically to data derived from Indigenous Peoples and their territories. There are many such principles, and this section does not intend to list them exhaustively; rather, it aims to outline the crucial frameworks that underpin Indigenous data management in nature markets. It is worth noting that the mere existence of such a large number of principles and guidelines signals the importance of reliable information, the lack of trust in this space and a history of poor transparency and misconduct with regarding nature markets (including carbon markets), Indigenous knowledge and Indigenous territories.

3.1.1 Principles related to Indigenous data: FPIC and CARE

An important starting point for any engagement with Indigenous Peoples is the UNDRIP, which was passed by the UN General Assembly in 2007, and has been endorsed by almost all the 193 UN member states. It aims to encourage national governments to work ethically with Indigenous Peoples to solve important issues, including the biodiversity crisis. Underlying much of the Declaration are the principles of FPIC, which are recognised by UNDRIP as follows (FAO, 2016):

- **F**ree: consent must be given voluntarily, without any direct or indirect factors that can hinder Indigenous Peoples' free will (including coercion, intimidation or manipulation), and with the freedom of the Indigenous Peoples to set their expectations and to contribute to defining methods, timelines, locations and evaluations.
- **P**rior: consent must be sought as early as possible, and not after important details have already been decided or initiated; and, allowing enough time for the operation of the Indigenous Peoples' own decision-making processes.
- **I**nformed: the information provided to Indigenous Peoples must be comprehensive, covering direct and indirect consequences — both positive and negative — and be clear, objective and accurate.
- **C**onsent: this key principle allows Indigenous Peoples to exercise their right to self-determination. All three criteria above (free, prior and informed) must be fulfilled.

FPIC allows Indigenous Peoples (and local communities that may not be officially recognised as Indigenous but fulfil the criteria to be so) the right to negotiate on their own terms, and to give or refuse consent for anything (such as a project or action) that would affect their territories. Consent is dynamic, meaning it is ongoing and should be obtained from Indigenous authorities (not just individuals), bearing in mind existing governance systems within Indigenous communities.

Communities have the authority to renegotiate when the conditions for data use change; in such cases, they can withdraw consent. In addition, Indigenous communities should not accrue the cost of the FPIC due diligence (Flores, 2025b).

Concerning Indigenous data and nature markets, FPIC presents Indigenous Peoples with choices over what type of data to provide and how data derived from their peoples and territories is managed across the data value chain, informed by their understanding of the risks and opportunities of doing so. This includes choices over whether to share sacred knowledge about traditions or customs, including stewardship practices, and whether to disclose information about sacred sites or species. More broadly, it also includes informed choices relating to market mechanisms, such as whether to participate in data collection regimes where there is a lack of benefit-sharing mechanisms in place to value the work of data collection and associated stewardship activities. And it includes informed choices about legal aspects of nature markets, such as whether to participate in nature markets that formalise private property rights over nature (potentially a risk with some carbon and biodiversity credit methodologies), or that could lead to patents for DSI on genetic resources. In all these instances, Indigenous Peoples can exercise their own judgement over their rights and interests and determine whether the benefits of sharing knowledge and data, and of participation in nature markets, are worth any associated risks.

Moreover, it is commonly accepted that refusal is a generative stance. When refusal is not a final 'no', there can be scope for ongoing engagement (Tuck and Yang, 2014). For nature markets, this could mean that market actors, such as project developers and credit issuers, take the opportunity to revise their processes and market instruments, to reconsider their methodologies for measurement and data management, and to more fully build FPIC and benefit-sharing mechanisms into data-gathering and project co-development, for example. In this regard, an initial refusal can serve as an invitation to develop more collaborative, mutually respectful approaches to data management and the resulting intervention, should the Indigenous party be willing.

As a foundational principle of engagement with Indigenous Peoples, for the purposes of this report, all recommendations and analysis assume that FPIC has been conducted and is continuously upheld.

To complement FPIC, the CARE Principles for Indigenous Data Governance were developed by the International Indigenous Data Sovereignty Interest Group. Published in 2020, these build upon the work and insights of Indigenous communities and researchers (Carroll et al., 2020). Briefly, the CARE Principles cover:

- **C**ollective benefit: data ecosystems should be designed and function in ways that enable Indigenous Peoples to derive benefit from the data
- **A**uthority to control: with respect to Indigenous Peoples' data, their authority to control encompasses everything from data holding to value creation
- **R**esponsibility: those working with Indigenous data have a responsibility to share how the data is used to support Indigenous Peoples' self-determination and collective benefit, and
- **E**thics: Indigenous Peoples' rights and wellbeing should be the primary concern at all stages of the data life cycle and across the data ecosystem.

The CARE Principles clearly articulate their relevance to biodiversity research and ecological data collection: "Ecology often neglects to consider the ethics and responsibilities relating to the data and intergenerational data relationships… the CARE Principles will ground ecology and adjacent fields in more ethical ecological and data stewardship practices, infrastructures and technologies" (Jennings et al., 2023). The CARE Principles complement the pre-existing OCAP® Principles (Ownership, Control, Access and Possession), which were established in 1998 by Canadian First Nations leaders (Jennings et al., 2023). These two frameworks aim to ensure that data usage aligns with Indigenous Peoples' rights and governance (Pyper et al., 2018; Carroll et al., 2020).

While the CARE Principles were designed to protect Indigenous Peoples' data in the context of research, these principles are relevant for the use, sharing and storage of Indigenous data in other contexts. Nature markets will generate a significant volume of environmental data through the processes of measurement, monitoring, reporting and verification. For example, the issuance of biodiversity credits requires the disclosure of significant data sets which relate to metrics and indicators. This data will often connect to the interests, resources and heritage of Indigenous Peoples, and should only be collected with their FPIC. Importantly, this also applies more widely where nature markets operate in places from which Indigenous communities were removed, such as state-owned protected areas, and when creating data about species of significance to Indigenous Peoples.

3.1.2 Principles related to data usage and access

Open data is data that anyone can freely access, use, modify and share for any purpose. The principle of openness is widely recognised as important because it creates value by providing researchers, communities, innovators and businesses with unhindered access to datasets to use to create new knowledge and insights, enable informed decision making and to innovate through new products and practices. To promote data openness, the FAIR principles (Findable, Accessible, Interoperable and Reusable) are guidelines to improve the quality and utility of scientific data management and stewardship. The FAIR principles require considerable amounts of metadata, along with registration in globally accessible repositories and machine readability (Starr et al., 2015). Such repositories should follow the TRUST principles (Transparency, Responsibility, User Focus, Sustainability and Technology), which promote data integrity, authenticity, reliability and accuracy (Lin et al., 2020).

The orientation toward open data is consistent with Article 19 of the Universal Declaration of Human Rights, which is best known for its protections of freedom of opinion and expression, but also asserts the right to 'seek, receive and impart information and ideas through any media and regardless of frontiers' (see also Article 19.2 of the International Covenant on Civil and Political Rights / ICCPR) (United Nations, 2007; United Nations, 1967). This is a right that imposes duties primarily on states for non-censorship, public disclosure of official information and accessibility and legibility of public information. Upholding these rights to open and accessible information can empower Indigenous Peoples to participate effectively in political and market processes, to advocate for their needs, to hold powerful actors accountable and to participate meaningfully in governance of territories. Indeed, the 'I' in FPIC (see Section 3.1.1) requires that Indigenous Peoples receive sufficient information to give (or deny) informed consent to development that affects their interests, which requirement is served by ensuring that relevant information is open, accessible and intelligible.

Turning to nature stewardship, access to environmental data can be useful for the effective management of natural ecosystems and resources. Open-access data and information (see Box 3, page 28) can also help Indigenous Peoples to effectively participate in formal processes for natural resource management, including engaging with private developers or regulators designing environmental legislation. Following the principle of collective benefit in the CARE Principles (the 'C' in CARE; see Section 3.1.1, page 25), nature data can and should be utilised for the benefit of Indigenous Peoples and all communities that depend on healthy natural environments. This includes sharing traditional and ecological knowledge as a source of culturally embedded, often site-specific knowledge that can improve environmental stewardship outcomes.

Bridal Veil Stinkhorn (*Phallus indusiatus*), Gabon.
Photo credit: Anna Ducroas/IIED

Successful participation of affected communities in the evidence-based management of natural resources, in turn, has follow-on effects for the rights of those communities, such as the right to sufficient, safe and affordable water for personal or domestic use, and the more general right to a clean, healthy and sustainable environment. This also relates to the rights of nature itself to exist, flourish and regenerate (often particularly important from Indigenous perspectives). Where open and accessible environmental data can improve nature stewardship, it can be rights-affirming, supporting communities, businesses and governments to competently exercise their duties to people and planet.

3.1.3 The framework of Indigenous Cultural and Intellectual Property Rights

The framework of Indigenous Cultural and Intellectual Property (ICIP) rights is well established and enshrined in specific declarations, such as the Mātaatua Declaration on Cultural and Intellectual Property Rights of Indigenous Peoples (1993) and the Julayinbul Statement on

Indigenous Intellectual Property Rights (1993). It is also supported by the rights articulated in UNDRIP, especially in Article 31.1, and regulated by country legislation.

> "Indigenous Peoples have the right to maintain, control, protect and develop their cultural heritage, traditional knowledge and traditional cultural expressions, as well as the manifestations of their sciences, technologies and cultures, including human and genetic resources, seeds, medicines, knowledge of the properties of fauna and flora, oral traditions, literatures, designs, sports and traditional games and visual and performing arts. They also have the right to maintain, control, protect and develop their intellectual property over such cultural heritage, traditional knowledge and traditional cultural expressions."

This right corresponds with a duty upon states to recognise and protect these rights (Article 31.2).

Although the commercialisation of culture and knowledge is not an objective of nature markets, it is important to consider ICIP in relation to traditional knowledge or practices and/or Indigenous concepts and motifs that are used for

Box 3. A push for open-access data

The open-access movement challenges the traditional model of academic publishing, in which research findings are locked behind expensive journal subscriptions accessible only to well-resourced institutions. Emerging from the early 2000s — catalysed by landmark declarations such as the Budapest Open Access Initiative — the movement advocates for the free, unrestricted availability of peer-reviewed research online. Its core argument is that knowledge generated through publicly funded research should be a public good. In this sense, it also upholds the rights and entitlements of all people, regardless of geography or wealth, to access the science that shapes decisions about the natural world they depend on (although academic publishing mainly focuses on Western rather than Indigenous sciences).

For environmental practitioners, effective ecosystem management depends on the evidence base, from biodiversity assessments to pollution monitoring to invasive species tracking. However, paywalled research has long placed much of that evidence out of reach of community stewards, field ecologists and resource managers in lower-income countries. Open-access dismantles these barriers, enabling a ranger in a Kenyan wildlife reserve or a policymaker drafting a national biodiversity strategy to draw on the same science as researchers at elite universities and in wealthier nations. This directly supports commitments enshrined in the Convention on Biological Diversity (CBD) and the UN Sustainable Development Goals (SDGs), which call for science-based decision making and the equitable sharing of knowledge. Ensuring that the best available science flows freely to those who need it most is not merely an academic ideal; it is an urgent practical necessity for achieving sustainability goals and upholding the right to a clean, healthy and sustainable environment. However, it is worth noting that Indigenous sciences are currently undervalued and underrepresented in academic publishing and are often not considered as valid science, which probably contributes to their erosion and loss.

The main drawbacks of open-access publishing relate to the issue of who pays to maintain high quality open access publications, and broadly fall into two categories: data quality and inequalities in the production of knowledge. There are costs associated with curating, publishing, maintaining and promoting data (for example, with making it findable and usable). Paywalls, where the data users pay to access and use the data, often cover these costs, and the data providers can contribute the data for free. Open-access usually (though not always) shifts the costs to the data and knowledge providers, who have to pay to publish. This contradicts the underlying logic of open-access; if data is a public good, the cost should not be borne by individuals. When the user pays, the incentives for the publisher are towards high quality and continued curation of data and other research outputs, to ensure that people will buy them. When the author or contributor pays, the financial incentives for the publisher switch towards publishing whatever is submitted to them. Although some publishers have procedures that mitigate this to some extent, the incentives for open-access therefore tend to lead towards weaker quality control and publication only by those who can afford it.

Additionally, when Indigenous data becomes open access, the communities in which the data and information originated may find it difficult to reap the monetary value of the data use. In economic terms, this revenue can be considered as the royalties generated from their data. It is crucial that data management plans incorporate ongoing benefit-sharing, or a royalty scheme, should the Peoples decide to allow their data to be open-access.

market development and/or marketing and branding purposes. For example, nature markets might create incentives for non-Indigenous market participants to implement Indigenous stewardship practices to protect an ecosystem, or might utilise Indigenous words, concepts or symbols as part of the branding. For instance, the nature-based solutions market has built Indigenous biocultural solutions into its market narrative without creating the data shareholdership mechanism for the Indigenous creators of those solutions (Nelson and Reed, 2025). Use of ILK of this nature risk being inappropriate, unsafe and even offensive, and can also be a breach of ICIP rights.

Protection of ICIP rights varies significantly around the world. In many countries, there is limited legal recognition of, or protection brought by, ICIP, unless it meets the requirements of intellectual property laws such as copyright. However, various protocols aim to fill this gap on a voluntary basis. These protocols and recommend practices of establishing consent, co-development and collaboration with Indigenous rights holders from the beginning to the end of any engagement, and cultural awareness and cultural safety training for non-Indigenous participants and include international trade agreements pertaining to intellectual property rights.

3.1.4 Acknowledging conflicts among rights frameworks and the right of refusal

It is well understood, however, that rights frameworks can conflict with one another, and thus it is often necessary in practice to balance one right against other rights. For example, considering FAIR and CARE Principles together, there are trade-offs between the two that can make it difficult to achieve both. In particular, the CARE principle 'Authority to control' can conflict with the other A, the FAIR principle of 'Accessibility'. Ways of addressing this include building biocultural and TEK into the data and metadata (see Section 2.2, page 21, on data genealogy) and ensuring that Indigenous Peoples co-develop with scientists ways of applying CARE Principles to data production.

An important conflict that needs to be considered is the right of refusal by all people, including Indigenous Peoples, to share knowledge or information if they so choose. The right of refusal overlaps with rights articulated in UNDRIP, including the rights to self-determination, customary governance and self-representation, and also various rights to protect Indigenous traditions, customs and sites. More generally, the right of refusal is necessary for the proper exercise of consent — that is, an Indigenous community can only truly grant others the right to access knowledge if they have the existing power to freely withhold that right. Unfortunately, in recent history Indigenous leaders have faced threats, violence and even death upon refusal and resistance. Though such measures are extreme examples, they are not uncommon, and we highlight them here to show the strong power dynamics at play when implementing FPIC that create environments in which consent is not freely given (Simpson, 2017).

Lastly, a number of countries, including Costa Rica, Kenya, Peru and Zambia, have introduced national laws that protect traditional knowledge related to biodiversity conservation and restoration, which require FPIC and benefit-sharing for its commercial use (Ouma, 2017). This aligns with the CBD, which requires states to 'respect, preserve and maintain knowledge innovations and practices of Indigenous and local communities relevant for the conservation and sustainable use of biological diversity' and to encourage the equitable sharing of benefits arising from their use. Attention must be paid to the regional and national jurisdiction in which nature markets are operating and any relevant legislation, principles or agreements.

3.2 Existing challenges to equitable data management and nature markets

The following section outlines existing challenges to ensuring that data that generates monetary value shares that value with environmental stewards in nature markets. These challenges are underpinned by self-perpetuating, systematic and historic challenges such as colonialism and epistemic power struggles. They lead to continued challenges around inclusion, transparency, accountability, legitimacy and demand for nature market products in the short and medium term.

3.2.1 Exclusionary application and use of technology

Technology is a critical driver of the emergence of nature markets, and for ensuring that both monetary and non-monetary value is generated. New measurement tools are unlocking new possibilities for nature finance products, including the development of biodiversity credits that encompass various metrics, indicators and models (Ford et al., 2024). Indeed, innovation in biodiversity measurement and assessment is arguably growing faster than market demand, meaning that developers are delivering measurement tools and datasets for which there are not yet viable business

models. Ensuring new technology balances rigorous analysis, cost effectiveness and equality and simplicity for buyers is crucial to generate demand.

The growth of a technology, as an innovation process, is not inherently attentive to or consistent with the needs and priorities of Indigenous Peoples. This is not to suggest that Indigenous Peoples are anti-technology; on the contrary, they have a long history of engaging proactively with new technologies on their own terms (Argumedo and Pimbert, 2006). Rather, questions need to be asked: When is adding more technology adding value, and for whom? Who developed these technologies and what is the benefit for ecological and socioeconomic outcomes? A technology-first approach may neglect trade-offs and risks for Indigenous Peoples.

For example, online communication tools such as social media create new opportunities for Indigenous Peoples to share knowledge and tell their own stories. However, these technologies can also crowd out or displace oral forms of knowledge transfer, diminish the value of lived experience or expose Indigenous knowledge to appropriation or misuse. An example of the latter is the Bush Legend online video series, featured on the Meta platforms Instagram and Facebook, which features an Indigenous Australian man, 'Jarren', who builds awareness and education about Australian wildlife. However, Jarren is an AI-generated character, interacting with AI-generated animals in AI-generated landscapes. The social media videos were linked to an account run by a South African person living in New Zealand with no Aboriginal heritage. While there were a range of views about this appropriation, Indigenous expert Dr Terri Janke described it as "theft that is very insidious in that it also involves a cultural harm". She added that AI content about First Nations people could be produced ethically, but only with the consent and involvement of the relevant First Nations people (Collard, 2026). Navigating the trade-offs involved requires seeing both the risks and opportunities of technology, rather than treating new technology as an unambiguous good or bad.

3.2.2 Balancing speed and urgency of market developments with Indigenous justice and trust

Nature markets are evolving rapidly, drawing on the joint resources and capabilities of corporations, international organisations and governments, as well as Indigenous-led forums and governing bodies. However, this fast pace, combined with the complexity of institutions, is challenging for Indigenous Peoples to engage with. The challenges include competing demands on Indigenous Peoples, lack of resourcing and capabilities, physical remoteness and telecommunication barriers and linguistic divides across Indigenous Peoples globally. The fast pace of nature market development is not always compatible with Indigenous Peoples' processes for collective decision making, which can require more time because they are, in many cases, deliberative and consensus-oriented. It is important to ensure that Indigenous Peoples are actively and meaningfully involved in processes to develop nature markets and that they are given sufficient time to conduct consultations in their communities (which has been challenging to date).

Similarly, the urgency of the biodiversity crisis encourages haste, but this poses risks for Indigenous justice. There is a paradox here: consent, trust, accountability and reciprocity are essential qualities of the relationships that are critical for justice-oriented coordination across societal institutions on any urgent matter. Yet they are precisely the kinds of qualities of relationships that take time to nurture and develop (Whyte, 2020). For Indigenous Peoples, it is especially important that a relational approach is prioritised, because of how colonial power has been wielded in the past — that is, by using real or perceived urgencies to mask or justify privilege, harm and injustice (Whyte, 2020).

Consequently, there is the challenge of working at the speed of trust. If nature markets develop faster than trust can be built, there is a danger that the solid foundations of consent by Indigenous Peoples cannot be secured, as has been and still can be in the case of carbon markets. This challenge is known in related sectors, such as community health data. A recent qualitative study found that members of the Great Plains Tribal Nations in the US were concerned that contemporary health data systems move at a speed and scale that exceed the capacity of many Tribal governance structures, and that emerging technologies introduce levels of opacity that complicate oversight and community decision making (Hurst et al., 2026). As nature markets rapidly adopt new technologies like remote sensing and blockchain, there is a parallel risk that authentic engagement and understanding will lag the pace of design and implementation.

These challenges strain FPIC, especially the quality of prior consent. It is critical that, before an activity begins that affects Indigenous rights and interests, the affected community has time to receive information about the activity, to understand the information and to review and consult in a manner that is consistent with that community's traditions

and protocols. If this requirement is not fulfilled, then FPIC cannot be said to be given. Additionally, given that many nature finance tools are in their nascency, providing full information of all the outcomes can be challenging, because there are few historic case studies from which to draw evidence.

3.2.3 Indigenous data sovereignty and self-determination

Indigenous Peoples are knowledge holders. This knowledge takes many forms, including traditional and cultural information, oral histories and ancestral knowledge, cultural sites, knowledge relating to environment and natural resources and nature-centred philosophies. Indigenous knowledge also takes contemporary forms as datasets, raster files, GIS coordinates and more. This knowledge, in all its forms, is part of the inheritance of Indigenous Peoples which is central to identity and survival. Therefore, a community's capacity to protect such knowledge and to influence how it is used is one aspect of the greater challenge of self-determination.

In recent years, the Indigenous data sovereignty movement has grown to defend against the appropriation and misuse of Indigenous data, and to ensure that Indigenous Peoples are the primary shareholders of their data. This is underpinned by wider concepts of self-determination and equity that are enshrined in the UNDRIP (Kukutai and Taylor, 2016). For an Indigenous Peoples to have the power of self-determination is, in part, to have influence over whether their data is collected/provided and how their data and data on their territory are measured, used, stored, managed and valued.

Nature markets involve the collection of data on ecosystems and species which may relate to Indigenous Peoples and territories. This process may also engage with TEK and other forms of ILK in various ways, such as mandating or encouraging traditional management practices or stewardship activities as part of the certification process. The Communities Advisory Panel of the Biodiversity Credit Alliance (BCA) has noted that: "Where data collected on such knowledge, or innovation, and practices is used for biodiversity credits, or data is collected from Indigenous Peoples' or local communities' territories and lands, the right to primary ownership of such data should be recognised and respected" (Communities Advisory Panel, 2024)

Box 4. The Indigenous data sovereignty movement

The Indigenous data sovereignty movement emerged from growing recognition that colonial power structures were being replicated and reproduced in the digital age through the rapid adoption of the FAIR principles on 'open data and science' (Open Data Charter, no date). Governments and researchers have collected vast amounts of data about Indigenous Peoples — including health records, land use patterns, cultural practices and census information. However, they were excluded from decisions about how that data was used, shared and interpreted. Data, it became clear, was not neutral; it carried political power (see Section 2).

The intellectual groundwork for the movement was laid by Indigenous scholars and activists who drew connections between data governance and broader struggles for self-determination. Tahu Kukutai and John Taylor's work on Indigenous demography highlighted how official statistics systematically misrepresented Indigenous Peoples' realities, and asserted the rights of Indigenous Peoples to determine the means of collection, access, analysis, interpretation, management, dissemination and re-use of their data (Kukutai and Taylor, 2016). International networks, notably the Global Indigenous Data Alliance, began articulating frameworks, including the CARE principles, to uplift Indigenous sovereignty by the proper treatment and management of Indigenous data (Carroll et al., 2020).

On the ground, Indigenous data sovereignty activism has taken several forms: Indigenous-led data governance frameworks embedded in treaty negotiations; community data trusts (such as those piloted by First Nations in Canada); advocacy at the UN level connecting the Indigenous data sovereignty movement to the UNDRIP; and pressure on national statistical agencies to reform how they collect and report Indigenous data.

A concern about the Indigenous data sovereignty movement as it has evolved so far is that its foundations are concentrated in wealthier, English-speaking settler-colonial states; thus, there is a need for greater outreach and inclusion of perspectives from Indigenous Peoples of Latin America, Africa and Asia (Global Indigenous Data Alliance, no date; Carroll et al., 2021a). There are concerns that the emphasis on data governance and engagement with state and research institutions may inadvertently legitimise those same structures, rather than challenge them more fundamentally. These concerns will inform the Indigenous data sovereignty movement as it evolves in the years ahead.

The growing importance of data in a digitalised, knowledge-based economy creates both risks and opportunities for Indigenous data. There are opportunities to respectfully engage with and apply ILK, which is crucial to addressing complex challenges of our era, including climate change and biodiversity loss. The risks are that Indigenous data sovereignty will be violated by the exploitation, mistreatment or unsafe use of ILK.

3.2.4 Commodification and assetisation

A common criticism of nature markets is that they perpetuate a process of privatisation, where natural resources that were managed collectively, or as commons, are subjected to a regime of private property rights. This process has been described as the commodification of nature (Sorsby et al., 2026). It is a process where nature is framed instrumentally, ecosystem services are articulated and accorded a monetary value, then that value is appropriated by the formalisation of property rights and commercialised through markets or other institutional structures (Gómez-Baggethun and Ruiz-Pérez, 2011). More recently, the focus is shifting to a related process of assetisation — that is, the conversion of things (for example, a land parcel, a patent, a sum of money, a dataset of DSI) into assets which 'can be owned or controlled, traded and capitalised as a revenue stream' (Birch and Muniesa, 2020). The digitalisation of markets, including nature markets, using blockchain and other distributed ledger technologies opens new possibilities for the assetisation of nature and the formalisation of private property rights over data, knowledge and culture. For some Indigenous Peoples, the process of privatisation is controversial because it conflicts with traditional norms and practices of commoning and collective custodianship (as opposed to ownership). This is well documented with respect to carbon markets (Gilbertson, 2017; Goldtooth et al., 2021) and there are parallel concerns regarding nature and digital markets (Sorsby et al., 2026).

This poses new risks and opportunities for Indigenous Peoples and ILK. On the one hand, new digital capabilities such as tokenisation — that is, the process of converting knowledge or data into a digital asset with unique identifiers — create new methods for appropriating and commercialising Indigenous, traditional and local knowledge. On the other hand, the cryptographic functions of digital tokens enable new possibilities for control over the digital asset (see Box 7, page 47), potentially strengthening the sovereign power of Indigenous Peoples to determine how the digital asset is used, and on what terms. It can also enable traceability, such that the provenance of this knowledge can be assured (see Box 5, page 33, for an example of self-sovereign digital assets in the Toha Network).

Indigenous Peoples are not passive actors with regard to these processes. By involving Indigenous Peoples in the design and development of data management technologies, it is conceivable that Indigenous aspirations for self-determination could be enhanced rather than undermined. This might involve applying different economic logics, including Indigenous economic ideas and holistic wellbeing concepts such as strengthening community ownership rather than privatisation, to the design and deployment of technologies and markets.

3.2.5 Attributing ILK and actions to environmental outcomes

One reason for valuing ILK and stewardship is their effectiveness in achieving environmental outcomes. The application of ILK can help to deliver the environmental outcomes that nature markets seek, such as avoided habitat loss and biodiversity uplift. However, another critical piece of knowledge is the causal link between ILK and biodiversity outcomes — that is, the knowledge of attribution. If this causality is not well established, there is not only a risk that Indigenous Peoples' contributions are continuously overlooked, but also that others might falsely claim attribution.

Consider the hypothetical case of a company involved in extractive industry in an Indigenous territory. The damages that resulted were never consented to by the Indigenous community; on the contrary, they were vigorously resisted. The Indigenous community applied its ILK by a variety of practical means, from moral persuasion to litigation to stewardship, to prevent habitat destruction and to repair the damage the company caused. Consequently, less environmental damage was done than would otherwise have been the case. After reassessing nature-related risks and opportunities, the company decides to convert its failure into success. It collects nature-related data to make claims about habitat protection and biodiversity improvement in its value chain, then uses this data to improve its market access and to reduce its cost of capital by claiming alignment to sustainable finance taxonomies (such as TNFD and ESG). Thus, the value derived from ILK is falsely attributed to the company. Without establishing Indigenous shareholders, the financial benefits are captured wholly by the company. This example shows that the right of attribution needs to carry through the data supply chain from knowledge to action (see Section 2.2) and Indigenous Peoples to need to be properly recognised for the investment and nature stewardship that follow from ILK, as well as the knowledge itself.

Box 5. Toha Network and consent-based digital assets

The Toha Network, a Māori-led tech collective based in Aotearoa New Zealand, is developing a community-led extension of digital public infrastructure that enables new forms of collaboration for nature and climate action. It operates as an integrated system for measuring, sharing and transacting impact data, bridging the gap between those who undertake regenerative activities (including Indigenous Peoples, local communities and Afro-descendant peoples) and those who seek to support them (such as impact investors, development finance institutions and supply chain actors).

Access to verifiable data is provided through consent-based digital assets called Toha claims. These claims are structured as verifiable bundles of nature- and climate-related data, generated through rigorous measurement and MRV processes. Data templates formalise and standardise these claims for common reporting standards, such as those set by the Taskforce for Nature-related Financial Disclosures (TNFD). Thus, the Toha system produces high-integrity data assets that substantiate environmental outcomes and support credible reporting and disclosures of nature- and climate-related risks and opportunities, as well as verification of claimable impacts within and beyond corporate value chains.

Crucially, the Toha system has been designed with the principles of Indigenous data sovereignty as a minimum operating standard. Ownership of underlying data remains with those who generate it, typically frontline communities, landholders and Indigenous groups, while the network enables controlled access to that data through consent-based sharing. This ensures that data is used and re-used only for agreed purposes, which upholds the ideal of self-determination in the data economy, promoting integrity for Indigenous data providers.

Rangi and Jayden water testing at Te Kautuku, Aotearoa New Zealand.
Photo credit: Renee Raroa

The Toha Network's Data Trust plays a central governance role, safeguarding data and intellectual property as a collective asset and managing access, licensing and integrity on behalf of members. This establishes a high-trust environment in which verifiable data becomes a reusable and valuable resource for the regenerative economy.

Monetary value exchange is enabled through a token-based payment system, where digital tokens represent funded action (Mahi) and rights to access and use data (Toha). These tokens facilitate transactions that link financial resources and verified labour and impact, enabling benefit-sharing across participants. By transacting access to Toha claims — rather than transferring ownership of data itself — the Toha system intends for ongoing commercial value to flow back to the data providers, creating a new revenue stream that supports their time and effort as stewards and care-givers of nature and community.

The Toha Network is in its demonstration phase, undertaking test transactions to validate market demand. By scaling up these transactions over time, the Toha Network intends to use new digital capabilities for assetisation to empower community self-determination, and to provide trusted digital infrastructure for complex transactions that would otherwise be out of reach. However, other Indigenous Peoples may feel that assetisation of their data and knowledge is not in line with their vision for self-determination. This highlights the need for tailored approaches to data management in nature markets depending on the priorities and objectives of Indigenous Peoples when they choose to engage in such approaches.

3.2.6 Extraction of Indigenous data

The extraction and use of Indigenous data increase the risk of negative or unintended consequences, especially when Indigenous data sovereignty is weak and key issues are not addressed, including data ownership, access agreements, appropriate use and consent.

Once Indigenous data, including ILK, is documented and/or transferred, it becomes vulnerable to misappropriation and commercialisation. Earlier sections allude to the dangers of commodification and assetisation of nature, which are perpetuated through the digitisation of data. Digitised Indigenous data can consequently be monetised and lead to the formalisation of private property rights, in turn diminishing Indigenous community practices of communal ownership and management.

When Indigenous data is shared, it becomes available to other groups, increasing the risk that Indigenous Peoples lose control over this data. As discussed earlier with respect to data value chain transformation, data value is transformed at successive stages of the data value chain, and with that transformation its economic value also transforms. As Indigenous People typically lose control over their data down the value chain (unless they are part of data sovereignty initiatives, see Box 5, page 33), they also lose control over the data as an economic asset and the ability to benefit from it, both monetarily and non-monetarily (Williamson et al., 2023), recreating ongoing patterns of extraction.

3.2.7 Balancing the demand for open access with Indigenous data sovereignty

The increasing demand for open-access data is yet another risk. Fundamentally, calls to create Indigenous knowledge databases to be used in Western science databases can normalise the assimilation and theft of Indigenous knowledge (Williamson et al., 2023). Indigenous Peoples have concerns that Indigenous data access through such mechanisms perpetuates its consideration through only a Western scientific worldview (Williamson et al., 2023). Additionally, with open data repositories, Indigenous Peoples can lose both ownership of the data and the ability to consent to how the data is used, or to withdraw consent. As highlighted earlier, disaggregated Indigenous data could decontextualise its usage and interpretation, as it is disassociated from its origins and genealogy.

Community assistant participating in vegetation survey, taking tree circumference measurements, in Tondwa Game Management Area, Zambia. Photo credit: Conserve Global

Balancing the demand for open-access data and transparency with Indigenous data sovereignty is especially challenging in the context of AI and AI scraping. Before AI, researchers and automated tools were used to gather information from online sources, a concept known as web scraping or online data extraction. AI scraping involves using AI to automate this process, enabling the very rapid extraction of data from online sources, as well as aggregation and analysis of data (IBM, 2025). There is little regulation of these methods. Though not inherently unethical, they can be problematic when AI is able to access data that should be private or uses the data without proper citation or attribution to the source. Put simply, AI and web scraping can undermine FPIC. In the context of Indigenous data and nature markets, AI scraping can be harmful because it dissolves the relational aspects of data, removing the information from the context and protocols in which it was created. Additionally, AI scraping often fails to cite the source of the data, presenting another way in which Indigenous data is 'extracted' with no attribution or dividends returning to the shareholders in the data. There are also concerns about the resource intensive needs of AI (for example, water and energy).

3.2.8 Distribution of costs and benefits of technology and data

One of the promises of nature tech is its potential to improve efficiency in data collection and measurement, and when funding for conservation and restoration is already constrained, this, in principle, promises to increase the proportion of time and investment that goes into actual stewardship action. New tools can reduce the time and labour costs involved in manual measurement methods, such as bird counts or sample plot measurement. However, employing new technologies comes at a monetary price, and who bears the cost and benefit of adding new technology and additional data needs to be carefully considered. It is important to consider whether greater use of technology is additive to the intervention, and who benefits from it (for example, local stewards, buyers, certifiers, and so on) and whether such technology is supportive of Indigenous Peoples' stewardship, monitoring and knowledge systems and used equitably.

For example, a private sector partner may require more information for their internal transparency standards; however, if they are the entity receiving the benefits of increased transparency, they are required (at least to a certain degree) to bear the costs, rather than pass on the cost to community nature stewards, either directly or indirectly. When technology is employed to reduce costs, this must be weighed against the efficacy and accuracy of these technologies for the objectives of the intervention.

3.2.9 Inappropriate use and appropriation of Indigenous data

Exploitation and inappropriate use of Indigenous data is another risk. As the custodians of Indigenous knowledge, Indigenous Peoples have a firm grasp of how this information is interpreted and applied. Commercialised Indigenous data typically excludes this intimate interaction between ILK and its appropriate application. For example, when faced with catastrophic bushfires, the Australian government took an interest in Aboriginal cool fire burning practices. However, the practice cannot simply be applied in the context of modern Australia, where human settlements have been built in locations that would normally be vacated due to seasonal fires (Kukutai and Taylor, 2016). The appropriate application of this knowledge lies with the Indigenous communities and is not fully captured in a digital system.

External access to Indigenous data can result in misuse and misrepresentation, especially when used for purposes beyond those of its initial production, leading to the implementation of solutions that are not locally or temporally appropriate and leaving room for ontological discrimination (Williamson et al., 2023). This exposure is much greater in situations with weak or no intellectual property rights, for example when patent systems do not recognise ILK.

3.2.10 Top-down validation of data and MRV

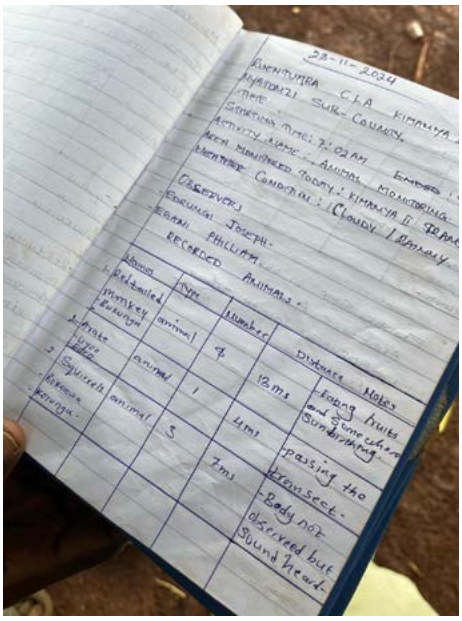
Current nature markets are dominated by an array of international standard-setting bodies whose certification standards are heavily data-dependent and top-down. While intended to ensure environmental integrity, this centralisation can create a de facto monopoly on what constitutes 'valid' data. These frameworks tend to be designed around Western scientific paradigms, favouring technology-based approaches such as satellite-based remote sensing and low-cost portal monitoring (for example, drones, camera traps, acoustic monitors). These approaches prioritise quantitative metrics that can be audited, and consequently, they can fail to recognise or value ILK as legitimate data. Indigenous data approaches are inherently localised, spatial, temporal, hereditary, ancestral, spiritual, relational and often qualitative, capturing ecological nuances that technologies like satellites might miss or undermine. The monopoly on nature market standards (including the indicators used) can thus create a rigid structure that suppresses ground-up, socially validated and verified data created as part of community-led biodiversity monitoring systems, including those that support the maintenance of TEK and stewardship practices.

If standards bodies do not provide pathways to validate or integrate Indigenous data structures, local communities are forced to adopt external methodologies. This sidelines community monitoring and conservation systems, erases local autonomy, destroys collective authority and reduces the level of data ownership by Indigenous Peoples, transforming them instead into mere data collectors (in other words, suppliers) for external agents. Or they can become subject to experimental approaches — for instance, big tech provides farmers with beta technologies for agroecosystem digitisation, onboarding data without FPIC or due diligence, farmers' shareholdership and with little benefit from the monetary value generated from the data (ETC Group, 2024).

The MRV systems favoured under international standards can also be exclusionary to Indigenous Peoples due to their complexity and prohibitive costs. These conventional MRV systems rely heavily on third-party auditors, proprietary software

and specialised technical expertise — all of which have cost implications. The high costs of MRV mean that a huge portion of the financial value generated by a nature market project is channelled away from the community and directed to external entities such as consultants, auditors and data firms. Indigenous Peoples are often consulted after the fact on the nature market project, adversely affecting their livelihoods. Unlike the commercial consultants, Indigenous Peoples are often expected to engage with the project for free (Flores et al., 2026).

Establishing a credible baseline prior to project commencement often requires historical data sets or expensive predictive modelling that communities cannot access or afford independently. Ultimately, such high MRV costs can block Indigenous Peoples from engaging in nature markets or lock them into a cycle of dependency, where projects are only viable if backed by external investors who may favour 'safe' conventional Western data approaches to justify their investments. By contrast, community-led monitoring systems can be more cost-effective and can contribute to revitalising traditional knowledge for nature stewardship and income generation. Simultaneously, they can generate rigorous datasets by linking traditional knowledge with Western science and technologies, for example, through community databases and GPS-enabled smartphones (Swiderska and Stenner, 2020).



Written species log, Hoima, Uganda.
Photo credit: Anna Ducros/IIED

3.3 Existing biodiversity monitoring tools used in nature markets

There are many technological innovations focused on capturing increasingly more data, promising a better understanding of the ecological processes and, in turn, more effective application of nature finance tools (Ford et al., 2024). This section, including Table 3, outlines Earth-observation technologies that are commonly used in nature markets, many of which have previously also been used in carbon markets. In recent decades, these technologies have become much less expensive and more widespread. Although a full evaluation of all technologies is far beyond the scope of this report, Table 3 (page 37 and 37) outlines some examples of technologies currently in use. With all these tools, it is important not to rely solely on one technology or data type. Complementary practices such as ground-truthing and focus group discussions can provide a more holistic view of a socioecological system, in turn adding value to nature finance tools.

Flying a drone for monitoring, Colombia. Photo credit: Savimbo

AudioMoth demonstration, Kenya.
Photo credit: Anna Ducros/IIED

Table 3. Existing earth observation technologies and their uses in nature markets

Earth observation technology	Description	Example use case in nature markets	Data lifecycle
Light Detection and Ranging (LiDAR)	Satellites send laser pulses toward the Earth and measure the time it takes for them to return, creating detailed 3D maps of the Earth's physical surface and canopy structure	LiDAR is effective for monitoring in areas that are challenging to access via land such as densely forested areas and wetlands. (Nature Tech Collective, no date)	Data collection
Synthetic Aperture Radar	Satellites send out radio waves (Radar is Radio Detection and Ranging) to capture information about what is on the surface of the Earth. (Nature Tech Collective, no date)	Radar can be used to collect dense time series including on forest condition, land typography habitat mapping. Because it can be used both day and night, and sees through cloud, it is effective at monitoring over time (Joint Nature Conservation Committee, 2020).	Data collection
Drones, also known as Unoccupied aerial vehicles (UAV)	Drones are aircrafts without a human pilot on board, and are controlled remotely by an operator or autonomously via computers and GPS. Drones for biodiversity monitoring can carry a range of cameras for high-resolution imagery, and can also use LiDAR technology (see above).	Drones can fly low to the ground, capturing higher definition images than satellite-based remote sensing. Drones can also access areas that may be dangerous or challenging for humans to reach, for example, cliff habitats or to assess damage after a natural disaster (such as a flood, landslide or wildfire).	Data collection
Camera traps	A digital camera connected to an infrared sensor that identifies when something moves (for example, an animal) and triggers a photograph to be taken, or video recording to start.	Camera traps can be placed and left in the field to continuously monitor an area. Because they cause little disturbance they are particularly useful for identifying animals that are hard to see because they avoid humans.	Data collection
Acoustic monitors (for example, Audiomoths)	Sound recorder that is placed in the field to collect acoustic information (Browning et al., 2017)	Acoustic monitors can detect a broad variety of taxa (including bats, insects and small birds) that may not be identified by camera traps (Browning et al., 2017). The recordings are then compared to existing data to identify species.	Data collection

Table continues »

Earth observation technology	Description	Example use case in nature markets	Data lifecycle
Genome sequencing of environmental DNA (eDNA)	eDNA is sequenced and compared to a database of existing DNA data to identify species.	Samples are taken from the environment (for example, small samples of water or soil) and trace amounts of DNA that is shed by organisms (for example, faeces, mucus, skin or carcases) is sequenced and used to identify species present (Illumina, no date). DSI can then be analysed and used for planning and implementation of management actions.	Data collection, processing and analysis
Machine learning (ML)	A type of AI in which computers learn from patterns in data. Via traditional coding, the computer uses existing data to extrapolate and determine rules for itself.	ML models can be trained to identify species from photos, audio recordings, video footage and DNA data, making them compatible with the tools noted above that are used for data collection. ML can also be embedded in those tools, to filter what information is collected (for example, to filter out the sounds of humans speaking near an audiomoth). ML can also be used to predict future biodiversity, based on current trends.	Data collection, processing and analysis
Large language learning models (LLMs)	LLMs are advanced forms of machine learning that are designed to understand and generate human language and simulate human thought processes.	LLMs have many potential uses, including downloading and managing large datasets, reviewing large amounts of literature and verbal accounts from humans, writing code, analysing data and producing reports	Data collection, processing, storage, analysis and interpretation
Cloud storage	Cloud storage is when data is stored on remote internet-connected servers rather than a local physical device, such as a computer.	Cloud storage can be used to store large datasets so that they are accessible to global teams. Cloud storage can also support remote wildlife monitoring when data is automatically uploaded to the cloud.	Data storage

4

From data sovereignty to an Indigenous data economy

The evolution of thinking on Indigenous data can be mapped across three complementary, non-sequential frames; data ethics, data sovereignty and data economy (see Table 4, page 40). Drawing on Table 4, on the previous literature work of data ethics, data sovereignty and sovereign data supply chain, we introduce the conceptual term 'Indigenous data economy', operationalising Indigenous data sovereignty, governance, and authority through a system where digital representations (digital twins) remain subservient to their physical equivalent (for example, the Indigenous territory).

An Indigenous data economy can be defined as (but not limited to):

> A system of value generation, circulation and governance in which Indigenous Peoples exercise authority over data derived from their territories, knowledge systems, communities and themselves, ensuring that such data creates collective benefit, collective privacy and rights, reinforces data equity shares (shareholdership) in ecological stewardship, territorial and biocultural assets and advances Indigenous self-determination across all stages of the data lifecycle. This economy is embedded within, not above, the living territory from which the data derives, and is governed by Indigenous customary laws, protocols and core values (for example, reciprocity), the rule of regional and national law, collective ownership, relational goods and services and intergenerational responsibility.

Thus, an Indigenous data economy does not mean inserting Indigenous data into existing markets or adopting external market language. Instead, it involves establishing a shared basis for communication. The concept of an Indigenous data economy reframes data governance itself as economic infrastructure, rather than treating Indigenous data governance as an external ethical requirement. This reframing enables negotiation over system design, obligations and longterm value retention, rather than oneoff consent or downstream benefit-sharing — shaping costs, structuring value and determining longterm benefits. Investment in these practices is therefore not ancillary to nature markets, but foundational to their credibility, durability and capacity to thrive and attract investment over time. In this way, Indigenous Peoples are not being invited into a data economy, but are articulating the terms of a different political data economy (Hilton, 2021; Trosper, 2022).

An Indigenous data economy builds on, and is one form of applying, Indigenous data sovereignty. (see glossary and Box 4, page 31). The Indigenous data sovereignty movement continues to grow and aims to (a) defend against the appropriation and misuse of Indigenous data, and (b) ensure that nature stewards, including Indigenous Peoples, are the primary equity holders of their data. The movement promotes the rights of Indigenous Peoples to determine how data pertaining to Indigenous societies, natural resources and territories is collected, accessed, analysed, interpreted, managed, disseminated and re-used.

Both Indigenous data economy and Indigenous data sovereignty are underpinned by wider concepts of FPIC and self-determination, which are enshrined in the UNDRIP (United Nations, 2007). For Indigenous Peoples to have the

power of self-determination, they must have influence over how their data is used, stored, shared and treated, including in nature markets.

Three features distinguish an Indigenous data economy from conventional data management, specifying the application of Indigenous data sovereignty to nature markets and economics:

- **Sovereign political economy** — value is plural and relational. An Indigenous data economy recognises non-monetary, ecological and intergenerational values alongside financial returns. Indigenous data governance maintains accountability to all stakeholders across all five dimensions of data simultaneously (see Section 2.1.2).
- **Indigenous data arbitration** — governance is collective and protocol-based. Decisions about data generation, use and retirement are made through processes that are consistent with Indigenous governance traditions, reflecting the relational and political dimensions of data (see Table 1, page 19).
- **An Indigenous data economy is embedded** — meaning that it is a means of generating economic benefit, as well as non-monetary benefit. It reflects ecological systems and intergenerational obligations, including variation over time, and does not recreate an extractive value chain; rather, it returns value to the custodians of ILK and TEK.

Figure 2, page 41, guides data actors through the Indigenous data economy concept, expanding on the linear, temporal data value chain discussed in Section 2. In this framing, cost, price and benefit are not neutral economic variables but expressions of sovereignty, governance and authority. Importantly, sovereignty determines the conditions and costs of making data exist. Deciding who collects, what data and how data is collected, how data is defined, and under whose authority establishes the cost of data creation and is not a neutral technical step. Data management, aggregation, analysis and interoperability govern how data is transformed into insight and foresight, and ultimately how data is valuable through analysis and use, so price is shaped through Indigenous data governance — not external valuation logics. Finally, monetisation, continued access, [re]use and data retirement define benefit as a

Table 4. Three complementary frames to conceptualise an Indigenous data economy

Frame	Core question (with dimensional grounding)	Key principles
Data ethics (informational and relational)	▪ How should data about Indigenous Peoples and ILK be collected and used responsibly? ▪ What obligations govern data collection? (relational) ▪ What knowledge is being extracted? (informational)	▪ Do no harm approach (Collaborative for Development Action, 2004) ▪ FPIC ▪ UNDRIP ▪ African Charter (African Union, 1981)
Data sovereignty (political and ontological)	▪ Who has the right to own, control, and benefit from Indigenous data? ▪ Who arbitrates? (political) ▪ What counts as Indigenous data? (ontological)	▪ CARE Principles (Carroll et al., 2020; Carroll et al., 2021b) ▪ OCAP® (First Nations Information Governance Centre, no date) ▪ UNDRIP Article 31 ▪ FAIR Principles (Wilkinson et al., 2016) ▪ African Charter (African Union, 1981)
Indigenous data economy (all five data dimensions)	▪ How can data generate collective value that reinforces self-determination and ecological stewardship on Indigenous terms and across generational timescales? ▪ How does value persist? ▪ How do ontological, relational, informational and political dimensions shape economic design?	▪ Sovereign Data Supply Chain (Kinray Hub et al., 2026) ▪ Indigenomics (Hilton, 2021) ▪ IEEE Std 2890-2025 (IEEE std, 2025) ▪ Africa Data Ethics (Barrett et al., 2025)

function of Indigenous authority over how value is realised, and how equity shares are formulated, sustained or withdrawn over time. This Indigenous data economy consistently shifts from participation to authority, from benefit-sharing to shareholding and from lifecycle efficiency to lifecycle accountability. This makes clear that these practical considerations are the operational mechanics through which an Indigenous data economy structures value and enables longterm equitable investment in nature markets.

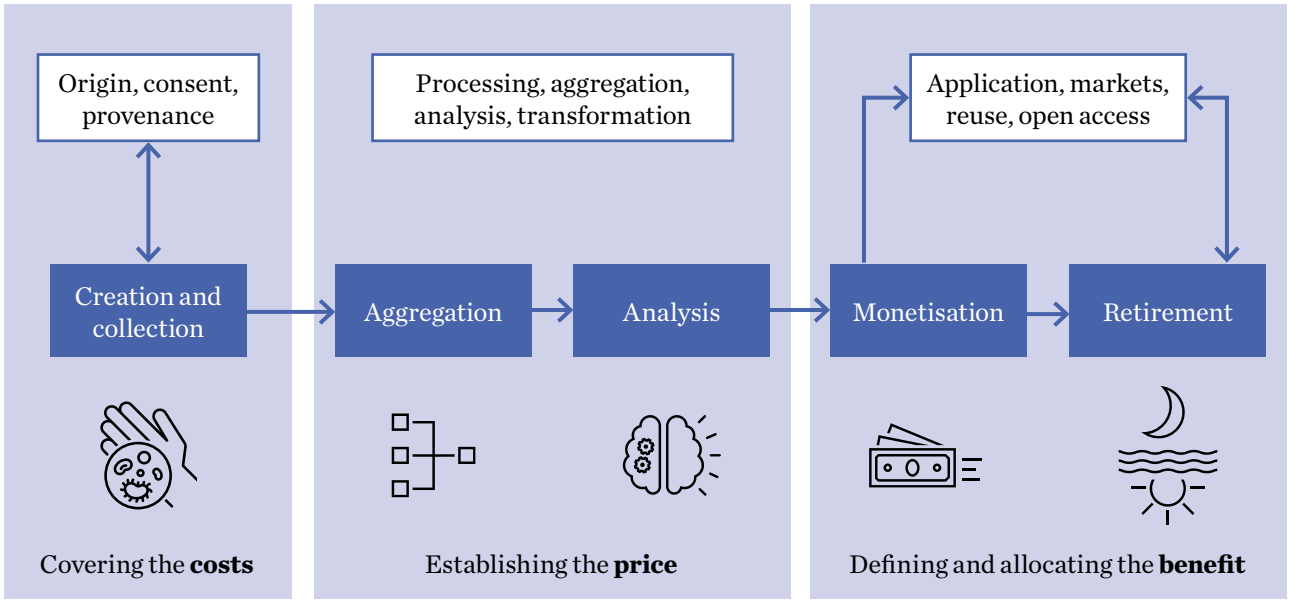
4.1 Practicalities of investing in an Indigenous data economy

The next question that arises is: what does an Indigenous data economy look like in practical terms? Done properly, it will allow ecosystem stewards to shape nature markets, balancing economic and social gains, and the use of scientific and TEK. Importantly, an Indigenous data economy allows ownership and sovereignty of data, including traditional knowledge, to remain with Indigenous Peoples.

Based on the authors' engagement in piloting biodiversity credit projects (in Uganda and in Zambia), and a review of case studies from other countries, here we turn to practical considerations that Indigenous Peoples, investors, corporations and governments need to consider at each step of the data value chain. This section complements previous sections by moving from theoretical to actionable guidance, including identifying what needs to be done to develop a data management plan that creates monetary value and socioecological benefits for shareholders of data, while mitigating and minimising risks related to the challenges for Indigenous data justice and sovereignty identified in Section 3. These practical steps can support project implementers to maintain best practice, as well as go beyond do no harm approaches, increase the integrity and monetary value of data management and better supporting nature stewardship practices and hence biological outcomes. Taken together, these practical considerations demonstrate how an Indigenous data economy is enacted across the data lifecycle, translating Indigenous sovereignty, governance and authority into concrete design, management and investment decisions.

Given these goals — a data value chain that promotes ownership, agency, transparency and accountability to people living with nature — we consider a range of tools and partners involved in applying financial and nature-related data to nature markets, and their appropriateness for both capturing the value of nature and upholding the rights of the people who live with it. The following sections work through the data value chain — data collection, data aggregation and storage, data analysis, data monetisation and data retirement (see figures 1 and 2) — and highlight the opportunities and challenges.

Figure 2. Conceptualising Indigenous data economy as the relational registry logic of data supply chain and markets



Source: Adapted from Open Data Watch (2018) and Flores et al. (2026).

Examples of practical challenges to an Indigenous data economy are: the need to find biodiversity credit developers who can build and maintain trust-based partnerships at the local level to work effectively with local communities; the need to ensure that community members have the power to establish governance mechanisms in line with their right to data sovereignty; and the need to ensure that sharing data or empowering the community with data management does not cause or exacerbate elite capture within a project area. The latter challenge arises because data is a powerful tool, and even community-managed data (especially amongst a relatively small population) needs safeguards, such as privacy restrictions, community rules governing the data economy and measures to prevent marginalised individuals from further unequal treatment.

4.1.1 Data collection

Data collection is a key step in the data value chain as it forms the basis of the stages to follow. This stage includes the choice of metrics (for example, data on what?), the methodologies and tools used to collect data and decisions related to who is best placed to collect the data and at what time(s).

Choosing what to measure

Deciding what is measured is a fundamental decision that affects what can be done with the data in the future. This decision can also determine if the data is useful and practical for the Indigenous Peoples and should therefore be made by Indigenous Peoples and nature stewards themselves, in conjunction with project partners and in line with global standards. Choosing biodiversity indicators that pertain to the relevance of biodiversity within the local context is key to ensuring that a nature finance mechanism is locally appropriate. For example, if there are species that are significant for economic and non-economic activities such as spiritual, cultural and tourism outputs, it would be beneficial to include these species in the measurement process. Equally, if Indigenous groups harvest or sustainably use wild species (for food security or medicinal purposes) it is important to factor in how the harvest of such species may or may not affect the measurement, and ensure that the data that provides the basis for nature market tools incorporates sustainable use, so as to not prevent the sustainable use of nature for socioeconomic and cultural activities. There are various tools and methodologies that can be used by Indigenous Peoples and their partners to determine what should be measured — for example, the Gender Action Learning System (GALS) methodology, Inclusive Participatory Community Assessment (IPCA) and Indigenous methods to data collection, which are outlined in boxes 6a and 6b on page 43 and page 44, respectively.

Beehives in Hoima, Uganda — part of sustainable business plans for communities. Photo credit: Anna Ducros/IIED

Box 6a. Methodologies for embedding local priorities in nature markets

There are various community-based participatory methodologies to shift power to those living in high biodiversity areas, and to ensure they are able to contribute to the design of biodiversity action. This box outlines two examples; Box 6b on page 44 outlines Indigenous methods and tools for data collection.

Gender Action Learning System (GALS)

GALS is a simple methodology that uses mapping and diagramming tools for visioning and planning for change (International Fund for Agricultural Development and Oxfam, 2022). Ultimately, GALS aims to aid community members in developing sustainable enterprises that are locally appropriate and gender transformative. There are various tools within the GALS methodology that are specifically useful for developing nature finance projects, including:

- Vision road journey: enables individuals and groups to set out clear visions, including targets and identifying challenges that would affect their enterprise.
- Challenge action tree: this is used to assess challenges and constraints in production, such as resource depletion or disease outbreak. It also goes one step further by assessing the cause of these challenges and possible ways to mitigate the threats.
- Gender balance tree: this is used to assess who does what for themselves, the household and the community in terms of nature actions. The tool also identifies any imbalances in responsibilities, for example, women contributing more to maintaining forests while they harvest firewood and actions to balance the responsibilities that need to be undertaken.

Women play a key role in nature stewardship and in maintaining and transmitting TEK amongst Indigenous Peoples, and therefore it is crucial to engage women in the design and governance of Indigenous data, as well as to assign them rightful shareholdership of data.

Inclusive Participatory Community Assessment (IPCA)

An IPCA is a collaborative assessment that brings together different members of the community, including those that are often marginalised (such as women, children, people with disabilities and older people), to identify needs, assets, priorities and ultimately solutions (Bharadwaj et al., 2024). The IPCA methodology encourages communities to lead the assessment of challenges they face by applying their local and historical knowledge. Practically, there are numerous tools that form the IPCA, for example:

- Transect walk: this involves walking with community members through key biodiversity areas, listening, observing, asking questions and clarifying details on the nature of degradation. For example, this could include walking to collect plants with a community leader, Indigenous knowledge-holder, youth leader and/or scientist (Swiderska and Stenner, 2020).
- Social mapping: this involves creating a physical map of the region on which participants draw infrastructure, such as schools, hospitals, community centres, and so on, that can support implementation of solutions. This tool can also be used to identify vulnerabilities in infrastructure such as houses that are at risk of coastal erosion due to loss of mangrove forests.
- Hazard and resource mapping: this is used to identify and assess the resources and risks in the community. It identifies all the natural and human-made resources, depicts the settlement of the population, and land and water resources such as forests, including common property resources.

Notably, the approaches above do not require participants to be literate and can be implemented using locally available and appropriate materials that allow many people to contribute at once. Facilitators can choose how to apply the tools, and which tools are most appropriate for the local context and support the engagement of those who are typically marginalised (for example, by holding focus groups with only women or children).

Continues in Box 6b, page 44 »

Indigenous knowledge can be applied at the collection stage to identify species and sub-species in the analysis. For example, in a biodiversity credit project in Uganda, where there are many bird species, a bird guide was developed with bird species indicated in both the local language and their Latin species name for use by both community members and the certification body. Indigenous Peoples may already have biocultural indicators that they observe regularly. For example, Andean and Himalayan communities use wildlife indicators (such as animal calls, birds and flowering plants) to know when to sow seeds or harvest crops, while Kaya elders in Kenya observe wild species when conducting rituals and collecting plants or fruits in sacred forests (Swiderska et al., 2025).

While choosing what to measure, it is important to consider existing data gaps. One notable data gap is in regard to disaggregated data on how women, men and diverse gender groups experience biodiversity loss and its resulting impacts, a gap which is reinforced by the way data is collected. Currently, there is a lack of gender-responsive data in biodiversity conservation, which creates a barrier to effective, equitable policy, governance and action at local, national, regional and international levels. However, at the same time, women and women's organisations hold a wealth of knowledge and play a critical role in addressing the biodiversity crisis. Using sex-disaggregated or gender-sensitive indicators can help to fill this data gap. Additionally, strengthening Indigenous women's organisations' capacity to generate gender-responsive data and transform data into gender-responsive biodiversity decision making is crucial to ensuring that the Indigenous data sovereignty movement promotes intersectional justice (Ajit et al., 2026).

Box 6b. Methodologies for embedding local priorities in nature markets

Continued from Box 6a, page 43 »

Indigenous methods and tools for data collection

Indigenous Peoples can develop participatory methods and tools for data collection and storage, building on their own Indigenous methods. For example, Quechua communities in Lares, Peru, have developed a participatory transect methodology to identify and monitor wild plants based on the Indigenous practice of walking to collect plants, with support from the Indigenous NGO Association ANDES (Peru). Indigenous experts, elders and youth collect data using a smartphone app called YupanApp, which allows photos of plants to be taken, records elders' knowledge about them and collects GPS locations. To record Latin names, they ask a scientist to accompany them (or alternatively they could use a plant identifier app). The data goes straight into a relational community database, which is structured to reflect the linkages between the different components of biocultural heritage (biodiversity, knowledge, values, customary laws, landscapes) and stores the data securely. The system does not require literacy, relying instead on audio-visual tools that align with the oral nature of Indigenous knowledge. The data is used by the community to monitor and locate useful plants for sustainable use (for example, for medicine, nutrition or income generation), and the process of data collection simultaneously promotes intergenerational transmission of Indigenous knowledge and reinforces Indigenous relational values that underpin conservation (Swiderska and Stenner, 2020; Swiderska et al., 2022).

A part of the collection stage is identifying what data is genuinely sensitive (for example, pertaining to traditional knowledge, cultural, or personal data). Such classification is context-specific, but is an important step towards ensuring that governance is not over-complicated and that governance effort is proportionate to sensitivity and scale of a project.

Aligning community priorities with global standards

It is important that the community objectives and priorities for data collection, and data management more broadly, be aligned with any third-party certification standards or verifiers, and with global standards for nature finance tools. For example, biodiversity credits receive certification from certified bodies and third-party auditing by a biodiversity data analytics body. Ensuring that the measurement plan aligns with desired certifications from the beginning of the project can mitigate risk of failing to achieve certification and ensure that biodiversity monitoring is conducted in a cost-effective way. Additionally, aligning community-established biodiversity plans with national strategies such as green economy plans, National Biodiversity Strategies and Action Plans (NBSAPs), Nationally Determined Contributions (NDCs) or 30 by 30 objectives, and with global goals, such as the SDGs and the Kunming-Montreal Global Biodiversity Framework, can increase support from government stakeholders and open opportunities for external funding.

At the same time, existing global standards should be reviewed with Indigenous Peoples to enable their co-creation with local nature stewards. Given that providing large amounts of data can increase threats to Indigenous rights and justice and be burdensome for communities, there is also a need to explore the feasibility of governance-based standards and certification in which evidence of a functioning Indigenous-led governance institution for conservation could reduce the amount of biodiversity data needed, including externally defined data.

Therein remains a core tension: community-defined indicators still must reconcile with comparable, verifiable metrics that the market needs to incentivise buyers. In the early stages of the market, one solution would be to use a both-and model — meaning that project develops can measure standard indicators as well as community defined indicators (where the indicators are not the same) to ensure that priority of all parties are being addressed, while supporting market convergence.

Choosing biodiversity monitoring technology, roles and responsibilities

Once decisions about what to measure are made, the next step is to determine how to measure biodiversity indicators. This can include various types of biodiversity monitoring technology (earth observation tools used in nature markets are outlined in Table 3, page 37). However, it is important to consider when the use of technology is beneficial and adds value to the project, and when adding technology is simply adding a cost with diminishing marginal returns for project integrity. Measurement plans must consider the resources required to measure indicators of interest and, in some cases, it may be necessary to make trade-offs on what to measure to ensure the cost of measurement is feasible within the bounds of the project.

All partners must first comply with FPIC before data is collected and monitored. This should result in the signing of data ownership agreements amongst partner teams and the community themselves, in line with local governance and protocol. This requires a careful balancing act between building on the community's resources and knowledge (such as local names for species) with external support, such as provision of scientific equipment (for example, acoustic equipment, cameras, drones, apps) and compensation or rewards for time spent on monitoring. One practical suggestion is to create species guides in local languages that allow Indigenous Peoples to identify species in their own language and then facilitate translation of the data into Latin names (which are very likely to be required to align

Jonathon Onongo (EcoTrust) setting up a camera trap in a tree, Hoima, Uganda. Photo credit: Anna Ducros/IIED

Zulenny installing a camera trap in the jungle, Colombia. Photo credit: Savimbo

with international standards). Species guides, developed in conjunction with the community, can also be used to train AI tools that, for example, scan camera trap data and identify species. Wherever possible, monitoring should incorporate existing biocultural indicators and Indigenous Peoples' own methods and tools for biodiversity monitoring, such as participatory transects, so that monitoring systems serve to strengthen TEK that forms part of cultural identity and thus are more likely to be sustained after a project ends for continued conservation (see Box 6b, page 44).

Understanding how the measurement tools work and ultimately what type of biodiversity exists and in what location can also promote ownership of the intervention, in turn fostering further community support and compliance with the project. Training community members, especially the often tech-savvy younger people, to install biodiversity monitoring equipment, access, use and download data from tech devices (such as acoustic recording devices, camera traps, drones and apps for identifying species and ecosystem health) can increase ownership over biodiversity interventions. Working with communities to support the design or co-design of new tools, such as smartphone apps and relational community databases of biodiversity and traditional knowledge, can also increase ownership while enhancing data sovereignty and reinforcing relational values that underpin conservation (Swiderska and Stenner, 2020).

Additionally, when the community knows where monitoring equipment is placed and for what purpose, this can mitigate the risk of equipment being poached or damaged and facilitate a quick response to any damage to the equipment caused by humans, animals or natural disasters such as floods or forest fires.

4.1.2 Data aggregation and storage

Full participation in the data economy involves various digital capabilities and infrastructures. These include access to a laptop or smartphone, and access to the internet via Ethernet, Wi-Fi or satellite internet services. For some Indigenous Peoples communities, these capabilities cannot be presumed, especially for communities that live remotely, experience economic hardship or experience neglect of infrastructure provision. Notably, existing nature markets projects tend to generate a lot of data and storing and transferring it requires infrastructure such as cloud-based storage services. Where communities do not have access to reliable cloud-based storage (for example, due to poor wifi connection), they may have to purchase physical hard drives to store biodiversity data. In fact, even communities with access to cloud-based storage may choose to use physical hard drives to back up data in case of lost connection to the internet. Communities may also be able to get support from a trusted NGO partner for data storage or back-up storage.

Data storage and transfer also involve digital infrastructures such as digital payment systems, which internet users rely on as part of online activities. Global awareness of the importance of digital sovereignty is growing, not only among Indigenous Peoples, but also amongst governments. The EU, for example, is proactively reducing its exposure to American hyperscalers (providers of cloud-based IT infrastructure for businesses) and pursuing the EuroStack as a pathway to technological sovereignty across all layers of the digital ecosystem. Web3, as a distributed digital infrastructure, can support data sovereignty when implemented and used in line with community protocols and customs (see Box 7, page 47) (Mackey et al., 2022).

For smaller countries and for Indigenous Peoples, the development of a fully sovereign data economy and the supporting architecture may be out of reach, as they are both prohibitively expensive and require specialised skills and a sufficient market size. Consequently, digital sovereignty is a more realistic goal if it is pursued by spreading risk across multiple providers, rather than a bespoke solution that is entirely controlled by one provider. As a digital governance expert David Eaves has argued: "Sovereignty through ownership risks being a fantasy for all but the wealthiest. Sovereignty through interoperability may be achievable for nearly everyone" (Eaves, 2025). Digital sovereignty that is functional at all scales requires a different set of circumstances, such as standardisation across providers to enable competition, and the public provision of open-source technologies which reduce dependence on proprietary platform services.

Camera trap training, Colombia. Photo credit: Savimbo

Box 7. Distributed ledgers: Web3 and nature markets

Web3 technologies — including digital tokens, blockchain and decentralised infrastructure — are the 'third era' of the internet. While the first stage, Web 1, was characterised by websites where the user could only read content, the second stage, Web2, allows the user to read and write, therefore creating content. However, in Web2, the content created is owned by the data platform, for example Meta. Web3, follows a read-write-own model, where the creator of the content is not just a user of an existing platform but the owner of the content they create (ethereum.org, no date).

Web3 offers transformative potential for data in nature markets by addressing core challenges of trust, data sovereignty, value distribution and access. These digital tools are not ends in themselves but are potential enablers that can rewire the way value flows among funders, frontline communities and nature. In their nascency, they offer one option to support decentralised governance and ownership of data.

A defining feature of Web3 is decentralised ownership, which creates new possibilities for upholding and expanding data sovereignty. Whereas traditional Web2 platforms tend to control user data and aggregate power centrally, Web3 enables data creators — including Indigenous Peoples, local communities, and small landholders — to retain ownership and control over their data. Potential benefits of data ownership may include data royalties and data value chain benefits for Indigenous communities.

Blockchain — a decentralised ledger that stores data across a network of computers — can enable the creation of trusted records of nature-positive action that are tamper-resistant, traceable and verifiable. Various nature market ventures are adopting these technologies, such as the Regen Network, Open Forest Protocol and Hypercerts (Regen Network, no date; Open Forest AG, no date; Hypercerts Foundation, no date). The potential benefits of blockchain are:

- Direct payments to frontline communities for stewardship work, bypassing intermediaries that typically capture most of the economic value.
- Provenance tracking so that companies disclosing nature-related claims can demonstrate that the data was acquired through legitimate channels with proper benefit-sharing.
- Reduced transaction costs for cross-border payments and data exchange, lowering barriers for small and medium-sized enterprises (SMEs) and producers in emerging economies.

Tokenisation of data on Web3 technology can enable decentralisation of nature data as a transferable asset. Tokens are programmable, meaning that incentive structures can be encoded directly into Web3 infrastructure. For example, data tokens can be programmed to ensure that nature data providers consent to their use, share in the benefits, and protect cultural knowledge. In this way, tokenisation provides a way of overcoming the tension between the FAIR and CARE Principles (see Section 3.1.2).

Web3 tokens also facilitate interoperability, as they can connect seamlessly across platforms. This addresses critical concerns about fragmentation in nature data markets by enabling interoperability between data providers, market intermediaries and reporting entities. Of course, blockchain, tokens and other elements of Web3 are tools, not a panacea, and there are very valid concerns about the high energy and water usage of these services (though increasingly highly efficient versions are available). As such, they can be used well or poorly, for purposes good or bad. The early years of cryptocurrency abounded with case studies that practitioners should not repeat, often characterised by poor governance and uninhibited greed. The opportunity for Indigenous Peoples lies in applying Web3 capabilities under values-based Indigenous governance, to build nature markets that genuinely serve both ecosystems and the communities who steward them.

The role of credit exchanges and aggregators

Demand from financial institutions and non-financial corporates for decision-grade nature data is set to grow and mature, driven by investor pressure, voluntary reporting standards (for example, the TNFD, Science Based Targets for Nature) and mandatory regulations (for example, the EU's Corporate and Social Responsibility Disclosure).

Currently, the nature data value chain is encumbered by obstacles and bottlenecks that inhibit its ability to meet market demand (TNFD, 2025). These include:

- Nature data sets are highly fragmented and were typically built for other use cases, making search and selection time-consuming. Many users are unaware of what data exists or how to navigate it (UNEP, 2025).
- Paywalls, complex licensing arrangements and the need for specialist consultants make access expensive and particularly prohibitive for SMEs and organisations in biodiverse majority-world economies.
- Significant gaps and variability in data quality and resolution exist across realms, biomes, ecosystem types and geographies, leading to fragmented and inconsistent assessments. The gaps tend to be biggest in the most biodiverse parts of the world, many of which are under Indigenous stewardship.
- Inconsistent metrics and methods prevent comparability within sectors, across asset classes, and over time; such comparability is essential for capital allocation.
- Data is often years old, which is an issue that is compounded when aggregated into metadata, especially when there is limited transparency about when the underlying data was collected.
- Multiplicity of similar data sources makes it difficult to assess provenance and evaluate credibility before use.
- Fragmented investment across the value chain, without coordination toward market-relevant metrics or composite data principles spanning scientific, open-source and corporate reporting standards.
- Concerns over data sovereignty and the reputational risks of infringement; hence the need to protect Indigenous data rights, intellectual property and the interests of nature stewards.
- Significant nature data collected by corporates remains locked in closed systems, representing a missed opportunity for shared value.

In light of these barriers, the role of exchanges and aggregators is critical. By mediating the nature data value chain, these entities can support the process of standardisation and enhance visibility and transparency.

The TNFD has proposed developing a Nature Data Public Facility (NDPF) to improve the nature data value chain. The TNFD endorsed seven nature data principles to "be adopted by nature data collectors, aggregators, distributors and end-users across the nature data value chain to help improve the discoverability, quality, temporality, consistency and decision-usefulness of nature data for market participants" (TNFD, 2025). The TNFD's principle of ethics and privacy protection acknowledges the CARE Principles as an important source of normative guidance on how to treat nature data, and specifically incorporates the mechanisms of FPIC and benefit-sharing as markers of high-integrity data sets. The establishment of such norms in the nature data value chain can redirect societal expectations about what high-integrity data should look like. Such standards and aggregators not only provide a way in which data can become more interopable, they create market coherence and convergence, providing early stage investors and market movers with a streamlined process that can allow the market to grow.

Another important factor is verifiability. The value in nature data stems partly from its trustworthiness and its ability to sustain the confidence of data users, as is true with all data. If data is verifiable and subject to auditing and authentication, then this helps to earn trust in data markets, regardless of whether the data was supplied directly by communities or by remote technologies. Accordingly, technology plays a key role in nature data markets for verification, authentication and validation, not only measurement. Various types of digital infrastructure can help to underpin data integrity, including identity authentication, timestamping and proof-of-location systems.

4.1.3 Data analysis

Currently, most nature finance projects require off-site analysis. This is in part due to a lack of data infrastructure at the project site, and in part because of a reliance on Western science, which means that certification methodologies tend to require analytical methods that are typically conducted in the global North. The most common model of data analysis in projects is to pass data on to a data analysis consultancy in the country capital or, most commonly, in the global North, for translation into outcomes (for example, measured biodiversity uplift). This can add costs to cover sending or physically transporting data (often the internet bandwidth is insufficient to transfer the terabytes of data generated by, for example, audio or video recordings, which tend to be favoured because of their auditability). Where possible, data should be analysed and assessed in situ or at least nationally, and the results and the data itself be returned to the project site. In addition, Indigenous and traditional biodiversity data collection, analysis and monitoring systems should be supported and recognised as valid where possible, for example, through applying the multiple evidence base approach (see Table 2, page 22).

AI is increasingly used to assist analysis of biodiversity monitoring data. For example, AI can scan data from acoustic recordings and camera traps to identify species and determine what that means for the state of an ecosystem. Given the large amounts of data captured, AI applied in data analysis can save both time and resources. Informing AI analysis with multiple ontologies can work to mitigate the impact of bias. Using AI for data analysis needs to be done in alignment with terms agreed in FPIC and the data management plan, and consideration of the environmental impacts of AI should be taken.

Reviewing camera trap data — footage of a spectacled bear (*Tremarctos ornatus*), Colombia. Photo credit: Savimbo

4.1.4 Data monetisation and governance

Nature market finance tools are in early stages of development, and because of this, many questions about data management at later stages of the financial mechanism (such as at the point of sale and credit retirement), and the solutions to these questions, have not been identified. Therefore, this section draws on examples of projects that exist, as well as lessons from financial governance of conservation projects more broadly. As noted at the beginning of the report, in data-rich markets such as nature markets, data itself has social, cultural and economic value. Data provides economic value by providing the market information that can form the basis of an economic product or asset. In addition, biodiversity credits with higher degrees of transparency and accountability can usually be sold for higher prices, often referred to as a 'transparency premium'. Data can therefore be monetised while also having more than just monetary value. However, in the Indigenous data economy concept, data monetisation does not refer only to the sale of data as an alienable commodity, in other words, a commodity that can be separated from its original owner and transferred to a new one. Instead, it requires Indigenous authority over how value is generated and distributed from Indigenous data and its repeated use. Monetisation is therefore inseparable from governance: decisions about access, licensing, aggregation and downstream application determine whether value is returned to or retained in Indigenous systems.

Indigenous data monetisation may also take the form of conditional access, licensing arrangements, royalties or equity in data-dependent platforms and markets. These mechanisms enable Indigenous Peoples to move beyond one-off benefit-sharing toward shareholding in the infrastructure through which data produces value. Monetisation within an Indigenous data economy is thus oriented toward sustaining the regeneration of biocultural systems, governance capacity and intergenerational responsibility.

Data trade within an Indigenous data economy

In data-driven nature markets and in an Indigenous data economy, 'data trade' does not occur as a single transaction but as a sequence of governed exchanges as data is transformed through the supply chain. Upstream, Indigenous sovereignty defines the conditions under which data can be created, or not, and enter circulation, establishing the initial costs of measurement and legitimacy. Midstream, governance over aggregation, analysis and interoperability determines how data is transformed into insight and foresight, shaping its price within financial and decision-making systems. Downstream, Indigenous authority governs how data is licensed, embedded in credits or disclosures, [re]used across markets, or withdrawn through data retirement. At all stages, Indigenous Peoples have a role, and their participation and leadership, including by integrating TEK and ILK systems, is crucial to ensure that the data management is conducted in a way that is effective and adds value for Indigenous Peoples.

Within an Indigenous data economy, data trade is therefore conditional, relational and cumulative. Value is generated not through the sale of data as a commodity, but through controlled access, licensing, recurring revenue rights and equity in data-dependent platforms and market infrastructures (see Box 8). These mechanisms ensure that as data continues to circulate and generate financial returns, Indigenous Peoples retain standing as economic actors (in other words, they rent rather than sell the data).

Box 8. Savimbo's Indigenous data sovereignty architecture

Savimbo is a social enterprise built by and for Indigenous Peoples from Kichwa in Colombia to access climate and biodiversity markets directly (Savimbo, 2026). Its data sovereignty architecture emerged from Silicon Valley data fairness practices and the lessons learned from the treatment of medical data applied to Indigenous territories. In medicine, and under GDPR more generally, the patient 'owns' their data and technicians use it under a 'licence' or permitted-use framework. Savimbo applies the same logic to community data in nature markets, which have historically required communities to expose ecological data with no rights or control over its downstream use or resale.

Savimbo's response is structural. The community owns all data collected on its territory at all times; no transfer of ownership occurs at any point in the data value chain. What is granted is a topical use licence. This is consistent with territorial rights, which are never transferred or transferable under UNDRIP or International Labour Organization Convention 169. Communities are encouraged to rent and not to sell data, in line with advice that is often given by investors to start-ups in Silicon Valley.

Crucially, Savimbo's biodiversity credits do not constitute a sale of data. Data is collected with community partners after FPIC-compliant permission and is used as proof of ecological condition; the unit sold is the underlying ecological condition. Partnering certifiers receive a licence to read, use or store a specific subset of the data for specific purposes and cannot redistribute without renewed community consent.

Data flows in both directions. Each community appoints a data steward (a community member trained on what is collected, how it is stored, and how to access it), who presents results back to community members. Savimbo, in turn, provides a data concierge whose remit is to be at the community's disposal: to explain, retrieve, correct, display or withdraw data on request. During pilots, communities retain the right to claw back data that has not yet been shared with third parties, depending on project stage and third-party verification needs, preserving the ongoing nature of consent wherever possible.

More sophisticated data structures are negotiated separately. Academic publications drawing on community data must credit traditional groups or individual Indigenous data trackers as authors or contributors. Open-access publication and any genomic data require additional, specific consents. eDNA samples are screened for human sequences, which are filtered and deleted before any analysis or publication; raw samples are destroyed after use, with the steward informed of disposal.

Ecological data collection within the Savimbo model explicitly isolates cultural data, which is placed under different access rules. Cultural data collection requires full context for proper translation and full ethics board oversight due to historical cases of misuse and mistranslation. Medicinal-plant and cultural data are therefore referred to external parties with proper ethical protections, such as the Beneficial Plant Research Association (bpra.org). Savimbo therefore sells biocredits, not biocultural credits.

Financial participation: from benefit-sharing to Indigenous shareholding

Conventional approaches to Indigenous participation in nature markets rely on benefit-sharing arrangements that redistribute value only after financial architectures have already been designed. In such models, Indigenous Peoples are positioned as raw suppliers of data, beneficiaries or stewards whose benefits are contingent, minimal and often timelimited. Such arrangements fail to account for the fact that data, once generated, aggregated and integrated into market systems, continues to produce value in perpetuity through [re]use, modelling and downstream applications.

The Indigenous data economy concept reframes this dynamic by shifting from benefit-sharing to Indigenous shareholding. Shareholding recognises Indigenous Peoples as co-owners of the biocultural data assets, infrastructures and decision systems through which value is generated. Within an Indigenous data economy, shareholding is not limited to financial equity alone but extends to authority over the terms of data trade — that is, how data moves, under what conditions it is exchanged and used and how value accrues over one or multiple trade(s) and over time.

As a first step, project developers need to plan how financial data can and should be used to increase the project's transparency to buyers, sellers and certifiers and to provide the necessary financial disclosure for buyers, sellers and governance requirements. This does not necessarily mean complete disclosure of all financial information. Indigenous Peoples have the right to privacy (collective and individual) regarding how much they earn and, in addition, have the right to choose whether to disclose how they use their income from the nature markets interventions.

It is important to put in place financial governance at all levels of a project, and determine what financial information is shared with whom, and when. Like biodiversity and socioeconomic data, this needs to align with international standards on biodiversity credits such as the High-Level Principles to Guide the Biodiversity Credit Market (Biodiversity Credit Alliance et al., 2025), and with the certification body for the credits. In addition, buyers are likely to require a certain degree of financial reporting for their own due diligence. For example, they may need confirmation that the money they have spent on biodiversity credits is reaching the intended beneficiaries (such as the household or community fund). The needs of various partners involved in the transaction and certification of the biodiversity credit should be identified at the project inception stage, and the data management plan should specifically consider how financial data is shared. In many cases, there will be a monetary cost of upholding the required level of financial transparency, and this needs to be built into the project budget. Doing so can support the biodiversity credit scheme in reaching certification, ensuring the credits are sold to high-integrity buyers, and can also ensure that the project is resilient to scrutiny, including regarding claims of greenwashing, or 'social' washing.

Some biodiversity credits disburse revenue directly to individuals and households. However, given the communal character of nature, it is important to have biodiversity credits managed through community associations, or similar structures. For example, in the biodiversity credit project in Uganda managed by IIED and EcoTrust Uganda (IIED, no date), the biodiversity credits are generated from a communal forest, and thus the profits are returned to the communal land association that manages the forest. In this case, and in similar arrangements, it is crucial that there is an appropriate level of financial governance within the communal land association that matches the scale of expected revenue. The distribution of revenues (for example, across villages, genders, project roles, and so on) should be determined ahead of time, and be complemented by financial systems (for example, mobile banking) to be able to disburse funds. An associated grievance mechanism to respond to any challenges should also be put in place. Some Indigenous Peoples, such as the Quechua Peoples who run the Potato Park in Peru, have decided to establish a communal fund so that a percentage of revenues from biocultural community enterprises is shared among all villages in accordance with customary law principles (Sorsby et al., 2026).

Tailored communication plans with project partners on the expected value of the revenues, the timing and the means of distribution need to be undertaken. There may also be community members who are not directly involved in the nature market mechanisms who require further communication and outreach to increase involvement, where appropriate. Engaging with a wider audience and the equitable sharing of benefits at community level can mitigate potential conflicts that may arise from varying degrees of external finance entering a community.

Additionally, nature market mechanisms are in their nascency, and often the development of an intervention is undertaken prior to the product being sold. There is, therefore, a risk of Indigenous Peoples investing time and resources in developing a financial mechanism (for example, FPIC, baseline data collection), and it not being sold. This risk needs to be managed carefully, and attention should be given to not overpromising on the amount of revenue that

will reach communities. Collecting biodiversity data that can also be useful to communities in other ways (for example, for livelihoods or developing community enterprises) is a way of mitigating this risk.

By embedding Indigenous authority into the mechanics of data trade, an Indigenous data economy enables concrete forms of Indigenous shareholding within nature markets. These may include equity stakes in data platforms and verification systems, revenue shares linked to the ongoing use of Indigenous data in credit issuance and reporting or governance roles within institutions that set market rules and standards. Crucially, such arrangements allow Indigenous Peoples to influence market design, risk allocation, credit insurance, investment insurance and temporal horizons.

In this way, an Indigenous data economy positions data as the connective tissue between Indigenous governance and financial architecture. Data trade becomes the mechanism through which Indigenous sovereignty, governance and authority are translated into durable economic participation. For nature markets, this shift is not ancillary but foundational: markets that depend on Indigenous data without Indigenous shareholding risk instability, contestation, lack of insurability and loss of legitimacy over time. By contrast, investment in an Indigenous data economy aligns financial returns with stewardship, accountability and long-term value retention, enabling nature markets to function as systems of regenerative finance.

Governance

Within an Indigenous data economy, governance functions as the institutional and relational mechanism through which Indigenous data sovereignty and authority are exercised across the data lifecycle. Governance constitutes the means by which Indigenous Peoples maintain authority over data as it is created, accessed, transformed, monetised, used or retired, in accordance with customary and Indigenous laws, protocols and priorities.

Governance decisions are therefore in part economic decisions. Choices regarding access, aggregation, interoperability, licensing and use shape how data is valued, how risks are distributed and whether benefits remain accountable to Indigenous rightsholders over time. In this sense, governance mediates the relationship between data and value, ensuring that data practices uphold Indigenous Peoples' rights to self-determination, development and control over their cultural and intellectual resources, as affirmed in UNDRIP Articles 3, 18 and 31.

Effective governance within an Indigenous data economy requires continuity across institutional and technical boundaries. As data moves through the data value chain, Indigenous governance mechanisms, including dynamic consent conditions, usage constraints and accountability requirements, must remain enforceable. This continuity

Jaguar (*Panthera onca*) caught on camera — still from camera trap footage, Colombia. Photo credit: Savimbo

prevents value leakage and misappropriation or misuse that occur when data is detached from its relational and territorial origins. The authority to reassess, restrict or retire data as conditions change is a core governance function that protects against perpetual extraction and inequitable use, threats to cultural and spiritual values and intergenerational harm.

Data retirement

Data retirement is a critical but often overlooked component of the data economy and data management plans. Like many data governance systems, such as GDPR, Indigenous data governance often recognises that data has a lifecycle that must eventually close and does not assume indefinite retention and re-use. Data may lose contextual integrity, become culturally unsafe or generate new risks as technologies and political conditions change. In an Indigenous data economy, 'rematriation' and 'repatriation'[5] play critical roles in data retirement.

The authority to withdraw, deactivate, or retire data is both an economic act and a governance act. It prevents perpetual extraction by implementing ongoing FPIC and preventing the use and re-use of data for purposes for which there was no consent (for example, AI aggregation). This can help ensure that benefits derived from Indigenous data do not extend indefinitely without renewed consent, accountability and ongoing benefit-sharing. By embedding data retirement within the lifecycle, an Indigenous data economy introduces temporal responsibility and intergenerational ethics obligations into nature markets and data-driven decision systems.

However, this needs to be reconciled with the need for stable and auditable baseline data. The conditions for when data can and should be withdrawn or retired should be established in the FPIC due diligence and be clearly stated in the data management plan at the initiation of the project. This includes the negotiated data use conditions. For example, it may be that data need to be withdrawn throughout the project period, but could still be used as complementary data to the project, rather than core information that supports the issuance of a credit, for instance.

[5] While repatriation refers to the literal return of cultural items, land or human remains, rematriation focuses on returning these items or land to the rightful caretakers in a way that focuses on restoring cultural continuity, healing and spiritual relationships.

Local community fisherman returning to shore during fishing season in Lake Tondwa, Zambia. Photo credit: Conserve Global

4.2 Transforming risk into opportunity

Stakeholders and entities involved in nature markets interact with risks and opportunities in various ways. By employing best-practice approaches, the project partners automatically increase the project's value because the costs of realised risks are reduced. Therefore, it is important to think about these risks and the opportunities their mitigation provides prior to embarking on nature market projects. Working in partnership with Indigenous Peoples, rather than in a buyer–seller relationship, is a fundamental step to mitigating risk. Table 5 summarises key risks to ITK posed by various entities (stakeholder groups), and some proposed best-practice approaches to mitigate them.

Table 5. Best-practice approaches to mitigating risks to Indigenous knowledge

Risk	Entity	Mitigation and best-practice approaches
Appropriation of TEK	Non-Indigenous project developers	Seek consent (FPIC) for the use of ILK and respect rights of refusal if consent is not given. Implement a benefit-sharing mechanism, such as stewardship payments, that redistributes benefits to frontline communities. Support Indigenous data governance to facilitate greater control of Indigenous data by Indigenous Peoples. Go beyond benefit-sharing, involve Indigenous Peoples as partners and co-developers in projects that utilise traditional knowledge, from the project's inception to completion.
Inappropriate use of Indigenous symbols or language for marketing and branding purposes	Non-Indigenous project developers	Along with use of knowledge, seek consent (FPIC) for the use of Indigenous and traditional symbols or language, and respect rights of refusal if consent is not given. Recognise ICIP rights and establish benefit-sharing from commercial gain. Provide cultural awareness training for non-Indigenous project participants to increase cultural safety/sensitivity and reduce the risks of misappropriation.
Appropriation or mimicking of Indigenous stewardship practices in ways that conflict with traditional protocol or create offence	Non-Indigenous project developers	Wherever possible, employ or fund Indigenous Peoples to undertake traditional stewardship practices on their own territories. Seek consent (FPIC) and establish dynamic renegotiation mechanisms for the use of ITK, and respect rights of refusal if consent is not given. Support the development and implementation of environmental stewardship practices and protocols that utilise Indigenous knowledge but are appropriate for non-Indigenous Peoples to use. Provide cultural awareness training for non-Indigenous project participants to increase cultural safety and reduce the risks of misappropriation.
Use of data for purposes outside projects for which it was collected	Non-Indigenous project developers	Seek consent for all subsequent use of data. Establish strict data control protocols with standards bodies and data analysis providers regarding access and use of Indigenous data shared with them.
Technology-driven approaches that displace TEK and Indigenous stewardship practices	Intermediaries	Involve ILK holders in decision making, design and deployment of measurement technologies so that they complement and accommodate TEK, rather than crowding it out. Enable Indigenous innovation by actively involving Indigenous Peoples in the design and development of measurement technologies, so that traditional knowledge holders can safely share and revitalise TEK through new technology.

Table continues »

Table continued »

Risk	Entity	Mitigation and best-practice approaches
Sharing or storing nature-related data and traditional knowledge in ways that exposes Indigenous Peoples to breach of privacy, exploitation, or other misuses	Intermediaries	Support Indigenous Peoples in designing community databases to securely store data. Use Indigenous frameworks and principles to inform data management protocols and processes. Enact appropriate governance structures to ensure proper risk management and accountability. Require publication standards for documentation of community support, participation and approval for publishing data and co-authorship. Use unique identifiers and metadata labels to ensure traceability and verifiability of Indigenous provenance.
Incentives for cultural appropriation are created by favouring Indigenous-aligned projects without due diligence on FPIC	Private sector investors	Use taxonomies with clear guidance on meaningful participation from Indigenous Peoples, minimum standards on FPIC and benefit-sharing and evidence of appropriate governance. Provide transparent information on the process through which Indigenous Peoples and their ways of knowing were embedded in the project design and implementation.
Profiteering from the assetisation and securitisation of Indigenous knowledge	Private sector investors	Ensure that Indigenous Peoples have influence over how their data is used and that they receive equity from any value derived from data derived from their customs and territories. Establish agreements with Indigenous Peoples on when and how their data can be accessed and how their data can be used. Establish Indigenous shareholdership agreements at the inception of the project, including how revenues will be dispersed over time.
Making claims that misrepresent Indigenous Peoples and the biological outcomes of the project	Private sector investors	Seek clarity on claims that can be made for nature market investments. Understand and respect the agreements of consent that govern what a buyer can claim with their investment or purchase.
Failure in duty under UNDRIP (Article 31) to recognise and protect Indigenous Peoples' rights	Governments	Incorporate the intent of UNDRIP's Article 31 into domestic legislation to ensure protections for ICIP by existing legal instruments such as copyright and moral rights. Provide legal resources and contracting capabilities to Indigenous Peoples for the development of contract templates for the protection of ICIP in private transactions. Introduce national legislation to protect the rights of Indigenous Peoples over traditional knowledge, including through requirements for FPIC and benefit-sharing, and disclosure in patent applications.
Breaches of privacy or misuse of Indigenous data held by government agencies	Governments	Establish appropriate governance mechanisms which create accountability and dispute resolution mechanisms for data protection and system integrity. Where appropriate, use cryptography and distributed ledger technology to design security and privacy provisions into the data infrastructure.

5 Conclusion and recommendations

We conclude with three overarching recommendations that need to be considered when developing a nature market project and an associated data management plan. A data management plan should be recognised as something that can add value to a project by promoting transparency and the recognition of Indigenous Peoples' rights and, therefore, enhancing the integrity of a biodiversity intervention.

5.1 Recommendations

5.1.1 Establish a data management plan from the beginning

Many of the opportunities to enhance data management for nature finance tools outlined in this report can be realised by establishing a data management plan from the inception of the project. A data management plan should be developed together with the entire project consortium, including Indigenous Peoples. We recommend that the project designate a data management lead, and that this entity leads the process of developing the plan. Within the data management plan, each project partner should be clearly assigned specific roles and responsibilities based on their strengths, shareholdership in the data value chain and consideration of legal and ethical standards.

Following the practical guidance laid out in Section 4.1, the data management plan should start by identifying what types of data should be collected and require management (for example, GIS, biodiversity surveys, reports and field notes, models and simulations, financial information and Indigenous knowledge) and the related sensitivity of the data. Subsequently, the project consortium, including Indigenous Peoples, can create a data inventory that notes the type of data, the source, the format, the estimated volume, the primary owner of the data and who has access to the data at what time and for what purpose. Standards for file naming, units of measurement and version numbers, among other standardisations, should be agreed ahead of time to ensure that the data is cohesive and in a format that allows integration across data sets. Establishing how and by who the data will be analysed and finally, how the value generated from the data will be distributed (shareholdership) should also be built into the data management plan.

Establishing a plan from the beginning can also inform investment needs, include pre-financing of a project. Planning how data is going to be managed at each stage can also inform an investment pipeline that is accurate to the needs and scale of a project.

5.1.2 Align the data plan with principles, legal requirements and ethical considerations

The data management plan should also include a governing framework that takes note of which legal requirements it is required to continuously meet (such as FPIC, UNDRIP and the African Charter), and which ethical considerations it intends to achieve (such as CARE Principles). A clear decision-making authority should be put in place, which includes Indigenous Peoples' participation, as well as a mechanism to raise concerns should one party feel that standards are

not being met. It is important that programme or project funds be allocated to support the governing framework, to ensure its full application, including covering the costs of continuous FPIC.

Alongside the clear governing framework within the data management plan, it is recommended that Indigenous Peoples develop a community rights statement that clearly outlines the community's relationship with the information and traditional knowledge being shared, what the shared data can be used for, and under which terms and conditions.[6] Community rights statements often draw on customary laws and protocols used within the community, which can be complemented by modern laws and protocols. This statement should accompany Indigenous data at each step in the value chain.

Project partners should further identify the regional or national jurisdiction, and relevant data management laws and standards the project must comply with, including Indigenous Law pertaining to the territories and Peoples' involved in the project.

5.1.3 Partnership as a key pillar of a successful data management plan

A data management plan can be strengthened and add value to a project through effective partnership. Each project partner brings valuable experience and information to the project. Therefore, a data management plan should clearly outline the various roles and responsibilities of each partner in the project consortium. Being practical about what each partner can do with the time and resources available to them will allow the consortium to identify any gaps that may affect the successful implementation of the data management plan and adapt accordingly. Trust-building among project partners and with market actors may also provide a way to reduce the quantity of data required, and hence, the data costs and the risks to Indigenous rights and the potential burden of top-down data requirements for communities.

5.2 Looking forward

As nature markets continue to evolve, the decisions made in early stages about how data is governed will shape not only the credibility of individual projects, but also the legitimacy and long-term viability of nature markets as a whole. Indigenous data governance should not be viewed merely as an input to market mechanisms or as a risk requiring additional safeguards, but as the foundation to generate monetary and non-monetary benefits and maintain relationships between people, nature and investment. Embedding Indigenous data sovereignty and investing in an Indigenous data economy offers an opportunity to move beyond extractive models of data use towards approaches that recognise Indigenous Peoples as leaders, innovators and long-term partners in generating value for nature and society. Achieving this transformation will require continued collaboration between Indigenous Peoples, governments, standard setters, project developers, investors and technology providers to ensure that governance frameworks, financial incentives and digital infrastructure evolve together. While there is no single model that will be appropriate in every context, a shared commitment to rights-based, transparent and adaptive data governance as well as continued learning can help ensure that nature markets deliver lasting environmental, social and economic outcomes. In doing so, data management becomes more than a technical exercise: it becomes a means of strengthening trust, supporting self-determination and creating the conditions for nature finance that is equitable, impactful and resilient over the long term.

[6] For an example of a community rights statement, see: Asociación de comunidades del Parque de la Papa (2026).

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Knowledge Products

Research Report

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Nature markets are expanding rapidly as governments and investors seek new ways to finance biodiversity conservation and restoration. These markets depend on vast amounts of data, much of it linked to Indigenous Peoples and their territories. Indigenous leadership, co-design and co-implementation of nature markets are key to ensuring that market-based tools deliver for both nature and peoples. This report examines how the management of Indigenous data (data derived from Indigenous Peoples and their territories) should be built into nature markets, examining the opportunities and risks posed by new monitoring technologies and offering practical guidance for designing equitable, rights-based and effective data management plans for nature finance.

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