UNITED NATIONS DEVELOPMENT PROGRAMME

The case for Nature ID

How Digital Public Infrastructure can catalyze nature and climate action

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Acknowledgments

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UNDP is the leading United Nations organization fighting to end the injustice of poverty, inequality, and climate change. Working with our broad network of experts and partners in 170 countries, we help nations to build integrated, lasting solutions for people and planet. Learn more at undp.org or follow at @UNDP.

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About this publication

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Glossary

Aadhaar: India's digital identity system, enabling access to government services and financial inclusion.

AI (Artificial Intelligence) : refers to the capability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings, such as reasoning, learning, and problem-solving.

APEX Cloud: A government API platform in Singapore enabling seamless integration of services and data for public and private stakeholders.

API (Application Programming Interface): A set of tools and protocols for building software applications and enabling system interoperability.

Anthropocene: A proposed geological epoch characterized by the dominant impact of human activity on the Earth's ecosystems and geology.

Biodiversity credits: Financial instruments designed to fund conservation by attributing value to biodiversity outcomes.

Blockchain: A decentralized digital ledger that records transactions securely and transparently across a network.

Carbon market: A trading system where carbon credits are bought and sold to offset emissions and incentivize reductions.

Carbon registry: A system for recording and tracking carbon credits, ensuring accountability and transparency.

Climate resilience: The ability of communities, systems and infrastructure to adapt to and recover from climate-related hazards.

Data exchange: A platform or mechanism enabling the sharing of data between entities while maintaining security and interoperability.

Data sovereignty: The principle that data is subject to the laws and governance structures within the nation it is collected.

Data spaces: Federated environments that allow multiple organizations to securely share and access data while maintaining control.

Decarbonization: The process of reducing or eliminating carbon dioxide emissions from activities like energy production and transportation.

DEPA (Data Empowerment and Protection Architecture): A framework enabling secure data sharing while maintaining user control over personal information.

DPGs (digital public goods): Open-source digital tools and technologies designed to benefit society and support public objectives.

DPI (digital public infrastructure): Foundational systems that enable society-wide digital capabilities, such as digital identity, payment systems and data exchanges.

EUDR (European Union Deforestation Regulation): A policy requiring companies to ensure that products sold in the EU are not linked to deforestation.

Ecological indicators: Metrics used to assess the health and functioning of ecosystems, such as biodiversity or water quality.

FPIC (free and prior informed consent): A principle that ensures communities have the right to grant or withhold consent for proposed actions that may affect them, with consent given voluntarily, in advance, and with adequate information.

Geospatial data: Information associated with geographic locations, used for mapping and analyzing spatial patterns.

Indigenous knowledge systems: Traditional ecological knowledge held by Indigenous Peoples, often critical for sustainable resource management.

Interoperability: The ability of different systems, platforms or organizations to work together seamlessly and exchange information.

Kunming-Montreal Global Biodiversity Framework (GBF): A global agreement focused on biodiversity conservation and sustainable development.

Land tenure: The legal or customary rights individuals or communities hold over land, including ownership and usage.

Microservices: Modular, independently deployable software components that perform specific functions within a system.

Minimalist data principles: Guidelines for collecting only essential data to reduce complexity and maintain privacy.

Nature ID: A proposed digital public infrastructure system for integrating and exchanging environmental, social and administrative data to support conservation and sustainability initiatives.

NBSAPs (National Biodiversity Strategies and Action Plans): NBSAPs (National Biodiversity Strategies and Action Plans) document national priorities, actions, and commitments to address biodiversity loss, aligning with global goals such as the Global Biodiversity Framework (GBF).

NDCs (Nationally Determined Contributions): National climate pledges submitted by countries under the Paris Agreement to meet global targets.

Paris Agreement: A legally binding international treaty aiming to limit global warming to well below 2° C, preferably to 1.5° C, compared to pre-industrial levels, through coordinated climate action.

Parametric insurance: Insurance that provides payouts based on predefined triggers, such as weather events, rather than assessed damages.

PES (payment for environmental services, alternatively can refer to the similar concept of payment for ecosystem services): Financial incentives provided to individuals or communities in exchange for maintaining or restoring ecosystem services, like carbon sequestration or biodiversity conservation.

Pix: Brazil's digital payment system enabling real-time, inclusive financial transactions.

PSP (payment service providers): Entities that facilitate electronic financial transactions, including credit card payments and online transfers.

Public accountability: Transparency, inclusivity and responsiveness in the governance and operation of systems or initiatives.

Remote sensing: The use of satellites or other technologies to collect data about Earth's surface without physical contact.

SDGs (Sustainable Development Goals): A set of 17 global goals established by the United Nations to address environmental, social and economic challenges.

Semantic interoperability: The ability of systems to exchange and interpret data accurately through standardized formats and definitions.

Traceability: The capacity to track products, materials or impacts throughout their lifecycle or supply chain.

Transparency framework: Mechanisms under international agreements to ensure accountability and openness in reporting and implementation.

UNDRIP (UN Declaration on the Rights of Indigenous Peoples): An international instrument adopted by the United Nations in 2007, establishing a universal framework of minimum standards for the survival, dignity, and well-being of Indigenous Peoples

UPI (Unified Payments Interface): India's real-time payment system enabling instant transfers between banks and financial institutions.

X-Road: A secure, interoperable data exchange platform initially developed in Estonia, enabling cross-sector and cross-border information.

Foreword

The escalating pace of climate change, biodiversity loss and land degradation has become an existential risk for humanity and many species of flora and fauna. Innovations that can deliver society-wide impact quickly and effectively are needed urgently. Through our Climate Promise, Nature Pledge and Digital for Planet offer, UNDP is working in over 140 countries to advance integrated solutions to these complex challenges. This includes country support for digital transformation that is needed to monitor and protect the world's biodiversity and unlock nature-positive incentives for the public and private sectors.

The value of Digital Public Infrastructure (DPI) - built on a foundation of digital identity, consent-based data exchange and instant payment systems - has emerged as a key area of consensus in global policy discussions. With UNDP's support as a knowledge partner, G20 leaders in 2023 for the first time endorsed DPI as 'safe, secure, trusted, accountable and inclusive.' The Global Digital Compact, a governance framework that aims to create a secure, open and free digital future for all, was unanimously adopted by world leaders at the Summit of the Future in 2024.

This paper explains how DPI can play a vital role in addressing the inter-connected climate and nature crises, protecting our planet's future and in building a more inclusive, equitable and sustainable world.

The robust monitoring, reporting and verification of ecosystem and environmental data is essential to protecting our planet. By collating and leveraging this data more efficiently to enhance transparency, reliability and timeliness of information related to a country's actions to address climate change and promote sustainability in agro-industrial supply chains it would become possible to unlock a wide range of incentives that can help guide financial flows and investments into more nature-based solutions such as rainforest conservation and land restoration.

By exploring the new forms of DPI conceptualized in this paper, countries have an opportunity to harness the transformative potential of digital technologies, develop more evidence-based policies and rapidly scale practical solutions to protect biodiversity-rich areas that simultaneously also support their traditional custodians such as Indigenous Peoples and local communities.

Francine Pickup
Deputy Assistant Administrator and Deputy Director, Bureau for Policy and Programming Support, UNDP

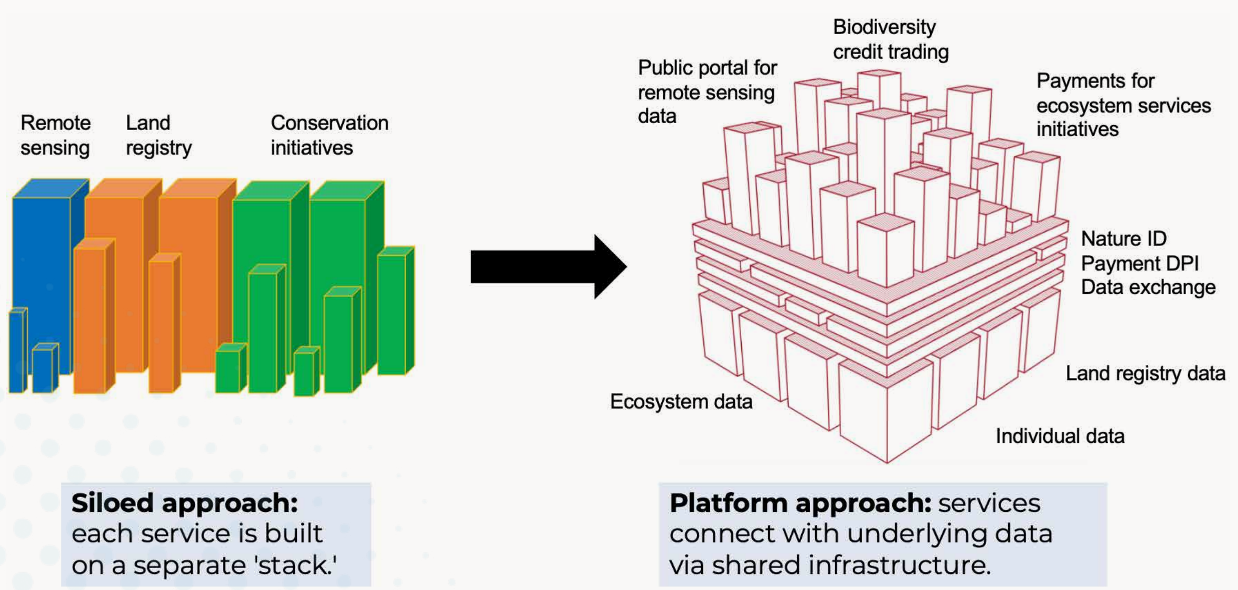
Executive summary

Climate change and biodiversity loss are interlinked global crises that demand new approaches to gathering and using data for more informed decision-making. Governments, businesses and communities alike must track and report on land use, habitat preservation and resource management to meet obligations under international treaties and environmental regulations. Yet today, environmental, social, financial and administrative data is largely scattered across separate platforms—making it challenging to form a complete picture of ecological health or to coordinate conservation at scale.

Digital Public Infrastructure (DPI) has emerged as a viable means of addressing this data fragmentation (ES Figure 1). By establishing secure, interoperable systems—such as digital identities, payment platforms and data exchanges—DPI is driving public service innovation and cross-sector collaboration. Drawing on lessons from successful DPI deployments, this paper explores the potential for **Nature ID** as a **data exchange system for environmental data**. Rather than a single repository of information, Nature ID would link diverse datasets (e.g., remote sensing, administrative records, Indigenous knowledge), serving as an interoperability layer that would enable different services to share and verify data securely.

To illustrate both the promise and complexity of implementing Nature ID, the paper references examples such as **Brazil's *Cadastro Ambiental Rural* (CAR)** and the **Forest Stack initiative in India**. These examples of digital initiatives illustrate opportunities and challenges for data platforms to support land use management, financial decision-making, biodiversity conservation assessments and policy enforcement. These examples also highlight the need to address concerns related to governance, institutional capacity and social inclusion if such platforms are to scale effectively and equitably.

ES Figure 1. Siloed vs Platform approach to digital systems for climate and nature action



Source: This draws on frameworks for digital transformation and DPI explored by Mazzucato, M., Eaves, D. and Vasconcellos, B., *Digital public infrastructure and public value: What is 'public' about DPI?* UCL Institute for Innovation and Public Purpose, Working Paper Series (IIPP WP 2024-05) (2024); and Richard Pope, Platform land, Harvard Kennedy School (n.d).

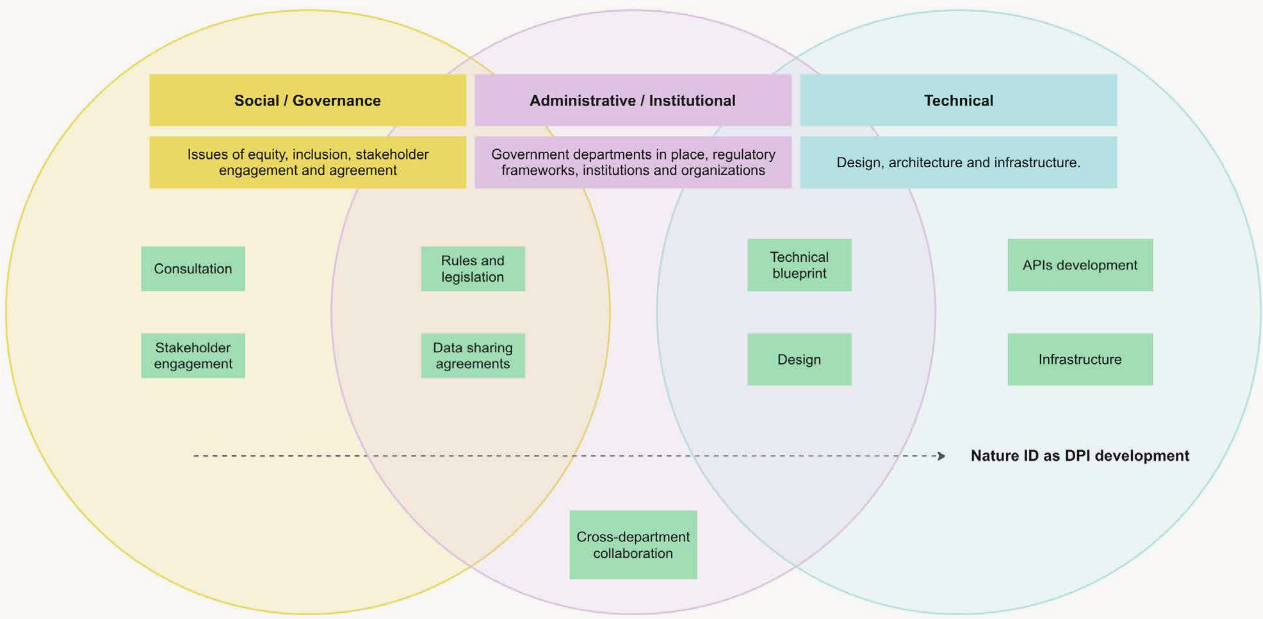
Key insights and recommendations

This study considers **three dimensions—technical**, **administrative/institutional** and **social/governance**—to explore the potential for developing Nature ID as DPI (ES Figure 2).

Rather than launching entirely new or large-scale ventures, this paper advocates for **an iterative approach** that leverages existing systems and policy frameworks (ES Table 1). Alongside robust legal and governance frameworks, an adaptive approach can help Nature ID evolve as an inclusive and powerful tool to guide conservation, land use management and climate action. Exploring the potential for Nature ID also serves as a case study for how DPI can **provide the society-wide capabilities needed to scale nature-positive incentives** in an efficient, equitable and transparent way.

Nature ID could also contribute towards **environmental justice.** For instance, by linking local community or Indigenous claims and traditional knowledge with environmental data, Nature ID could help empower these communities to verify and defend their territories against encroachment. In jurisdictions where ecosystems have been accorded legal standing, the platform's integrated datasets **could strengthen enforcement and stewardship efforts.** By facilitating access to ecological data to inform distributed decision-making, Nature ID can help **unlock the finance and collective actions** needed to address our most pressing environmental challenges—and to do so in a manner that respects diverse stakeholders, protects Indigenous sovereignty, and sustains planetary health for generations to come.

ES Figure 2. Key dimensions shaping the development of Nature ID as DPI



Source: UNDP Digital for Planet.

ES Table 1: Summary of insights and recommendations for Nature ID as DPI

Core value of Nature ID: Enhancing the visibility of complex ecological systems in decision-making	By synthesizing information on biodiversity, climate and social factors, Nature ID can make environmental considerations more prominent in policy, private sector and local community decision-making. This can unlock nature-positive incentives and direct financial flows—such as payments for ecosystem services or carbon credits—toward conservation and restoration initiatives.
Enabling conditions for Nature ID: legal foundations, governance and institutional capacity	A successful Nature ID requires robust legal and policy frameworks defining data ownership, consent and access rights—This is an upstream effort that each country undertakes through inclusive, whole-of-society processes. Once these safeguards are in place, well-coordinated institutions (such as digital government departments) can protect sensitive data (including Indigenous-held knowledge) while ensuring transparency and accountability. This paper primarily addresses Nature ID's technical feasibility and downstream applications, building on the foundation of strong legal and governance structures.
Proposed roadmap for Nature ID: build modularly on and adapt to existing digital infrastructure and capacity in a country	Nature ID need not rely on unproven technologies; it can leverage open standards and proven architectures (e.g., secure API gateways, modular data exchange platforms). Incremental deployments—starting with pilots in existing government or community projects—allow stakeholders to test interoperability and the resources needed to ensure data quality before scaling.
Principles for the proposed development and implementation process: Inclusive and collaborative	From Indigenous Peoples and local communities to private enterprises, different groups have specific needs, capacities and knowledge. Emphasizing inclusive governance models and robust consultation processes can foster broader buy-in and ensure that Nature ID aligns with diverse cultural, economic and legal contexts.

1. Introduction

Incorporating diverse streams of environmental, social and administrative information in decision-making at scale is critical for addressing interconnected climate and nature crises while also enabling sustainable development. This presents challenges for different actors across regions and sectors but could help unlock trillions of dollars needed to finance the green transition between now and 2050.[1,2]

As an illustrative example: an incoming national government is implementing a new commitment to protect biodiversity and manage greenhouse gas emissions through land use and conservation initiatives while supporting local livelihoods. A team of civil servants is tasked with developing a plan to fulfill this mission.

To identify different areas to prioritize for conservation, the team might set about gathering and aggregating different sources of information. Data on the distribution of species and habitats, sensitive ecosystems and bioregions from different government, academic and civil society sources could help them develop a picture of potential priority areas for conservation initiatives. While the government might have existing data, additional academic and civil society sources could help confirm the accuracy of this data and fill in gaps. No party is likely to have the complete picture, so the team could pursue a series of agreements with local and international partners, granting them access to additional local species monitoring and large-scale satellite data. In the process, they might automate some of their workflow using tools that leverage artificial intelligence. Creating maps based on the emerging picture of ecosystems would suggest areas that could be important in meeting the government's conservation targets.

These scenarios raise the question of who might have an interest in decisions about land use in the areas identified. An agreement with government stakeholders enables the team to overlay their new map with available land registry data. In parallel, they engage with several Indigenous communities who have heard about their efforts. While some Indigenous leaders are keen to collaborate, others are concerned about sharing sensitive information. While this offers new sources of information for the team, they face challenges in merging data from these new sources because the way their datasets are configured does not align with the traditional knowledge shared. As a result, they decide to deepen their collaboration to develop frameworks for translating between knowledge systems. This growing partnership also highlights the potential role of traditional stewardship practices in achieving the overarching conservation mission.

Integrating data from different sources would help the team identify an overarching vision for land use planning at scale. But achieving government biodiversity and climate commitments requires ongoing planning and implementation. In other words, the team and its collaborators face a recurring need for integrating updated environmental, administrative and other data. Moreover, effectively aligning stakeholders and supporting distributed initiatives, programs and services, could require connecting to other government services and infrastructure. For example, implementing results-based payment for environmental services (PES) schemes would require the ability to monitor, report and verify environmental outcomes over time and deliver payments.[3]

Governments are not the only ones who might benefit from this integrated environmental and administrative data. The same data can help scale green finance mechanisms and support trade in ethically produced commodities. For instance, financial institutions managing risk in their lending portfolio could do so by promoting agricultural practices that increase local climate resilience. This could involve monitoring the impacts of lending on deforestation or adding conditions to loans that preserve local habitats. Lenders are increasingly adopting this approach.[4] Separately, international importers seeking to comply with the forthcoming European Union Deforestation Regulation (EUDR) will need to prove the products they sell on the European market complied with local legislation and are not derived from commodity production that caused deforestation.

With different actors seeking to address similar needs in parallel, the result is often fragmented services and data. Data is frequently gathered and managed in ways that create silos between different projects and services. As a result, decision-making often happens in isolation, leading to missed opportunities for coordinated, nature-positive outcomes. Building capacity by investing in the development of shared and interoperable digital infrastructure can create a foundation for scaling action on the climate and biodiversity crises. The example shared above illustrates one setting where a shared infrastructure approach may be valuable.

At its heart, this paper is motivated by two ideas. Firstly, climate and nature crises are interconnected and significantly shape the available pathways for human development.[5] Responding to these crises requires joined up effort at scale across sectors and countries. **Secondly, digital public infrastructure (DPI) can provide a foundation for action by linking data from different sources and unlocking the door for a wide range of nature-positive services to flourish in a way that is currently not possible.** DPI serves as shared infrastructure that can provide a common foundation for different actors to build on. As a result, DPI enables society-wide digital capabilities that are essential for participation in the digital era, whether as a citizen, entrepreneur or consumer. This approach can enable broader access to ecosystem, climate and social data, increasing the visibility of ecological systems in decision-making and serving as a shared platform for a variety of services. The functionality of DPI can be enhanced through the integration of Artificial Intelligence (AI) modules and can serve as a platform for the development of AI tools.[6] This approach holds promise for scaling the green transition.

Drawing on lessons from successful DPI deployments, this paper examines the potential for a DPI system to facilitate the exchange of environmental and ecosystem data. We call this 'Nature ID.' Rather than assigning formal credentials to every ecosystem or species, Nature ID functions as an interoperability layer that links diverse datasets—from remote sensing outputs and administrative records to local and Indigenous observations—so that data on a given natural asset (e.g., a forest, watershed or protected area) can be verified and shared securely**.** In this way, **Nature ID provides a more holistic and reliable view of environmental information** without creating a single, centralized repository.

Within this context, this paper begins by reviewing the climate and biodiversity policy context (Section 1), exploring how digital technologies and DPI can scale nature and climate action (Section 1.2–1.3), and presents highlights from the DPI for Climate and Nature research and stakeholder engagement initiative being undertaken by UNDP in collaboration with partner organizations and key stakeholder groups (Section 2). Section 3 proposes a conceptual architecture for Nature ID, drawing from case studies, and outlines emerging use cases in biodiversity monitoring, climate finance and supply chain traceability. Finally, the paper highlights key challenges, risks and opportunities associated with each of these three dimensions as part of the concluding guidance for implementing Nature ID at scale. This paper is the result of a landscaping study complemented by a series of collaborative workshops, consultations and roundtable discussions with governments, partner organizations, Indigenous Peoples and other stakeholders. After launching in 2023, Key milestones during this initiative included public events during the Summit of the Future in New York City in September 2024, followed by one in October 2024 at the United Nations Biodiversity Conference (CBD COP16) in Colombia and another in November 2024 at the United Nations Climate Change Conference (COP29) in Azerbaijan. These conversations informed research into potential business cases for green DPIs and the conceptual development of Nature ID.

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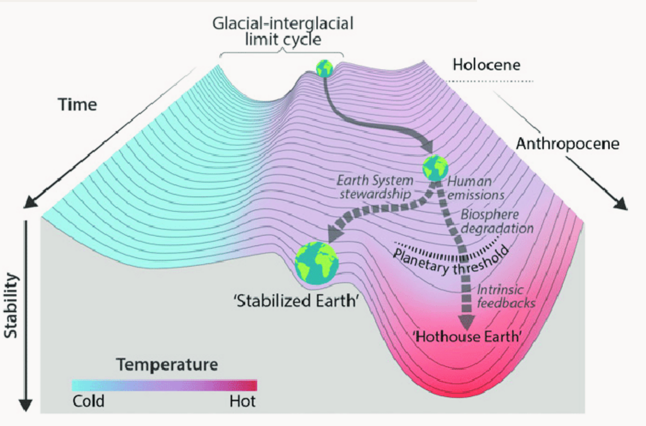
featured content

1.1. Interconnected climate and nature crises

The climate crisis, biodiversity crisis and pollution crisis are interconnected.[7] Rising concentrations of atmospheric greenhouse gas emissions have resulted in the last five years being more than one degree warmer than the historical average,[8] with July 2023 - June 2024 being more than 1.5 degrees warmer.[9] Climate change puts pressure on ecosystems and is leading to mass migration of humans and animals, species extinction, and net increases in desertification and deglaciation. For example, over the last 30 years, more than 420 million hectares of forest (approximately 10 percent of the global total) have been lost globally, due to conversion to other land uses.[10] The combined impacts of climate change and human activity are having globally significant impacts on the biosphere.

Unsustainable resource use and overconsumption are driving these interconnected crises. Over the last 50 years, the global economy has grown nearly fivefold, due largely to a tripling in extraction of natural resources and energy that has fueled growth in production and consumption.[11] The benefits and costs of this expansion are distributed unevenly and vulnerable communities who have historically contributed the least are disproportionately impacted.[12] This rapid expansion of human impact on the biosphere, including carbon cycle, water cycle and ecosystems, has resulted in scientists christening the start of a new geological epoch called the **Anthropocene**.[13,14] In short, humanity has developed the capacity to reshape Earth systems, but continuing on our current path will likely trigger cascading tipping points and the collapse of critical life-giving systems (Figure 1).

Figure 1. Mitigating the risk of a 'hothouse' Earth



Source: Steffen et al., "Trajectories of the Earth System in the Anthropocene," (*PNAS*, 2018).

International agreements provide the basis for collaboration towards shared goals by setting guidelines and principles through which country-level commitments scale to global, collective responses. The Paris Agreement and Kunming-Montreal Global Biodiversity Framework (GBF) adopt overarching goals to address climate and biodiversity challenges. They are underpinned by two key national policy tools, Nationally-Determined Contributions (NDCs) and National Biodiversity Strategy and Action Plans (NBSAPs), and supported by a range of mechanisms such as enhanced transparency frameworks, market mechanisms, finance mobilization and technology transfer mechanisms. These policy processes and their accompanying reporting requirements establish international information sharing protocols needed to monitor progress, but they require dedicated capacity. This creates one form of recurrent country-level demand for tools to support compliance to these two global Agreements.

However, collective efforts are currently falling short of the scale needed. NDCs submitted as of 2024 are not sufficient to reach Paris Agreement targets.[15] While many countries are stepping up and pledging ambitious NDCs, annual climate finance is falling short of the scale needed to meet these commitments, resulting in countries not meeting several of their NDC targets.[16,17] Meanwhile, this is happening in the shadow of continued fossil fuel production, which brings the achievement of Paris Agreement targets even further away.[18] Similarly, collective efforts are not yet sufficient to meet the goals of the Montreal-Kunming Global Biodiversity Framework: for example, protected and conserved areas must almost double on land and more than triple in the ocean to 'conserve 30 percent of land, water, and seas,' a key target for 2030.[19]

Achieving the Paris Agreement goals and biodiversity targets requires radically reshaping the flows of materials, energy and information that make up the global economy.[20] Promising progress is being made in accelerating the deployment of renewable energy and clean technology.[21] And yet, meeting exponentially growing demand for renewable energy and clean technologies will require significant supply of minerals and, in the short-term, expansion in mining. The land footprint of mining and biofuel production will put additional pressure on ecosystems and planning processes. Achieving climate and biodiversity targets and managing a just green transition will also require making difficult tradeoffs and reassessing what is economically valuable.

Incorporating new information in collective and distributed decision-making is essential for addressing interconnected climate and nature crises while enabling sustainable

development. Recognizing the realities of human-driven climate change and biodiversity loss initially depended on insights from global data and local knowledge. These insights formed the basis of international agreements and have informed policy and private sector decision-making globally.[22] There is increasing interest in integrating holistic environmental and social information in decision-making. However, accessing the breadth of information will require systematizing and integrating information from a greater variety of sources.

Public and private sector stakeholders face common challenges and opportunities in confronting the climate and biodiversity crises. For example, international climate and biodiversity agreements require submitting regular updates on country-level climate action plans, biodiversity strategies, and implementation progress. Accessing financing mechanisms such as carbon markets requires the creation and maintenance of credit registries and monitoring and verification capabilities. International initiatives, such as the new EUDR, create a need for tracing the environmental impacts of specific commodities across value chains. These all require monitoring, verifying and reporting on the impacts of initiatives at the local level, as well as aggregating, interpreting and sharing insights with national and international stakeholders. While local contexts vary, these needs are standardized and shared across the public and private sector.

In recent decades, increased access to remote sensing data, including from satellites and various sensors, and an increased ability to gather locally sourced data, has generated an increasingly holistic understanding of the causes and consequences of climate and nature crises. Ongoing efforts to address climate and nature crises, including top-down policymaking and bottom-up initiatives, rely on increased access to and systematization of this information. **Increasing the breadth and availability of information can help identify strategies for working with entrenched interests and identifying alternative pathways towards decarbonization, restoration and resilience.**

Collectively scaling efforts to reduce emissions, protect nature, build resilience and support communities impacted by environmental crises is vital, and involves actors across all sectors. Countries around the world are grappling with these challenges but with different capacities and responsibilities. Yet despite facing additional hurdles in accessing financing, the Global South is likely to surpass the Global North for renewables as a share of total electricity generating capacity within the next five years.[23] The green transition is a global collective undertaking.

1.2. Digital technologies can help scale the green transition

The green transition is not happening in a vacuum. The ongoing digital technology revolution is transforming the economics of creating and sharing information. This revolution began with the development of semiconductors and has resulted in cascades of innovation in hardware and software, including personal computing, software, telecommunications, the global positioning system (GPS), the internet, smartphones, and more recently, artificial intelligence (AI). This is reshaping the basis of global patterns of value creation, competition, trade and governance.[24]

Given the volume of emissions reductions needed to avoid catastrophic climate change, and the pace of action required to reverse biodiversity loss and minimize extinction, we must explore all avenues to scale urgent action. Facing these critical needs, **digital solutions can build the society-wide capabilities needed to avoid cascading ecological tipping points and steward social and ecological systems towards regeneration, adaptation and ultimately, resilience.**

Strengthening the digital transformation of government promises to revolutionize governance and service delivery. Various proposals, including 'government as a platform,' aim to provoke experimentation within the core model of government.[25] Recently, the COVID pandemic highlighted the value of building digital capabilities in the public sector for responding to complex challenges. Rwanda, for example, rapidly deployed digital tools to communicate timely health information and coordinate services for its population, while Singapore used similar systems to trace COVID-19 cases and manage public health responses effectively.[26] India was able to leverage its digital public infrastructure capabilities to quickly implement a new cash transfer program.[27] In addition to enabling delivery at scale, digital services and infrastructure have enabled new policy designs and more adaptable public sector responses to complex challenges.

So far, the digital transformation of government has largely occurred in parallel to the transition to net zero. **A growing discussion of 'twin' transitions, digital and green, is building connections between the need for climate solutions at scale, and the possibility for digital technologies to offer novel and scalable solutions.**[28] Recognizing this growing momentum, COP29 in Azerbaijan hosted the first 'digitalisation day.'[29]

However, these opportunities are also accompanied by significant challenges that must be managed. The digital technology revolution triggered new challenges along the value chain, from environmentally harmful natural resource extraction, to component production, to product operation and disposal. Skyrocketing demand for digital era products has driven an expansion in land-, energy-, water- and resource-intensive mining and mineral processing, resulting in land use conversion and human rights concerns. Managing e-waste is also a key challenge. The current linear 'take, make, waste' model results in the accumulation of hazardous materials and additional pollution at the end of products' useful life. Additionally, the operation of digital era technologies and infrastructure, and the growth in demand for networking and compute power is driving significant increases in demand for basic inputs such as electricity. Driven in recent years by the growth of AI,[30] data centers now account for 1 percent of electricity consumption.[31] Managing technology lifecycles, moving towards circular models of production and the appropriate deployment of digital solutions is critical for ensuring their adoption does not subvert the overarching aims of the green transition.

1.3. DPI: Foundational elements and deployment trends

DPI enables society-wide digital capabilities that are essential for participation in the digital era, whether as a citizen, entrepreneur or consumer.[32] DPI connects underlying data from various sources with user-facing services, serving as a flexible middle layer. Examples of foundational DPI include digital identity systems, payment platforms, and data exchange mechanisms, which collectively serve as critical enablers of public services and market participation. Adopting a DPI approach builds the capacity to rapidly scale efforts to address complex societal problems by standardizing how information is shared.[33] Interest in DPI is growing, as illustrated by it being one of the UN's High Impact Initiatives focused on mobilizing action for the Sustainable Development Goals (SDGs), and a priority of India's G20 Presidency.[34]

UNDP has played a key role in shaping global discussions and progress on DPI, advancing the DPI Safeguards Framework and supporting the launch of the Global Digital Compact. These efforts align with UNDP's broader goal of supporting countries on their digital transformation journeys.

Across the globe, DPI is being rapidly developed. According to the DPI Mapping Project,[35] **57 countries have active digital identity systems**, offering citizens a secure means of authenticating their identity to access essential services like healthcare, education and banking. **Digital payment systems are in place in 93 countries**, supporting real-time transactions and ensuring that financial systems are accessible to diverse populations. As of August 2024, **103 countries operate data exchange systems at the national level**.

DPI is designed to serve as a "middle layer" that sits between hardware and data at the foundational level, and services at the top. This concept is depicted in the layered diagram (Figure 2), which illustrates DPI as an essential intermediary that links hardware and data with the services built upon them. It depicts DPI as enabling modular, reusable solutions that can be applied to multiple contexts, thereby functioning as a versatile and scalable foundation for societal systems.

In this sense, **DPI is not just a collection of digital services**. It serves as a public utility that can be leveraged broadly, allowing various stakeholders—government, private entities and citizens—to build and innovate upon it. The difference between DPI and typical digital services lies in an intention to provide **shared, reusable and interoperable components** that provide a foundation for multiple applications.

1.3.1 Identification, payments and data exchange: The public value of foundational DPI

One key example of DPI's impact is in promoting financial inclusion through digital payments. India's financial inclusion efforts, primarily driven through its digital identity system, Aadhaar, and the Unified Payments Interface (UPI). Working together, these enable access to essential services such as opening bank accounts or receiving direct benefit transfers. Aadhaar is interoperable, built on open standards, and integrates multiple service providers, both public and private, ensuring broad accessibility. A 2019 Bank of International Settlements report found that India's Aadhaar ID enabled an increase in bank accounts in nine years that would have taken 47 years along a typical development trajectory.[36] During the COVID-19 pandemic, Aadhaar facilitated direct benefit transfers, helping millions of Indians receive social and healthcare support without bureaucratic delays, thus demonstrating its critical role in crisis response.

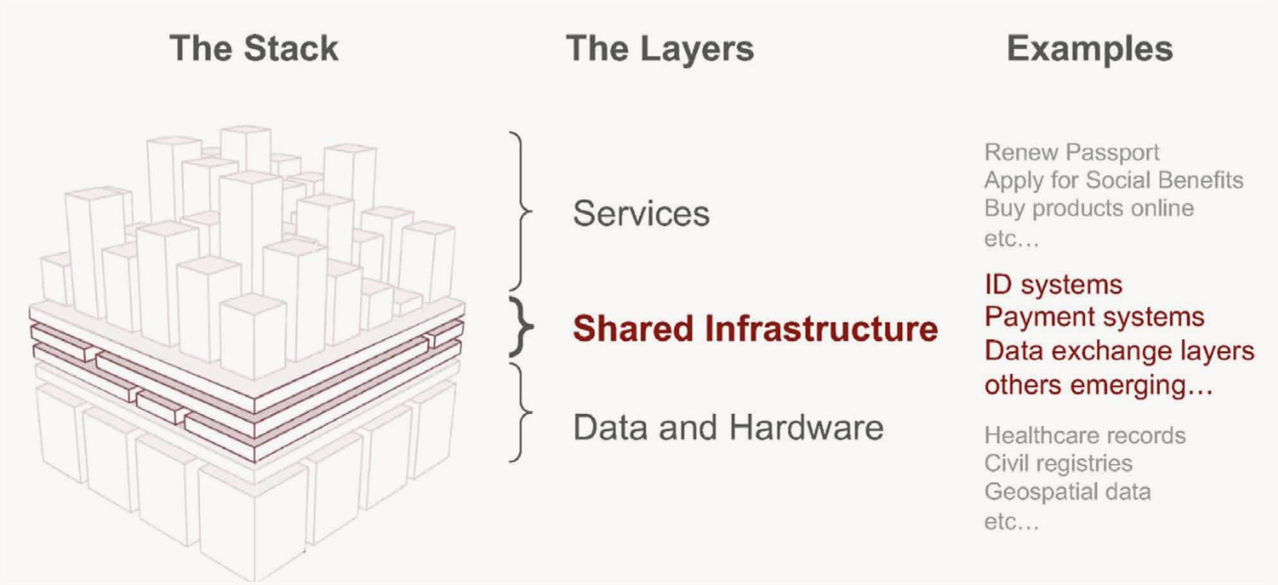
Brazil's Pix illustrates the value of a DPI model for payments. Managed by the Central Bank of Brazil, Pix provides an interoperable and inclusive framework for real-time payment interactions, integrating various financial institutions, including banks and payment service providers (PSPs). Unlike traditional platforms, Pix standardizes payment mechanisms across all participants,[37] ensuring seamless transactions with no fees for people. This ensures that all institutions within the system provide the same level of service, making Pix accessible to all users in a consistent manner. Essentially, Pix is like a public highway system where any vehicle can travel without restriction, fostering a shared resource that can be used by all.

Data exchanges standardize information sharing agreements in code, making it a lot easier–and cheaper–for organizations to share data at scale rather than through ad hoc contracts. A prominent example of DPI in the form of a data exchange is X-Road, which originated in Estonia as an interoperable digital infrastructure with the capacity to connect multiple public departments and data formats through the same "road", saving time and resources for public service delivery. Another example is India's Data Empowerment and Protection Architecture (DEPA), a framework that enables secure data sharing across financial institutions and service providers, allowing individuals to authorize the use of their data for services such as targeted credit offerings for small businesses.

These cases illustrate how the design of data exchange systems can increase the visibility of societal challenges while prioritizing trust-building. By standardizing data formats and access protocols, a data exchange system enhances the ability of policymakers and institutions to identify and address policy challenges like financial exclusion among marginalized communities. The permission structures embedded within systems such as X-Road or DEPA are crucial as they ensure that citizens maintain control over their personal data while enabling access to services. These consent mechanisms not only protect individual privacy but also build trust in the system, encouraging broader participation and data sharing.[38]

To ensure DPI serves the public effectively, it should be guaranteed by public institutions to be inclusive, foundational, interoperable and publicly accountable.[39] Inclusivity ensures that everyone, including underserved populations, has equitable access to the benefits of DPI. As a foundational system, DPI must support a wide array of public and private services, functioning as a core infrastructure layer. Interoperability is critical to ensuring that systems can communicate and integrate effectively, which allows diverse stakeholders to participate without barriers. Lastly, public accountability ensures that DPI systems are managed transparently, with safeguards to protect public interests.[40]

Figure 2. The DPI approach in action



Source: Richard Pope, Platformland, Harvard Kennedy School (n.d.); in Mazzucato, M., Eaves, D. and Vasconcellos, B., *Digital public infrastructure and public value: What is 'public' about DPI? UCL Institute for Innovation and Public Purpose, Working Paper Series* (IIPP WP 2024-05) (2024).

2. Overview of the DPI for Climate and Nature initiative

The vision for developing Nature ID as a data exchange is the result of a broader initiative exploring the potential for DPI to scale efforts to protect nature and address climate change. Under the banner of the 'DPI for Planet' initiative, UNDP, in collaboration with co-convenors The Rockefeller Foundation, Co-Develop, World Bank, USAID, Digital Impact Alliance and GIZ, has facilitated dialogue and collaboration with diverse stakeholders that resulted in the emergence of a common and shared understanding on the potential for DPI to tackle the pressing global challenges of nature, climate, energy and environment (i.e. planetary challenges).

This initiative builds on previous efforts to conceptualize the role of DPI in the green transition by UNDP,[41] UNEP,[42] DIAL,[43] Co-Develop,[44] the World Bank,[45] and others. This early exploratory work served to identify potential strategic opportunities for leveraging DPI to scale climate and nature action that results from specific country needs, enabling technologies and policy frameworks, and opportunities to create public value.

This initiative supports the priorities outlined in UNDP' Digital Strategy, the Climate Promise and Nature Pledge. Climate Promise 2025 is a UN System-wide effort to help countries align their national pledges with the 1.5°C Paris Agreement target, strengthen their quality and investability, and accelerate their implementation. The Nature Pledge is UNDP's commitment to provide accelerated and upscaled support to over 140 countries in reaching their ambitious targets under the historic Kunming-Montreal Global Biodiversity Framework. The pledge provides a pathway to transform our global systems to meet vital targets to protect and restore the planet, eradicate poverty, reduce gender and other inequalities, protect human rights and accelerate overall progress on the Sustainable Development Goals. Given the demonstrated ability for DPI to serve as a flexible foundation for essential services at society-wide scale, if configured appropriately it could serve as a vital tool for enabling progress towards national and international climate and nature commitments.

This initiative builds on UNDP's support to national-level climate, nature, and development initiatives. At a project level this includes support for NDC and NBSAP development and implementation, the development of open-source digital public goods (DPGs), and the promotion of safeguards for the development and operation of digital public infrastructure.[46] As a collaborative initiative, DPI for Climate and Nature also advances partners' priorities and interests, including the efforts of the Digital 4 Climate working group. At an overarching level, this initiative supports emerging frameworks such as the Global Digital Compact.

The research, advocacy and convening initiative began with a broad and exploratory approach to explore three potential domains where DPI can scale the green transition:

- Ensuring transparency and traceability in carbon markets and climate finance
- Enabling nature-positive incentives
- Addressing climate change induced vulnerabilities and risk

The highlights of this initial research are presented in three cases outlined in Annex 2.

2.1. Stakeholder engagement summary

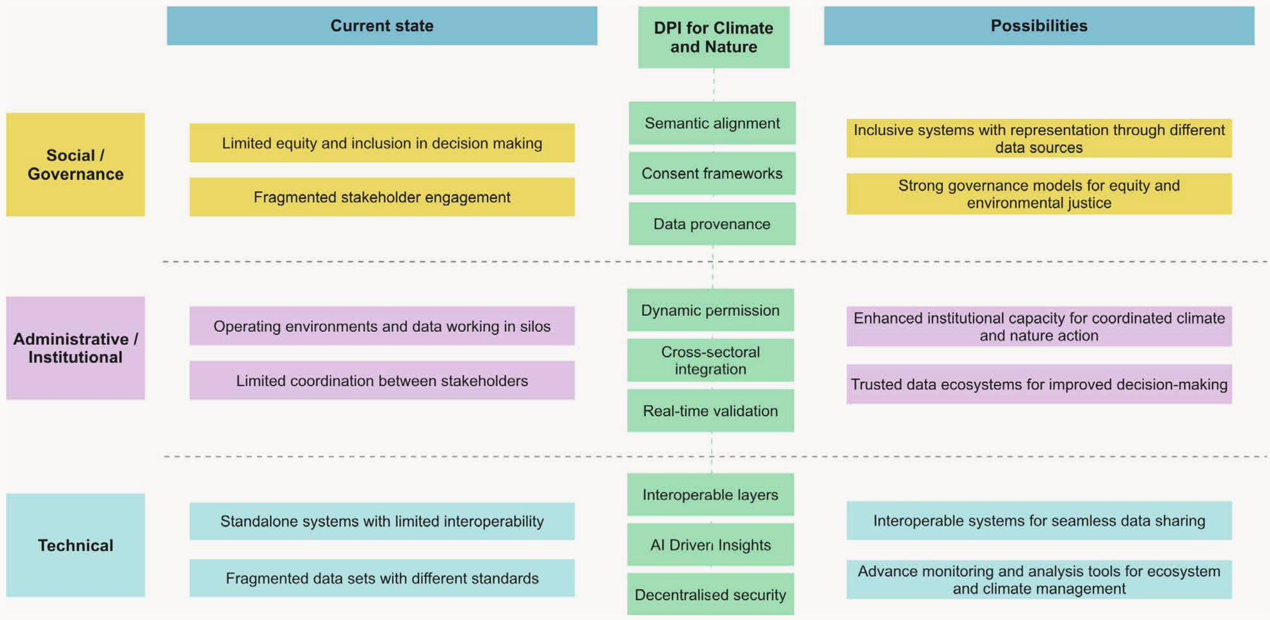
A workshop in June 2024 explored multiple potential DPI use cases—ranging from carbon market transparency and supply chain traceability to climate resilience. During breakout discussions, participants identified a recurring need for a "Nature ID" system that could integrate data from diverse sources—such as remote sensing, administrative records, and local communities—drawing comparisons to existing digital identity frameworks. Following heightened interest at a follow up roundtable in September 2024 in New York, the scope of research narrowed down to exploring and testing the potential of the Nature ID concept, noting its potential to underpin a range of climate and nature initiatives. While other use cases remain promising, Nature ID was seen as a foundational digital solution with broader applicability across various domains. The concept was further developed and refined at side events held during the 2024 United Nations Biodiversity Conference (CBD COP16) in Colombia and the 2024 United Nations Framework Convention on Climate Change (UNFCCC) Conference of Parties (COP29) in Azerbaijan, incorporating stakeholder feedback and insights from government policy makers, Indigenous leaders, the private sector and others. Figure 3 summarizes the timeline for these events and engagements.

Figure 3. DPI for Climate and Nature: initiative convening timeline

2.2. Analytical framework to situate DPI in a broader social context

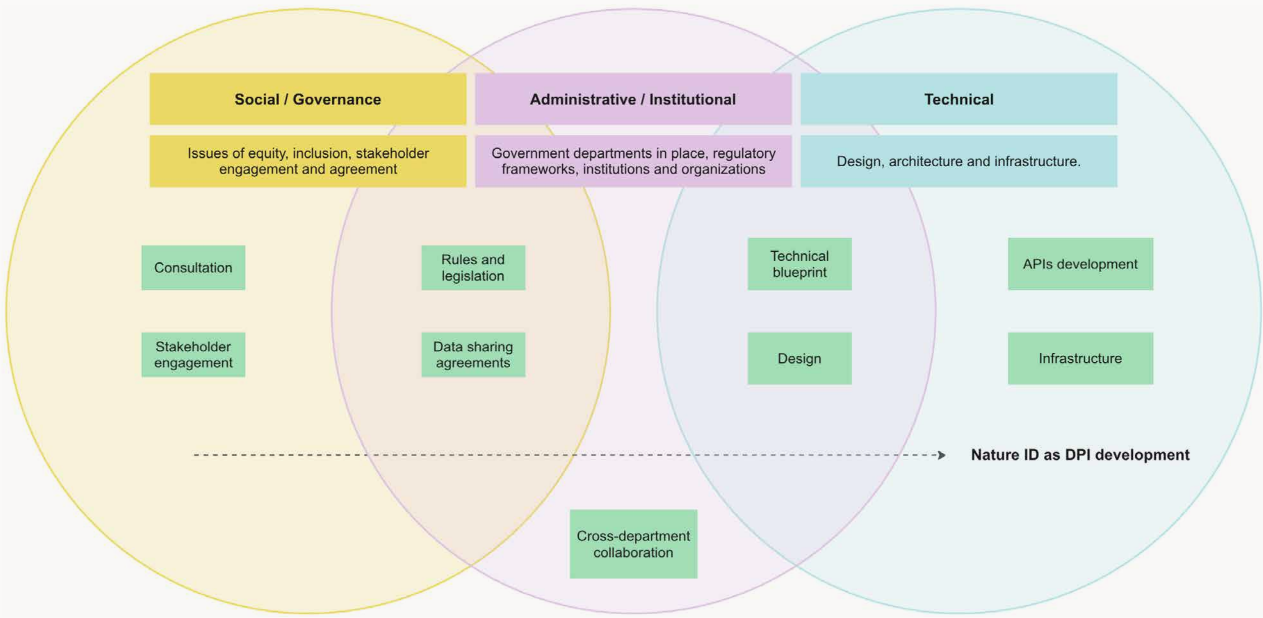
This research employs an analytical framework that examines Nature ID through three key dimensions—technical, administrative/institutional, and social/political—each evaluated under both current realities and future possibilities (Figure 4). By taking a holistic approach, the framework highlights how governance structures, technological capabilities and societal factors intersect in shaping DPI (Figure 5). Rather than advocating for the development of entirely new technical solutions, the aim is to draw insights from existing pilots and established systems. Learning from existing initiatives will help the vision for Nature ID as a data exchange aligns with real-world constraints, stakeholder needs and opportunities for scaling.

Figure 4. Analytical framework for Nature ID



Source: UNDP Digital for Planet.

Figure 5. Key dimensions shaping the development of DPI over time



Source: UNDP Digital for Planet.

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*"Science, technology and innovation may not be the silver bullet to address all the small and grand challenges we face, but we know for a fact that **STI has the proven potential to accelerate the achievement of the SDGs**. Promotion of biodiversity and climate sensitive agriculture is important to Malawi, and there should be a focus on initiatives that build capacity, protect the environment, conserve natural resources and promote sustainable development."*

H.E. Madalistso Kambauwa Wirima, Minister of Education, Science, Technology and Innovation, Republic of Malawi (September 2024 event)

*"If we don't use [technology] correctly, it is very dangerous for us. But if we use it properly, it can be used for our collective future. For [Nature ID] to work, it must consider the **wisdom of nature, and Indigenous Peoples, and help permanently protect nature.**"*

Uyunkar Domingo Peas Manpichkai, President of the Board of Directors, Amazon Sacred Headwaters Alliance (September 2024 event)

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*"Deforestation is a major problem for us. **Nature ID can be important for better forest governance.**"*

H.E. Mr Laurent Tchagba, Minister of Water and Forests, Government of Cote d'Ivoire (COP29 event)

*"Starting from our efforts to preserve native vegetation, **our challenge is now to design a DPI architecture that can serve to gather and connect data from different places**. Nature ID could be very close to this concept."*

Henrique Dolabella, Director, Rural Environmental Registry, Government of Brazil (COP29 event)

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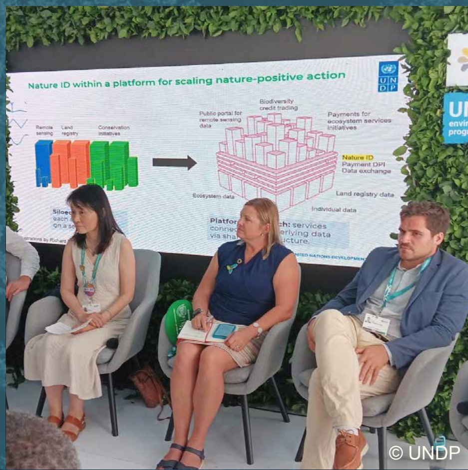
"Indigenous Peoples have managed to protect their territories and deeply understand local biodiversity and water resources. ***Combining scientific knowledge with Indigenous Peoples' knowledge can help us understand the value of nature and drive impacts we want to see on the ground."***

Hugo Jabini, Spokesperson, Association of Saamaka Authorities, Suriname (COP16 event)

"There is a critical gap between companies' understanding of how their business depends on nature, and the level of risk disclosure. As companies are now faced with a slate of new regulations, they need better information to guide their decisions. Companies face a lack of data, a lack of understanding. Nature ID could be a shortcut to overcoming those challenges. ***A new data platform could help companies take action, make new investments, innovate****, and support the reporting and disclosure that they need to do."*

Anastasia Thatcher Marceau, Managing Director, Accenture Development Partnerships (COP16 event)



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"We need to work together as coalitions and partners, to listen to each other, and especially to the voices of Indigenous Peoples*, as we aim to build a platform out of shared building blocks. Norway is proud to continue leading efforts to bring several actors together and continue this discussion."*

Ida Hellmark, Senior Advisor, Norwegian Agency for Development Cooperation (COP16 event)

"We have a window of opportunity to establish and protect data on climate and nature as a public asset. Some of this infrastructure must be public. As with the Internet or GPS, that will unlock more value. ***The value of having climate and nature data as a public asset cannot be overstated."***

CV Madhukar, Chief Executive, Co-Develop (September 2024 event)


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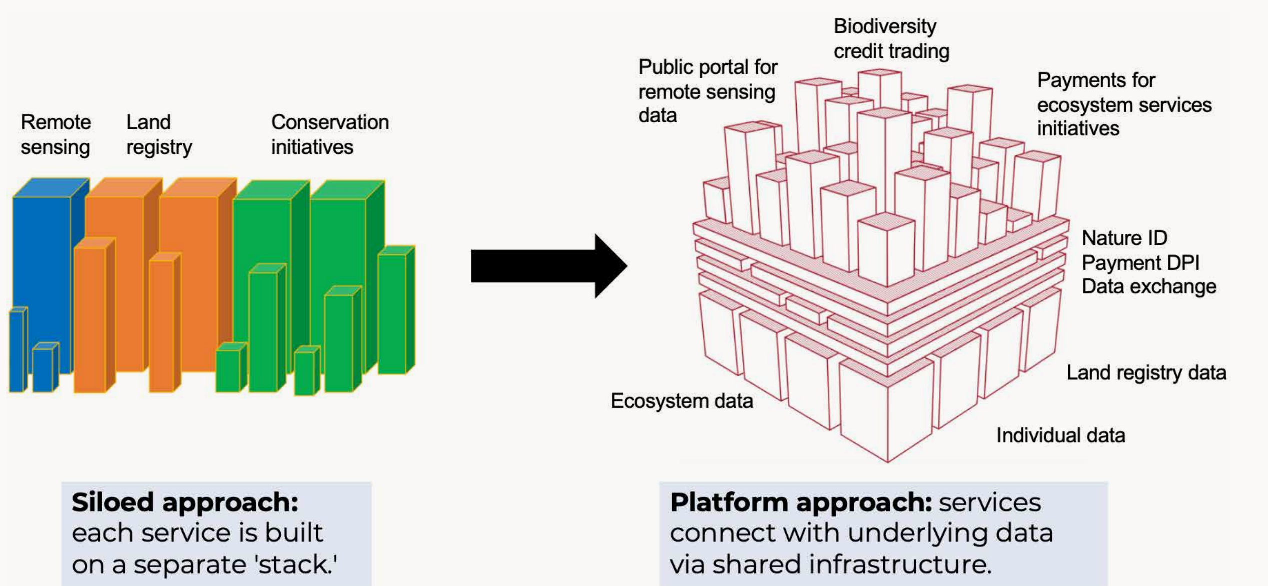
3. The potential for Nature ID as DPI

The current approach to environmental data management is often fragmented, with various services and initiatives operating in isolation using their own distinct data systems. Remote sensing applications might focus solely on satellite imagery within specific regions, carbon market platforms may utilize only certain environmental data relevant for carbon sequestration and conservation projects often rely on disparate datasets pertaining to different species or habitats. These initiatives are also typically modest in ambition due to capacity and resource constraints in a country that limits the potential for scaling impactful solutions to a whole-of-society level. Moreover, critical data related to infrastructure, transportation, energy and mobility information are often stored across governments, research institutions and other organizations.[47]

A DPI approach offers a different model. Instead of each initiative building and maintaining its own software and data in isolation, DPI acts like a shared network that multiple services can tap into without needing to gather all data in one place (Figure 6). In practical terms, this means different datasets (for example, satellite images, land registries and community observations) can be exchanged and combined securely through common rules and technical standards, rather than each project reinventing its own methods. By providing this underlying layer for information sharing, DPI can reduce complexity, avoid duplication, and make it easier for a variety of stakeholders—governments, private sector actors, and civil society—to work together on environmental challenges.

By moving away from siloed data systems and embracing a shared infrastructure approach, Nature ID can help build a more cohesive ecosystem for environmental data management. Nature ID, as a data exchange layer, should bridge this gap by facilitating interoperability across diverse data providers and consumers. This integration can support resource allocation, decision-making capabilities, and the ability to address environmental challenges more effectively at scale. Leveraging common standards and modular building blocks in the development of Nature ID would enable more seamless integration with existing systems and the incorporation of future technological advancements. Adopting a modular and adaptable DPI approach would allow Nature ID systems to accommodate the evolving needs of various stakeholders.

Figure 6. Siloed vs Platform approach to digital systems for climate and nature action



Source: This draws on frameworks for digital transformation and DPI explored by Mazzucato, M., Eaves, D. and Vasconcellos, B., *Digital public infrastructure and public value: What is 'public' about DPI?* UCL Institute for Innovation and Public Purpose, Working Paper Series (IIPP WP 2024-05) (2024); and Richard Pope, Platform land, Harvard Kennedy School (n.d).

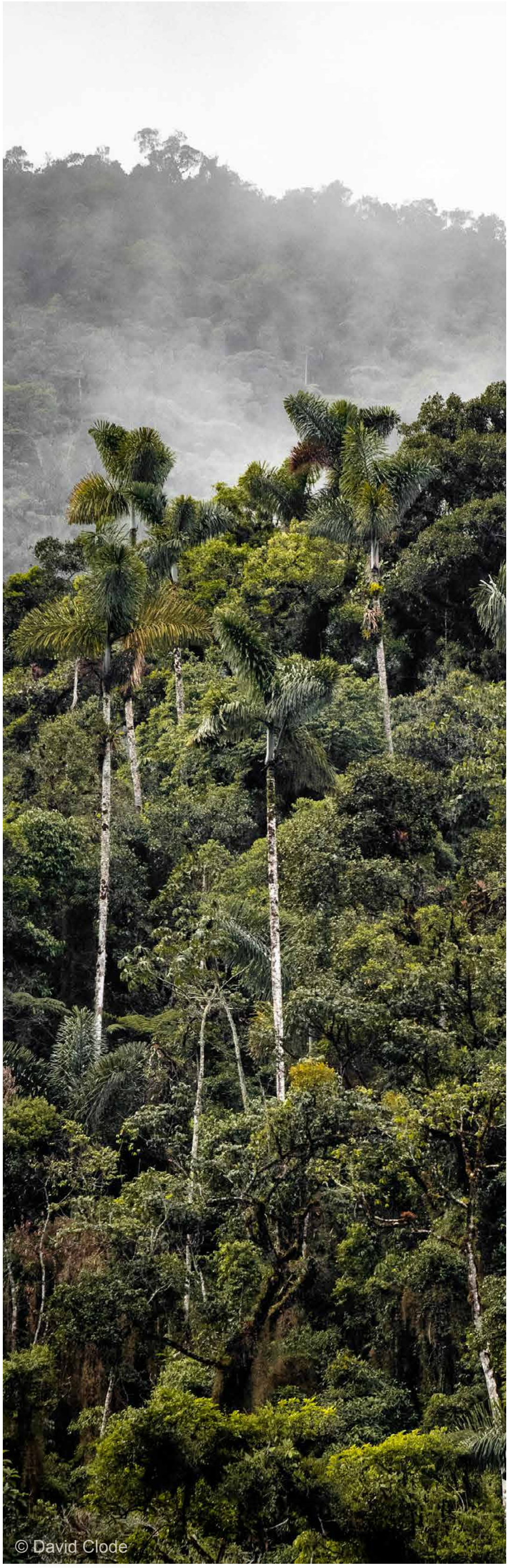
Case study

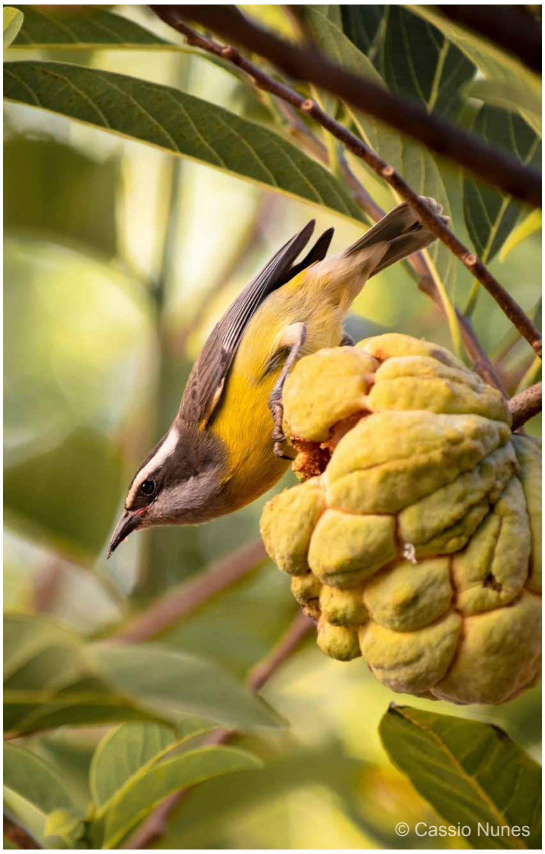
Brazil's digital land registry *(Cadastro Ambiental Rural)*

Brazil's *Cadastro Ambiental Rural* (CAR) is a digital land registry that supports the conservation and sustainable use of forests and native vegetation, with a goal to ensure 80 percent of landholdings in the Amazon remain home to native vegetation. The CAR is a key element of Brazil's environmental policy framework under the Native Vegetation Protection Law, also known as the 'Forest Code.' Registration under the CAR is mandatory. Landholders must self-declare property information, including environmental attributes, via a digital portal. This information can then be verified and enable environmental regularization programs and monitoring.

However, CAR has faced challenges[55] related to low levels of data verification, overlapping claims[56] and consistency in use and application across regions. Since CAR relies on self-reported information from landowners, boundaries can overlap. Verifying and addressing these overlaps requires significant administrative capacity. Only about 3 percent of registrations have been verified so far, mainly due to a lack of resources for validation at the regional level.[57] Many states are adopting tools that can help automate this process. Additionally, while there are provisions for traditional peoples and communities to submit information on collectively managed or pooled territories, research suggests that one impact of the CAR has been to surface land disputes that may undermine these communities' claims. Despite these issues, CAR remains a vital resource to support various efforts, from forest conservation to financial services that incentivize sustainable practices.

Brazil is currently strengthening CAR using a DPI approach. In practice this means enhancing its interoperability with different data gathering systems and services including remote sensing or satellite data systems, local data gathering initiatives supported by



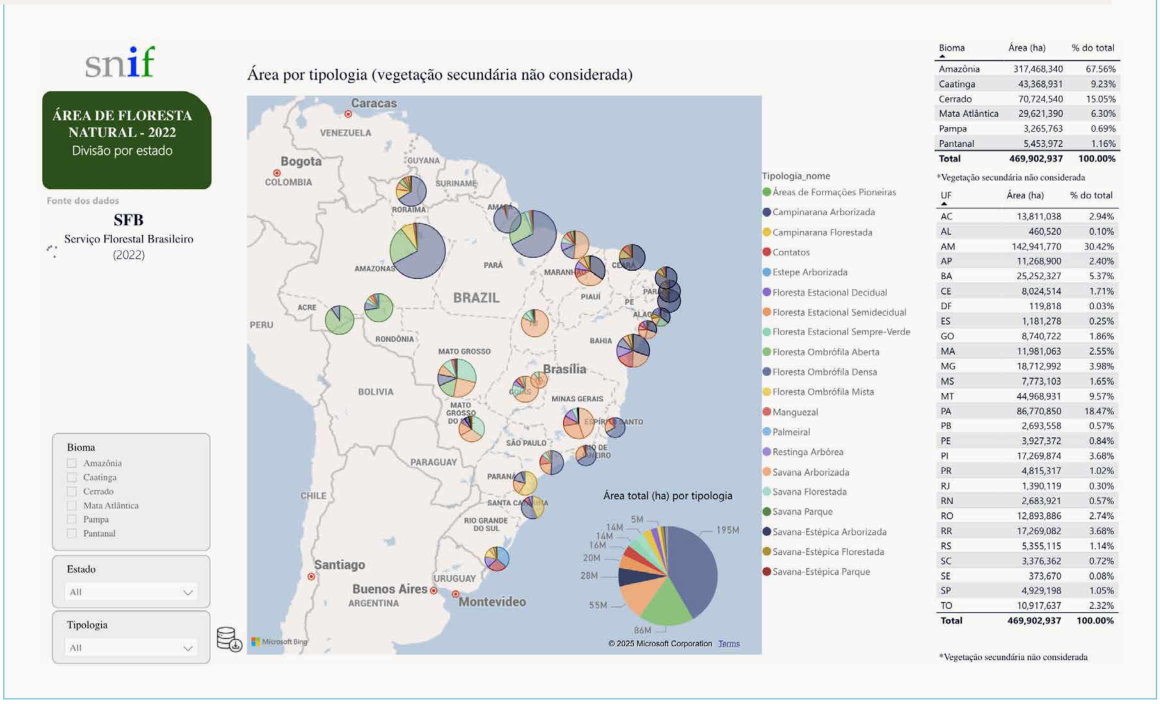


drones and sensors as well as the payment systems used by financial services providers. This multi-dimensional approach can strengthen the ability of CAR to serve as a foundational layer that integrates data from various sources and enables stakeholders to access integrated data on land use, ownership and environmental health of ecosystems to gauge their holistic value from a planetary perspective.

This infrastructure approach can further support social protection programs like Floresta+, which depend on CAR data for processing payment disbursements under the PES scheme. CAR data could also be leveraged to promote sustainable and low-carbon agriculture, restore degraded natural habitats and protect native vegetation.

This supports efforts to develop digital systems for territorial and land use planning, a key pillar of Brazil's NDC. Additionally, the NDC includes specific commitments to integrate real estate, environment, registry and tax databases, leveraging georeferenced data, unique identifiers, and disseminating the data in open and accessible formats (see Figure 7).[58]

Figure 7. Brazil's National Forest Information System displays aggregated information including CAR data



Case study

India's Forest Stack

The 'Forest Stack' is an initiative to transform forest conservation and management in India with DPI. With support from the Japan International Cooperation Agency (JICA), the stack aims to integrate data and governance standards into a cohesive digital system that benefits diverse stakeholders. This initiative addresses challenges such as deforestation, habitat loss, illegal encroachment and insufficient monitoring of protected areas by creating a foundation for better data exchange and coordinated policy action.

At the core of the Forest Stack concept is a layered architecture that supports forest conservation, enhances biodiversity and unlocks economic opportunities, including the potential for carbon credits. The model features:

- **A data layer**, where central and regional data repositories (e.g., forest registries, species directories, carbon project inventories) are maintained with unique identifiers and geo-referenced information.

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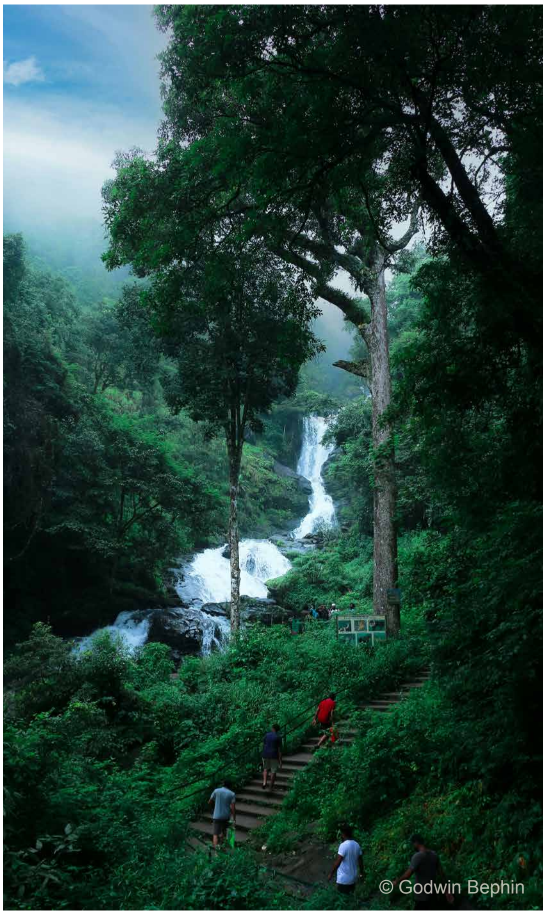
- **A technology layer**, comprising analytical tools for forest health monitoring, deforestation risk assessment, and carbon stock estimation, as well as secure data exchange and consent mechanisms.

- **An application layer**, which provides services for forest monitoring, biodiversity conservation, community empowerment, and carbon market participation. Government agencies, private-sector stakeholders, NGOs, researchers and local communities can build or access services on this layer using standardized Application Programming Interfaces (APIs) and data formats.

- **An infrastructure layer**, offering a scalable, cloud-based foundation to store, process and transmit forest data securely across various regions and systems.

In pilot deployments, the Forest Stack has enabled real-time data collection and analytics to support afforestation projects, human-wildlife conflict mitigation, and wildlife habitat monitoring. By unifying fragmented data sources—ranging from satellite imagery to field surveys—this infrastructure helps to pinpoint areas of high ecological value, track illegal activities, and guide targeted interventions. Local communities and private-sector entities can also leverage the data for sustainable forest produce marketplaces or carbon-credit initiatives, fostering both environmental protection and economic development.

The Forest Stack's emphasis on modular, interoperable components is particularly relevant to the vision for Nature ID. It demonstrates how a DPI approach can be adapted to various ecosystems and scaled across different jurisdictions. For instance, integrating near-real-time sensor data and multi-stakeholder governance arrangements can inform policy decisions at municipal or regional levels, supporting more transparent land use planning. The project also underscores the importance of carefully designed permission structures and secure data exchange, ensuring that sensitive data—such as protected species locations—is accessed only by authorized actors.



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While challenges remain—such as harmonizing data standards, ensuring data sovereignty, and bridging technology gaps in remote areas—JICA's Forest Stack illustrates how incremental improvements within existing frameworks can catalyze broader ecosystem benefits. By aligning with global and national sustainability goals, the initiative not only supports climate change mitigation and biodiversity conservation but also highlights the potential economic impact of well-managed forests, including new revenue streams from carbon credits.

The Forest Stack project offers a valuable reference point for Nature ID's development, revealing how a layered digital architecture can facilitate the collection, validation and strategic use of environmental data. Its successes and lessons learned underscore the promise of applying a DPI lens to forests and other critical ecosystems around the world.

3.1. Nature ID components and functions

At its core, Nature ID aims to support the monitoring of key ecological indicators—such as vegetation cover, water levels, and pollution metrics—over time. This would enable comparisons between current data and historical benchmarks. By leveraging tools from multiple data sources such as satellite imagery, remote sensing technologies, and environmental monitoring stations, the system could detect trends and changes, allowing for timely interventions and serve as a platform for biodiversity monitoring at scale. By integrating data on flora and fauna collected through sensors, camera traps, acoustic monitoring and citizen science initiatives, Nature ID would provide detailed assessments of biodiversity, supporting species identification and ecosystem health evaluations. While this would require significant–and likely inefficient–amounts of resources to embed for all locations, adopting this approach in specific ecologically sensitive or culturally significant locations could enable Nature ID to better support local initiatives.

Linking economic activities to spatial environmental data would allow for the assessment of environmental footprints and support the development of sustainable resource management policies. By incorporating socio-economic data from tourism statistics, agricultural registries and industrial reports, the system would provide insights into how human activities interact with the environment at particular locations. This could enable users to leverage Nature ID to monitor how human activities–such as tourism, agriculture and industrial operations–impact ecosystems.

In addition, Nature ID could help coordinate the activities of organizations and governments within specific ecosystems by aggregating information on conservation programs, funding initiatives and policy interventions. This would facilitate coordination among stakeholders, identify overlaps and gaps in conservation activities, and enhance transparency and accountability in resource deployment.

The potential interoperability of Nature ID is fundamental to its envisioned effectiveness. Acting as an interoperability layer, Nature ID would process diverse data inputs—including legal ownership records, Indigenous claims, ecological indicators, biodiversity data, and human activity metrics related to specific natural assets—to facilitate a comprehensive understanding of natural ecosystems. By integrating this data, Nature ID aims to enable services and applications that promote conservation, sustainable development and environmental justice. The interoperable nature of data exchange platforms within DPI frameworks means that services across healthcare, finance and welfare can be coordinated effectively, addressing multiple needs simultaneously. By integrating digital ID, payments, and data exchange, DPI creates an ecosystem that supports equitable access to essential public services. The exponential increases in financial inclusion enabled by digital services built on top of DPI illustrates the potential if DPI can be successfully deployed to scale the green transition.[48]

Potential models and functions for Nature ID include API gateways to facilitate streamlined interactions between systems, federated data spaces that allow data providers to retain control while enabling interoperability, and secure interoperability layers akin to those used in cross-sector government platforms (X-Road or the Enterprise Architecture Framework in Rwanda[49]) and transnational environmental monitoring initiatives (e.g. WMO, Copernicus and GEOSS). Such models have been successfully employed in various contexts to ensure efficient, decentralized and accountable data sharing, forming a strong technical foundation for Nature ID's design.

Learning from these models, Nature ID could facilitate data exchange without necessitating the centralization of sensitive information. Robust security measures, including encryption and access controls, can ensure that data contributors retain control over their information, particularly concerning land claims and proprietary ecological data. An intentional balance of openness and security can encourage wider participation and collaboration and build trust among users.

Data providers could plug into this shared infrastructure using standardized APIs (Figure 8). For data providers, this integration would involve exposing their datasets through secure APIs, allowing them to specify access permissions and usage conditions. By doing so, they could contribute valuable information to a broader ecosystem without relinquishing control over their data. Providers might set conditions under which their data can be accessed, employing permission structures that ensure security and compliance with data protection regulations.

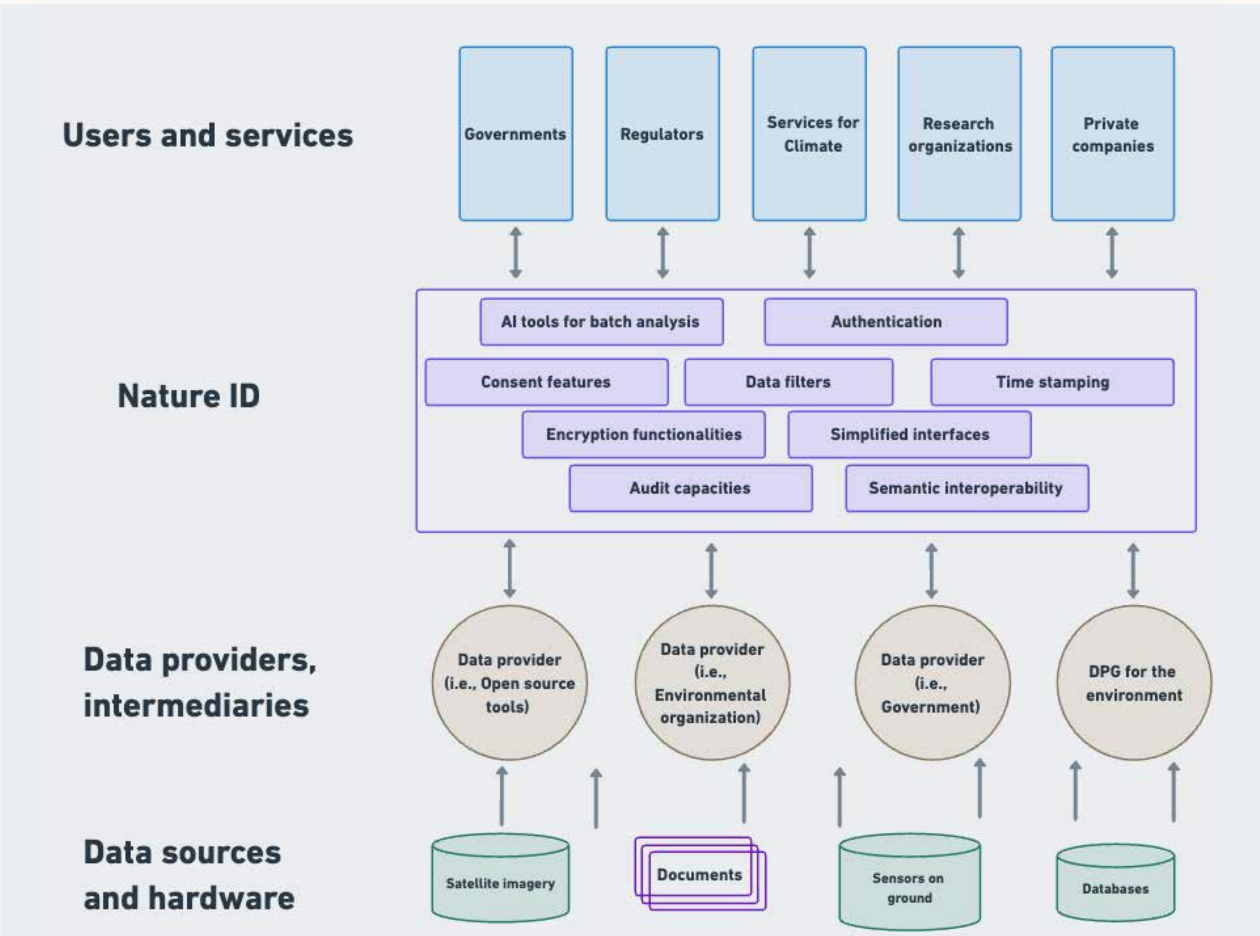
Data consumers could access data by connecting their applications and services to Nature ID's APIs. This access would grant them a wealth of information that was previously fragmented or inaccessible, enabling them to develop more effective strategies, make informed decisions, and create innovative solutions to environmental challenges. Access to integrated data on ecological health, land use and human activities allows them to consider multiple factors simultaneously, leading to more informed and effective environmental regulations by policy makers. By providing a holistic view of environmental dynamics, Nature ID supports the development of policies that are better aligned with ecological realities and societal needs.

At a technical level, the functionality of this data exchange architecture would be supported by an array of microservices. These microservices could include user permission management, ensuring that data providers retain control over their contributions and that sensitive data is used appropriately; validation and verification processes to ensure that incoming data is accurate, consistent and trustworthy; and standardization tools that harmonize diverse formats into coherent and interoperable schemas. Acting as a dynamic intermediary, these microservices would enable Nature ID to transform fragmented datasets into actionable insights while maintaining efficiency and security.

This approach, designed around minimalist data principles, would focus on collecting and processing only the essential information needed to achieve meaningful outcomes. In this context, minimalist data principles mean prioritizing the collection of data that directly contributes to understanding or improving ecosystem health, avoiding the unnecessary accumulation of redundant, non-critical, or overly granular data that could burden the system or compromise privacy.

Nature ID should ensure that the recognition of Indigenous knowledge and rights are respected within the development and management of this architecture and associated data. Developing Nature ID in partnership with Indigenous communities could support collective capacity for environmental stewardship. Indigenous data sovereignty, allowing Indigenous communities to retain control over their data and its usage, must also be respected. These essential considerations for the development of Nature ID are further explored in the following section on Indigenous data governance in a Nature ID ecosystem.

Figure 8. Proposed data exchange architecture for Nature ID within an overarching technology stack



Source: UNDP Digital for Planet.

By invitation

Indigenous perspectives on data governance within the Nature ID ecosystem

Data sovereignty relates to redressing Indigenous Peoples' right to own, control and supervise both the tangible expressions, as well as intangible forms, of data collection and production. Emerging forms of data governance offer opportunities to provide new protocol mechanisms and infrastructures for Indigenous data to exist temporally in non-Indigenous systems. In the context of data governance, Indigenous Peoples and civil society voices have recommended for the creation of 'biocultural notices' and 'traditional knowledge labels' to provide safeguards on the provenance of Indigenous data.

As part of the new Cali Fund on Digital Sequence Information (DSI) approved at the Convention on Biological Diversity (CBD) COP16 in 2024, Indigenous data not only needs to address the provenance or 'identifier' mechanisms in the information ecosystem and intellectual economy (such as synthetic biology, alternative proteins, fibers and enzymes), but also the legitimacy deeds and titles in the supply chain for Indigenous Peoples to exercise their right to data's profits and revenues.

Biocultural data legitimacy deeds and titles have been suggested as legal instruments to establish and protect Indigenous legal rights over their data by providing unique identifiers to verify data deeds and titles to their rightful owners as addressed by Articles 5, 14 and 45 of the UN Declaration on the Rights of Indigenous Peoples (UNDRIP). These biocultural data identifiers have been proposed to ensure that data governance

aligns with Indigenous cultural values, free and prior informed consent (FPIC), and self-determination principles, providing legal mechanisms to prevent the unauthorized misappropriation of Indigenous data (as addressed by Articles 8, 11, 13 of UNDRIP).

Developing a Nature ID in harmony with Indigenous rights to data

The development of a Nature ID ecosystem at a sub-national, country or regional level in relation to Indigenous data must prioritize Indigenous Peoples' right to data collection, interpretation, FPIC and self-determination, thereby ensuring that Indigenous communities are considered as equity partners or shareholders from the outset.

Integrating biocultural responsibility and accountability into the Nature ID architecture may involve a two-way verification framework that certifies on-the-ground Indigenous rights to data, and treats nature capital assets as relational entities rather than commodities. This responsibility could be enforced through biocultural data legitimacy deeds and titles to sustain the biocultural records throughout the data lifecycle within the Nature ID ecosystem of relations.

From the earliest stage, the co-design of a Nature ID ecosystem at the relevant spatial scale, should be based on principles of biocultural governance, which positions Indigenous Peoples as nature capital investors and shareholders of their environments and territories. By aligning data with Indigenous value systems, the Nature ID ecosystem has the potential to reflect the interconnectedness of cultural and ecological well-being, fostering and recognizing human-nature agency in the form of reciprocal relationships between people, technology, and nature.

From an intellectual property rights perspective, a Nature ID ecosystem offers scope for the recognition of knowledge production and sovereignty, formalizing Indigenous contributions to environmental data collection, as well as reinforcing Indigenous Peoples' role as environmental stewards. However, the Nature ID ecosystem also presents risks such as commodifying nature, assigning market value to nature assets that reduce complex ecosystems to transactional property relations, as well as data misappropriation. Biocultural data legitimacy deeds and titles therefore need to integrate robust safeguards, operationalizing Indigenous Peoples' legal rights to data.

Regulatory alignment in the use of DPI

To ensure that all forms of DPI, including Nature ID, are used correctly, transparent monitoring systems will be required for the implementation of public dashboards which incorporate biocultural data. Nature ID must adhere to regulatory alignments for Indigenous Peoples and international standards, such as the UNDRIP; the Nagoya Protocol's arrangements on access and benefit-sharing (ABS); the Article 8j provisions on the protection and transmission under the CBD; alongside the design of the new DSI Cali Fund, all of which involve Indigenous knowledge.

If established on a respectful foundation, Nature ID complemented by biocultural data is positioned to articulate new instruments, pathways and partnerships for delivering benefit-sharing pledges in the biodiversity and data economy. Blockchain-based systems on biocultural data legitimacy deeds and titles offer promise to ensure data-responsible connections to its cultural and ecological origins.

Beyond its primary applications, Nature ID may also support Indigenous rights and sovereignty through cultural heritage protection, by integrating geospatial data to map and protect sacred natural sites, preventing unauthorized development. Other opportunities exist for incorporating Indigenous sustainability strategies into disaster preparedness and response systems, climate justice advocacy to support Indigenous claims in climate litigation, as well as for assessing the extent of inequality and discrimination.

By Ňkwi Flores

Kinray Hub (Indigenous-led climate research and resiliency development think tank)

3.2. Emerging use cases for Nature ID

Nature ID could deliver significant public value at scale across three use cases in particular: biodiversity monitoring, enabling nature- positive climate finance and value chain traceability. Each domain is currently hobbled by fragmented data sources, diverse governance requirements and overlapping commitments to address climate and nature targets. All three share the following characteristics based on research findings that make them well-suited for a holistic, infrastructure-based approach:

1. **A clear need to share and integrate data**. They demand robust frameworks for monitoring, verification and reporting that rely on timely, accurate information from multiple stakeholders—including local communities, research institutions and government agencies—yet these data sources often remain siloed.

2. **Existing technology and prototypes**. Pilot projects have already revealed promising digital solutions—ranging from data exchange platforms to advanced sensor networks—that can be scaled up. These early efforts highlight how various technologies and infrastructure components could be harnessed to address complex environmental and socio-economic challenges.

3. **Opportunity for public value and efficiency**. By expanding interoperability and enabling secure data exchanges, Nature ID can reduce duplication of efforts, foster innovation, and empower stakeholders (i.e. conservationists, local communities, private enterprises and policymakers) to make more informed, coordinated decisions.

The three cases adopt a **holistic** perspective of Nature ID as a **DPI that depends on supportive governance, institutional capacity and social inclusion**. Each use case underscores how an interoperable, standardized platform for environmental data can drive meaningful progress across key arenas of the green transition.

3.2.1 Use case 1: Monitoring biodiversity and supporting environmental justice (Figure 9)

A key challenge in biodiversity monitoring is ensuring that existing datasets—ranging from global satellite imagery to locally gathered observations—can interact and enrich one another. While advanced platforms like the United Nations Biodiversity Lab (UNBL) and SERVIR provide invaluable satellite-based insights, it is often difficult to integrate these with data collected directly in the field using mobile devices, community-led species inventories, or localized environmental indicators. The result is a fragmented picture where important nuances, cultural contexts, and ground-level realities may be lost or underutilized.

Nature ID, as a data exchange DPI, could bridge these gaps by ensuring semantic interoperability[50] and aligning diverse data sources under common reference points and standardized formats. For example, if one platform documents species based on local naming systems and another uses global scientific classifications, Nature ID could serve to translate these references, so a query for "red-eyed frog" in one system can seamlessly match "*Agalychnis callidryas*" in another. By enabling semantic interoperability, Nature ID helps diverse datasets "understand" each other, facilitating data merging and more seamless queries and analysis. This functionality would require the integration of different components within an overarching Nature ID architecture, as outlined in Figure 9 below.

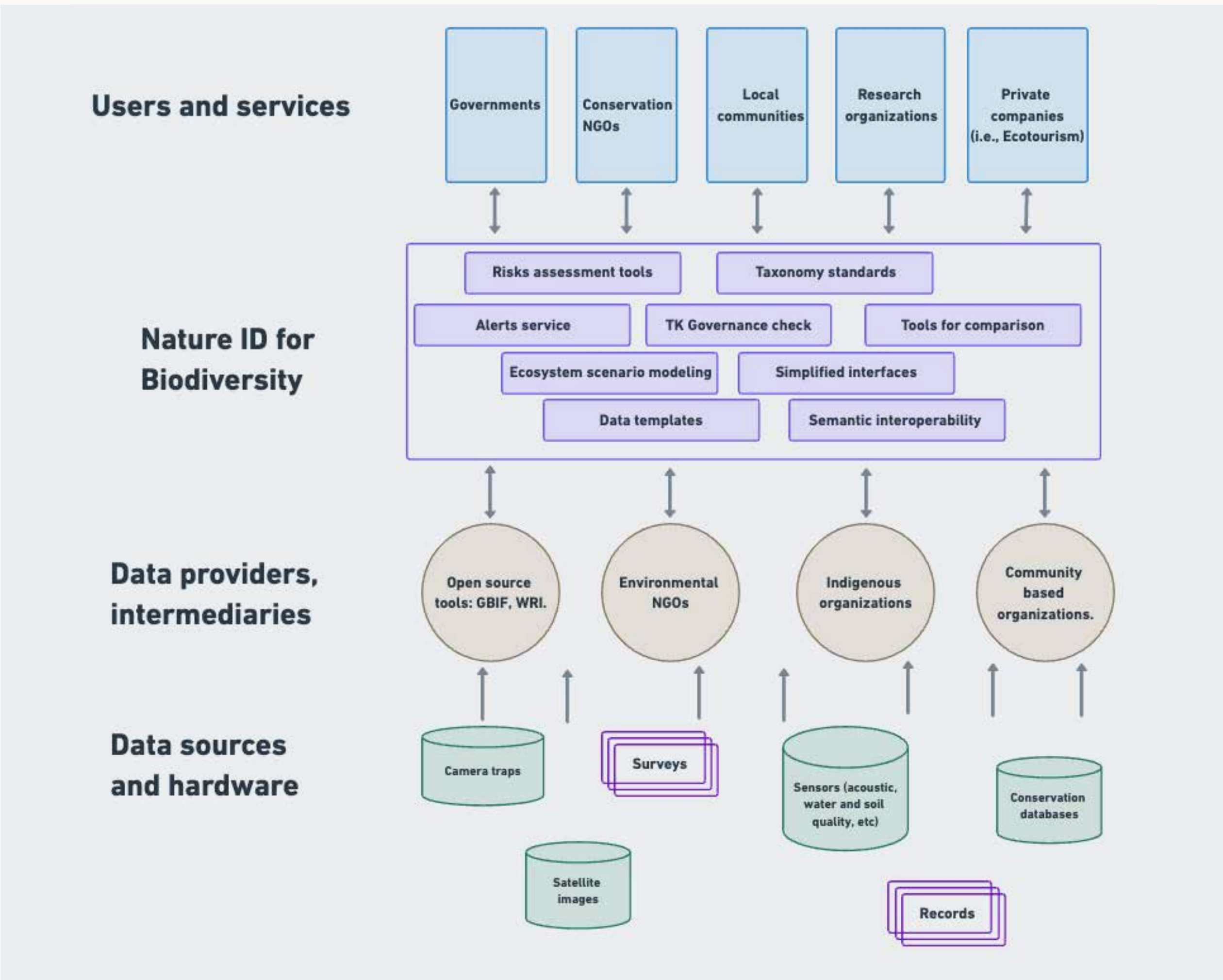
Embedding minimalism as a principle in the design and development of Nature ID will help address the risk of data overload. For instance, instead of documenting every ecosystem attribute available, a core set of critical metrics—such as the presence and abundance of key species, basic habitat quality indicators, or evidence of invasive species—can provide a sufficient basis for robust analysis. Restricting the scope to a minimal set of data points helps streamline the system and ensure that users are not burdened with unnecessary details. This also eases the process of building interoperability. However, implementing a system that embraces this minimalist principle requires ongoing agreement about what constitutes critical data.

Indigenous Peoples and local communities, who often hold critical ecological knowledge and manage lands with high biodiversity value, could benefit significantly from this integrated approach. Through adherence to international guidelines and principles such as those reflected in Article 8(j) of the Convention on Biological Diversity, Nature ID can incorporate a diverse range of mechanisms to protect Indigenous data, such as the Traditional Knowledge (TK) labels.[51] These labels indicate when data originates from Indigenous or community sources, ensuring that sensitive cultural information is recognized and managed according to agreed-upon protocols. For example, if certain plant species hold cultural or spiritual significance, Nature ID could mark these entries with TK labels that limit access or specify conditions for their use. A microservice dedicated to TK governance could assist in implementing these protocols by verifying that requests to view or utilize such data meet pre-established criteria. In practice, this means Indigenous communities can share their knowledge on their own terms, retaining control over how it is integrated with external datasets, and ensuring that the benefits—such as recognition in biodiversity credits or informed conservation decisions—are fairly distributed.

From the perspective of environmental NGOs, researchers and policymakers, a DPI approach offers a practical, scalable solution. Instead of trying to retrofit dozens of stand-alone tools for biodiversity assessment, they can plug into a single data exchange environment. By doing so, they inherit shared standards, validated taxonomies, and minimalistic data templates that reduce the complexity of collaboration. This interoperability also positions Nature ID to become a valued backbone over time, capable of incorporating new technologies or analytical methods as they emerge. For instance, as machine learning models improve, a microservice could be developed to automatically classify species in images uploaded by community monitors, or to predict ecosystem changes under various climate scenarios.

This effort to enable the seamless exchange of biodiversity information can support global policy frameworks. The Kunming-Montreal Global Biodiversity Framework calls for measurable and comparable indicators at multiple scales. Nature ID could help link local data with national and international reporting initiatives. For example, a local wildlife survey can feed into national biodiversity dashboards, which in turn inform international reporting and decision-making. If Nature ID can maintain a high level of quality and coherence across datasets, these indicators become more trustworthy and meaningful. Stakeholders are then better equipped to craft targeted conservation policies, direct resources effectively, and measure the impact of interventions over time.

Figure 9. Nature ID for Biodiversity



Source: UNDP Digital for Planet.

3.2.2 Use case 2: Enabling climate and nature-positive finance

The level of climate and biodiversity finance must increase rapidly to meet local needs and deliver on global targets. This is not just a challenge of scaling the amount of overall financing, but also of making sure that it is appropriately targeted and results in verifiable progress towards measurable climate and biodiversity targets. Mobilizing finance is not just a matter of directing new funding to new initiatives but also addressing and redirecting the flows of financing that contribute towards the climate and nature crises in the first place. Various approaches exist for monitoring international climate finance flows, but it is often more difficult to link environmental impacts and financial flows within countries. Identifying funding needs, targeting financing activities, structuring contracts, and monitoring and reporting on impacts benefits from a more comprehensive view of the local and international financing landscape that integrates environmental and social data. The overarching need is to pursue all avenues to align the financial system with climate and biodiversity targets.

At a micro or project level, standardization, data sharing, and rigorous monitoring, reporting and verification help integrate local initiatives within a broader nature and climate finance ecosystem. These are shared needs across lending, grant financing, and the delivery of robust carbon and biodiversity credit markets. While there is already extensive infrastructure in place for certifying voluntary carbon credits, there are ongoing challenges in verifying their integrity. At the root this is about ensuring local initiatives deliver their intended outcomes, and their impacts are not double-counted.

Biodiversity credits are a more nascent mechanism that is still emerging. Given the need to monitor and certify multilayered data, early leaders in the biodiversity credit market are turning to tokenized solutions built on blockchain architecture.[52] This also has the benefit of enabling different designs that compensate for work and outcomes. However, blockchain-based solutions come with additional technical complexity that may not be the simplest or most fitting solution to implement for all contexts. This architecture still requires robust monitoring, reporting and verification functions to link blockchain registries with real outcomes.

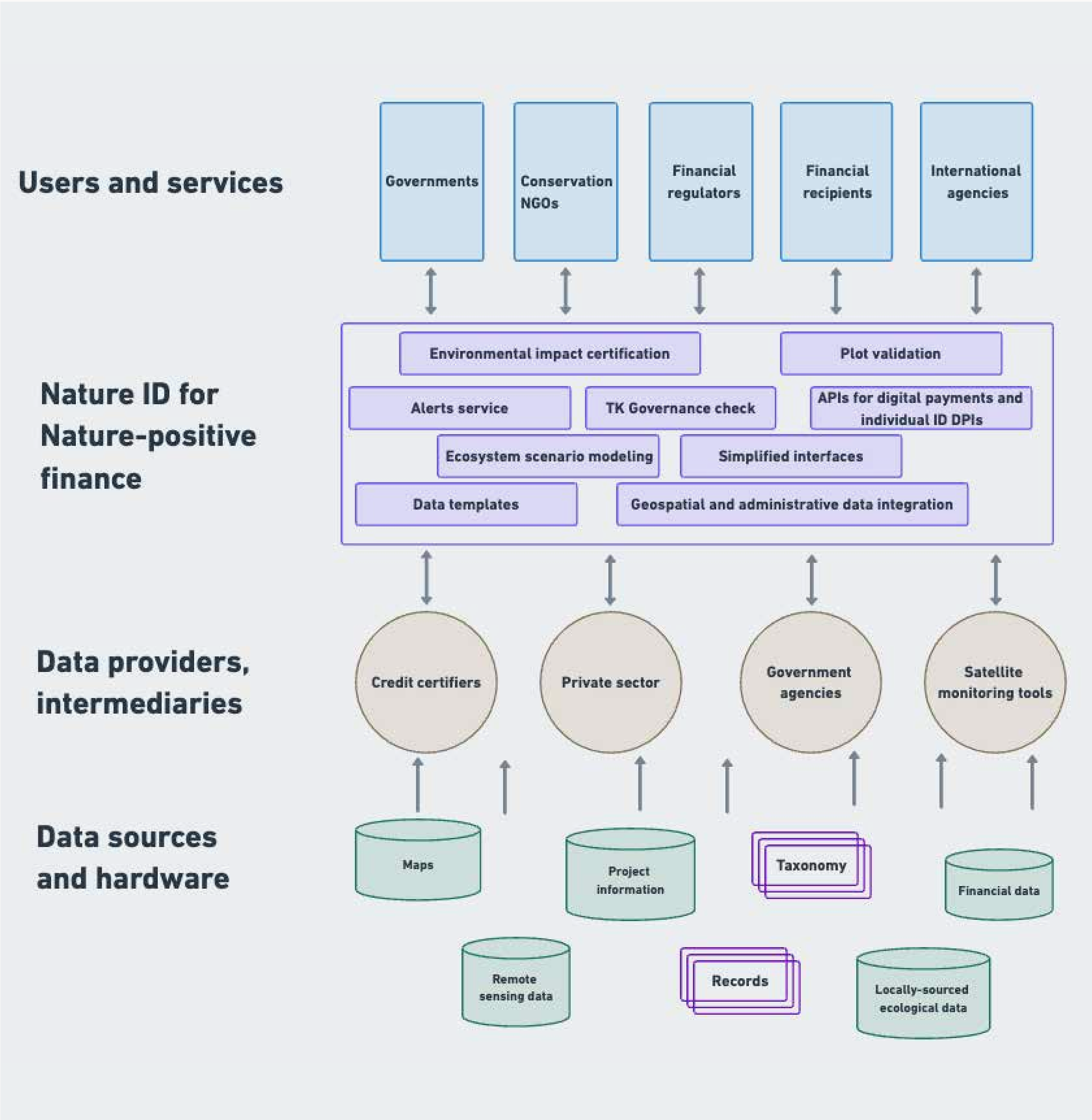
At a macro level, the Taskforce for Climate-related Financial Disclosures and the Taskforce for Nature-related Financial Disclosures are part of a wider effort to embed information standards throughout the financial system. These are being accompanied by additional regulations and reporting requirements in some jurisdictions. Compliance introduces costs to the public and private sector where this reporting is not already common practice, but this source of information can serve as a basis for pricing climate risk and the design of additional measures to align financial flows with local, national and international climate and biodiversity targets. New agreement on mechanisms for carbon credit trading under Article 6 of the Paris Agreements enable further standardization for carbon markets. This represents important progress on policy, but data sharing frameworks and infrastructure are important tools for operationalizing these frameworks. CAD Trust offers a blockchain-based solution for carbon registries, but there is potential to develop a broader infrastructure that goes beyond carbon credit trading to highlight ecological–financial–social interactions.

Deployed at national level, Nature ID can serve as a data gateway between different monitoring, reporting and verification tools, registries, initiatives, and databases, and other DPIs, including individual identities and payments where these exist. Building a horizontal interoperability layer that enables access to data for different users creates a common source of truth on financing activities and projects. **Data sharing through Nature ID can serve as a platform for scaling and targeting climate and nature-positive finance, such as for rural lending programs, financing local initiatives, and biodiversity and carbon credit markets. Connecting Nature ID with other existing DPIs for identities and payments can also enable novel financing models, such as PES.** This functionality would require the integration of different components within an overarching Nature ID architecture, as outlined in Figure 10 below.

This functionality could also be useful for third parties in the financial sector. For example, financial institutions and regulatory bodies could use Nature ID to monitor the environmental impacts of lending, and implement loan conditions to support biodiversity conservation, avoid deforestation, and manage land use change. Performing this function requires integrating environmental data associated with the impacts of interest from remote sensing and local sources, as well as administrative data on the location of interest, including ownership and financial data.

As explored in the biodiversity use case, the architecture of Nature ID as a shared infrastructure layer incorporates different modules, or microservices, dedicated to specific functions. Semantic interoperability is also critical for enabling nature positive finance. This enables the core functionality of Nature ID, including merging corporate information from different sources, and aligning geospatial and administrative data. Other microservice functionality would include plot validation, certification of environmental impacts, and data submission and access gateways. The ability for Nature ID to serve as a platform for aligning financing with environmental goals would require a transparency module that can enable different stakeholders to access the latest environmental and administrative data. This will require a verification function that can enable or restrict access to sensitive information. Microservices that enable user submission of data, as well as TK labelling and governance could enable local-level auditing and reporting. This in turn can enhance system accountability and mitigate any adverse impacts or unintended consequences of financing activities. Combined, these microservices can serve as a flexible foundation for different nature positive financing initiatives.

Figure 10. Nature ID for nature-positive finance



Source: UNDP Digital for Planet.

3.2.3 Use case 3: Enabling supply chain traceability across sectors

Greening global value chains is essential for achieving decarbonization and restoring ecosystems. In practice this means incorporating environmental impacts into production and buying choices. However, in complex and globalized markets, this information has not been shared by default. The ability for any single business or buyer to capture and report on the full impact of purchasing decisions is limited or requires significant investment.

Traceability and transparency are critical for understanding the drivers of pollution and environmental degradation, resource extraction and energy use. The drive for traceability and transparency is not just motivated by environmental concerns, they are also key for promoting a more socially just economy. Additionally, in the wake of the COVID-19 pandemic there has been additional focus on the need for supply chain resilience. Value chains are currently in flux.

New policies, including the 2023 EU Deforestation Regulation (EUDR), aim to mitigate the expanded global environmental impacts of imported products. These initiatives set standards for compliance and disclosure for importing and selling certain commodities in the EU. This creates a common need among importers to prove that they know where commodities are produced and are mitigating deforestation risk. However, this compliance requirement may be more difficult for regions with a high share of smallholder farmers, resulting in competitive disadvantages versus those with higher concentration among large producers.[53] Investments to build tools to support compliance with these regulations can support the competitiveness of exporting countries while also supporting local producers.

By enhancing the interoperability of data from different sources, including linking environmental data, producer data and corporate registries, Nature ID can support compliance with regulatory regimes across supply chains. This can form a foundation for digital services to enable different stakeholders–including importers and regulators–to access supply chain data.

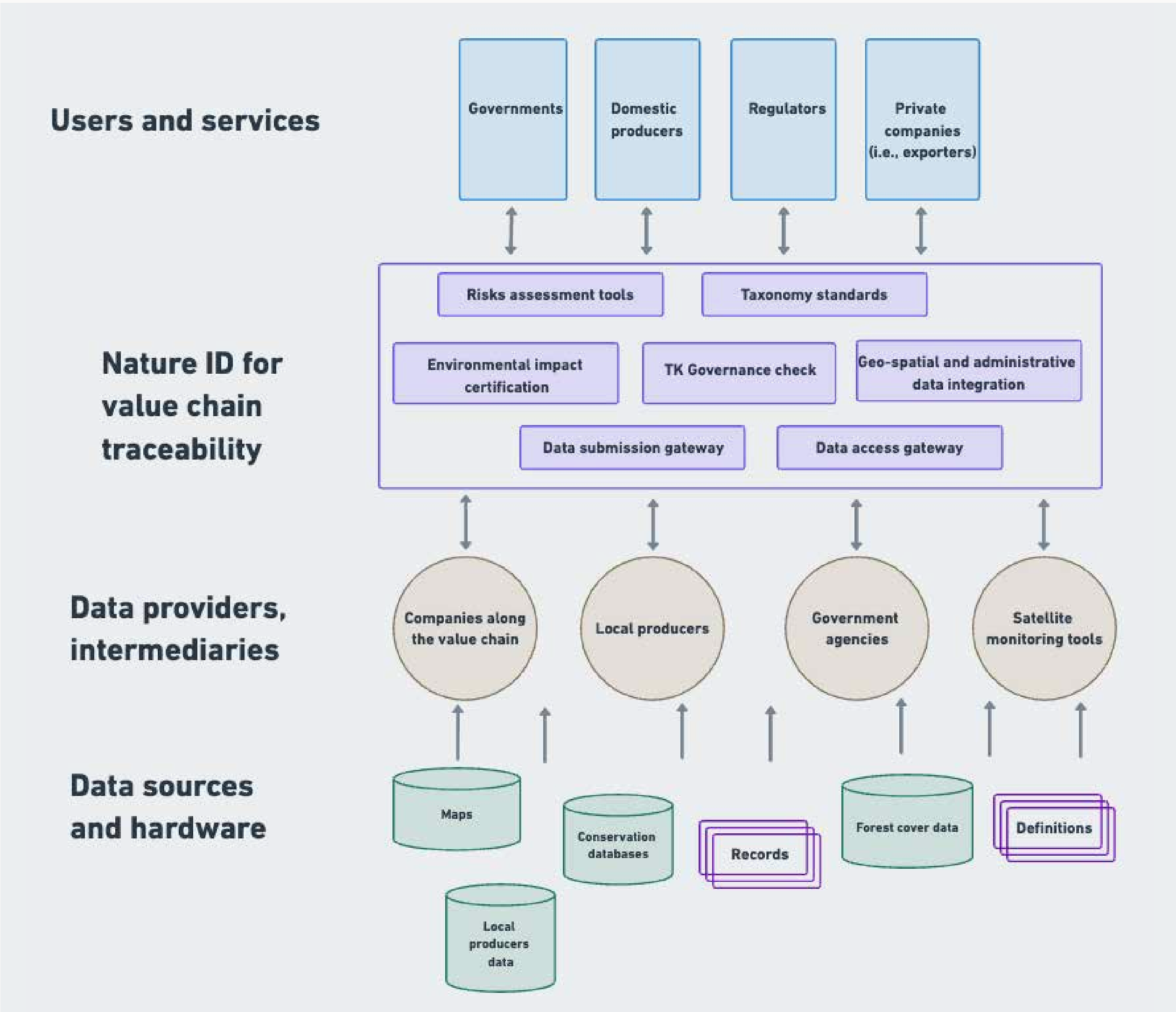
The case of the EUDR illustrates the potential value of this data exchange. The EUDR mandates that companies selling products in the EU ensure their products are not derived from key commodities–cattle, coffee, soy, rubber, wood, cocoa, palm oil–that caused deforestation after 2020.[54] This requires collecting detailed information on compliance, as well as a risk assessment and risk mitigation plan. This challenge becomes more complex when commodities and intermediate products are traded before reaching EU markets. In these cases, providing the required evidence will rely on sharing commodity and environmental data with parties along the value chain.

Several existing tools and services can support EUDR compliance. The EU has issued resources to assist companies in monitoring and evaluation, including remote sensing data, trade data from UN sources, and data processing tools such as open-source modules. These are accompanied by monitoring and verification and risk assessment guidance that set reporting standards. For instance, UNDP is piloting a coffee supply chain traceability tool as a digital public good in Latin America, the Caribbean and parts of Africa, which includes a partnership with Lavazza in Ecuador to establish a fully traceable, deforestation-free coffee supply chain. EUDR compliance is also an emerging market for private sector advisory and legal services offering value chain traceability tools. Other initiatives are establishing georeferenced identity systems for farms, forests and universal references for corporations. At a national level, Brazil's CAR illustrates an established infrastructure that could be configured to support EUDR compliance across different value chains, and inform the development of Nature ID.

Integrating these efforts within a modular and reusable Nature ID architecture can support compliance at scale. This DPI can incorporate learnings from existing experiments and strategically integrate data from different sources. Key data sources for supporting EUDR compliance include commodity data to identify what is being produced where, environmental data from local and remote sensing sources to monitor the impacts of production, and commodity transaction data to create a traceable link between primary production and final goods. This is particularly important for commodities that undergo significant processing, refinement, manufacturing and trade along the value chain, including leather and rubber. Practically speaking, this functionality requires geolocated commodity provenance and production data, geolocated deforestation data, and producer/corporate registries.

As explored in the biodiversity use case, the architecture of Nature ID as a shared infrastructure layer incorporates different modules, or microservices, dedicated to specific functions. For traceability, semantic interoperability is important for a variety of functions, including merging corporate information from different sources, and aligning geospatial and administrative data. Other microservice functionality would include plot validation, certification of environmental impacts, and data submission and access gateways. The ability for Nature ID to serve as a platform for generating compliance reports would require a transparency module, to enable access to traceability data for different stakeholders. This will require a verification function that can enable or restrict secure access to any sensitive information. Combined, these microservices would link environmental impacts from primary production (commodity harvesting) to traded goods, and clarify for intermediaries that commodities are compliant, as an input to mandated reporting from the EU. A proposed architecture that integrates these modules is outlined in Figure 11 below.

Figure 11. Nature ID for value chain traceability



Source: UNDP Digital for Planet.

3.3. Challenges, risks and opportunities in developing Nature ID systems

In Section 3.1, we introduced a potential technical architecture for Nature ID, recognizing that any such design must not only be **technically** robust but also **publicly valuable**, **feasible** and **responsive** to diverse political and social interests. A purely technical solution cannot, on its own, resolve the deeper institutional and governance issues that shape how environmental data is shared, validated and used. Therefore, elements such as **governance structures**, **institutional arrangements** and **administrative capacity** are integral to creating a functioning Nature ID. These factors must be carefully woven into the technical architecture from the outset to ensure that Nature ID delivers benefits equitably and sustainably.

Tables 1-3 summarize challenges, risks and opportunities across three key dimensions: **Governance/Social**, **Administrative/Institutional**, and **Technical**. It highlights how these dimensions interconnect and jointly influence the potential for Nature ID to become a trusted and valuable DPI. By viewing each dimension through the lens of challenges, risks and opportunities, we underscore the need for proactive strategies that anticipate pitfalls, mitigate potential harms and tap into valuable avenues for growth. This holistic approach complements the technical considerations laid out earlier, reinforcing that a balanced integration of **people, processes and technology** is essential for Nature ID to achieve its goals.

Table 1. Key dimension 1: Social / Governance

Challenges	Risks	Opportunities
- Aligning diverse interests and legal frameworks (local, national, cross-border) - Securing broad political buy-in for transparent data sharing -Lack of robust legal frameworks for recognizing nature's rights can make it difficult to integrate protections through digital services or data systems - Ensuring meaningful Indigenous Peoples and local communities engagement and culturally appropriate data governance, particularly in contexts where area-based planning and territorial governance require multi-actor collaboration and agreement - Bridging digital divides in low-connectivity or low-literacy contexts - Ensuring AI transparency to build stakeholder trust	- Potential resistance if disclosure of sensitive data (e.g. major polluters) provokes political conflict - Risk of excluding or misrepresenting marginalized groups if consultation is not inclusive - Misuse or misinterpretation of Indigenous knowledge without robust consent protocols	- Strengthening trust and legitimacy through transparent, co-governance models that embed Indigenous rights and support the legal recognition processes for nature - Learning from or leveraging existing DPI successes (e.g., Estonia–Finland X-Road) for secure cross-border data sharing - Empowering local communities with user-friendly tools thereby democratizing access to environmental information -Facilitate area-based planning by integrating diverse data layers (e.g. cultural heritage, land tenure) within the system to support multi-actor governance and territorial management -Work with jurisdictions where legal rights of nature[59] are recognized to pilot Nature ID approaches. Successful prototypes can serve as models for other jurisdictions seeking to adopt or strengthen legal recognition frameworks for ecosystems and build monitoring systems.

Table 2. Key dimension 2: Administrative / Institutional

Challenges	Risks	Opportunities
- Uneven levels of digital maturity among public agencies - Siloed government structures lacking a unified strategy for environmental data - Limited administrative capacity to implement and maintain Nature ID at scale	- Data mismanagement if sensitive environmental information lacks clear protocols - Fragmented adoption if mandates and responsibilities between agencies are unclear or conflicting - Erosion of trust if proprietary or Indigenous-held data is compromised	- Building on existing digital government departments and best practices in data exchange - Positioning Nature ID within broader national or mission-driven goals (e.g., climate adaptation, biodiversity targets) to motivate cross-agency collaboration - Running pilot projects that demonstrate tangible benefits and encourage broader institutional buy-in -Linking data to legal frameworks by creating formal precedents that tie Nature ID's geospatial and ecological data to recognized rights-of-nature statutes. This could help administrative bodies more effectively track and enforce protections for ecosystems, ensuring that the legal status of nature is supported by robust, verifiable data. -Synergy with existing multi-actor platforms (e.g. for biodiversity or land use planning) that can oversee territory-based data governance

Table 3. Key dimension 3: Technical

Challenges	Risks	Opportunities
- Integrating diverse data sources (satellite imagery, field observations, sensor networks) in varying formats and standards - Achieving semantic interoperability for complex ecological and cultural taxonomies - Handling large volumes of real-time/historical data without overloading systems -Designing and training AI models that handle diverse ecological conditions and data formats (e.g., remote sensing, sensor networks, community observations) without losing accuracy	- System bottlenecks if ingestion and processing capacities are overwhelmed - Data mismatches and errors (e.g., inconsistent species naming) undermine credibility - Technological obsolescence if the core architecture cannot evolve with new standards	- Leveraging proven, modular architectures (e.g., secure API gateways, X-Road-like frameworks) to reduce technical risk - Adopting a minimum viable product (MVP) approach to test and refine performance before large-scale deployments - Drawing on global expertise (over 100 countries operate data exchange systems) for knowledge sharing and continual improvement - Using AI to automate large-scale data processing, accelerating environmental assessments while reducing costs. - Using AI to enable predictive analytics to support interventions and more effective resource allocation.

4. Conclusion

Countries around the word encounter similar hurdles in countering the growing threat of environmental degradation, deforestation, agricultural sustainability and/or air pollution: scattered data sets, limited data interoperability, and structural barriers that make it difficult to turn information into actionable insights. Responding to these challenges, DPI can serve as a shared platform that builds interoperability between data from different sources and makes this usable and accessible for different services. Recognizing the value of a DPI approach is also reflected in UNDP's efforts to develop and manage a portfolio of open, adaptable and reusable digital public goods, including those supporting deforestation-free supply chain tracking and transparent carbon credit registries.

Nature ID responds to the widespread and persistent need for data to support more ambitious and coordinated climate and biodiversity action. As proposed, Nature ID can serve as a shared platform for integrating local data, remote sensing outputs, and insights from Indigenous Peoples and local communities, offering a more encompassing infrastructure than many single-issue platforms can manage. Rather than inventing entirely new systems from scratch, as envisioned, Nature ID would build on existing digital solutions and public policy, leveraging opportunities for standardization. Incorporating minimalism as a collective design principle can help manage the complexity and cost of developing and managing this shared infrastructure. This measured approach reflects both the reality of resource constraints and the urgency of environmental pressures, underscoring the value of working with what is already available while setting the stage for incremental innovation. As with other DPIs, the feasibility, trustworthiness and value of Nature ID relies on investing in the development of robust governance and partnerships.

Adapting Nature ID to respond to specific local needs and build on existing capacities is critical. **The ultimate goal is not to achieve a single, rigid model of what a Nature ID data exchange should be, but to foster an ecosystem where locally-relevant climate and biodiversity data can be collected, shared, validated and integrated in an interoperable system that connects disparate administrative, economic and social data sets.** Adopting a flexible approach to Nature ID that responds to local needs and opportunities can help turn disparate initiatives and data into a coordinated response to pressing ecological challenges. Adopting a modular approach to development can ensure that components can be shared and reused, facilitating more widespread adoption.

By building interoperability between data from remote sensing, government and community sources, Nature ID can enable a more complete and nuanced understanding of natural assets, land tenure, stewardship practices, ecological health, and human-environment interactions. By enabling access to data for different stakeholders, Nature ID could support efforts to develop traceable value chains, enable broader recognition of Indigenous rights and knowledge, and support nature positive finance. This can contribute to implementing climate and biodiversity commitments connected to land use change, nature-based solutions, and conservation, and help scale climate and nature finance. Additionally, Nature ID can help monitor and enforce the legal rights of nature in jurisdictions that grant these.

Moreover, Nature ID could support increasing protections for nature over time. Nature ID can help strengthen existing protections for nature by enacting and enforcing regulation through digital systems. By offering a more complete picture of ecological health, Nature ID could help justify further protections for nature. Looking ahead, the partnerships, governance structures and technical infrastructure of Nature ID could further evolve to incorporate area-based planning and emerging legal frameworks for nature—ensuring that diverse jurisdictional contexts, cultural perspectives, and rights-based approaches are fully supported by resilient, inclusive digital infrastructure.

Collectively scaling efforts to reduce emissions, protect nature, build resilience and support communities impacted by environmental crises is vital, and involves actors across all sectors. The proposal for Nature ID illustrates the potential for DPI to serve as shared infrastructure and build the society-wide capabilities needed to navigate the green transition.

Annexes

Annex 1. Stakeholder event summaries

DPI for a Green Transition Workshop June 27, 2024

The DPI for a Green Transition workshop brought together partners and key stakeholders to discuss and assess the potential role of DPI in ensuring transparency in carbon markets and green finance, enabling nature-positive economic incentives, and addressing climate change induced vulnerabilities and risk. Common themes across breakout rooms included the importance of capacity-building, the need for interoperability and access to data, governance and policy frameworks. Some challenges raised included insufficient private sector engagement in data sharing, and challenges of designing and implementing digital solutions to incorporate different local, traditional or Indigenous community needs and interests. Specific examples from Ecuador, Côte d'Ivoire and Armenia showcased the possibility of leveraging DPI to integrate environmental data for climate resilience.

Participants envisioned Nature ID supporting holistic ecosystem health measurement, connecting with carbon markets and enabling more dynamic early warning systems. As envisioned, this ID could encompass multidimensional aspects of nature and be designed to enable the recognition of Indigenous value systems. Participants proposed different functions, including identifying ownership, environmental service delivery, monitoring and integration of payments. Additional key considerations discussed included large variation across different ecosystems, the legal framework for Nature ID and Indigenous rights, the importance of recognizing different stakeholder interests, and complexities in integrating a PES layer.

The Case for Nature ID Roundtable New York, September 26, 2024

Co-hosted with The Rockefeller Foundation, The Nature ID roundtable included government, Indigenous, civil society and private sector representatives. Speakers included H.E. Madalitso Kambauwa Wirima (Minister for Education, Science, Technology and Innovation, Malawi), Uyunkar Domingo Peas (Indigenous Peoples leader, Ecuador), Pedro Hartung (CEO, Alana Foundation), Louise James (Managing Director, Accenture Development Partnerships), CV Madhukar (Chief Executive, Co-Develop), Peter Houlihan (Executive Vice President, XPRIZE Foundation) and Midori Paxton (Nature Hub Director, UNDP). Participants emphasized that Nature ID should reflect the complexity and interconnectedness of ecosystems rather than reducing or fragmenting their elements into individual data points, such as carbon or biomass. The design of a Nature ID should reflect this complexity across different stages while embedding a minimalist design principle. By integrating

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geospatial, environmental, administrative and social data, Nature ID could serve as a bridge between ecosystems and legal or economic systems. Nature ID could be leveraged to help monitor ecosystems, unlock biodiversity financing, prevent ecosystem destruction, and promote environmental justice. Participants identified the potential for Nature ID to help build trust, ensure traceability, and enable results-based monitoring.

Participants also highlighted the importance of maintaining climate and nature data within the public realm. Additionally, participants recognized **the concept of 'public' must also enshrine the distinct rights and sovereignty of Indigenous Peoples**. Participants emphasized the need to ensure Indigenous knowledge systems are reflected in the way Nature ID is co-designed as DPI. Indigenous Peoples' knowledge, cultural heritage and ecological expertise should not only inform Nature ID but also ensure that these communities have rights and ownership over the data collected, disaggregated, reaggregated, and interpreted. Indigenous communities must retain sovereignty over their data lifecycle across the supply chain.

COP 16 Event Colombia, October 23, 2024

The roundtable introduced Nature ID as a DPI to map and monitor ecosystems integrating data from different sources. Speakers included Anastasia Thatcher (Managing Director, Accenture Development Partnerships), Hugo Jabini (Spokesperson for the Saamak), Felipe Villela (Head of Latin America, The Landbanking Group), Walter Jetz (Professor of Ecology and Evolutionary Biology, Yale University) and Midori Paxton (Nature Hub Director, UNDP).


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Participants highlighted the importance and challenge of demarcating data and the potential for Nature ID to support the implementation of legal rights of nature where these have been established. Clear demarcation is important for enabling verification and identification functions for Nature ID. However, this is a greater challenge for environmental data than when identifying legal persons. Participants also highlighted the potential for Nature ID to serve as a platform for distributed innovation in services from the private and public sectors. This could support corporate reporting, combat greenwashing and promote investments tied to measurable biodiversity outcomes.

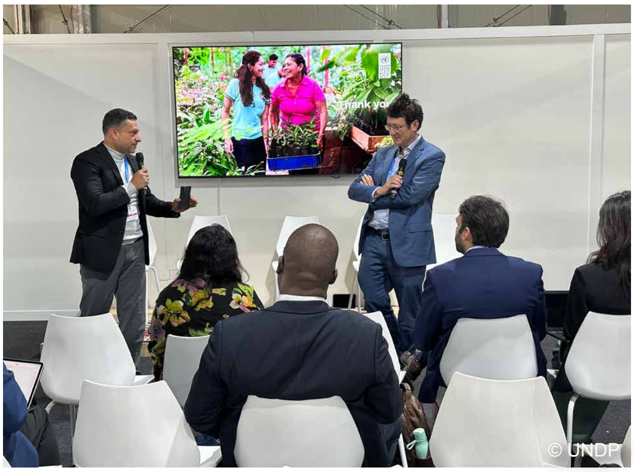
At a broader level, participants emphasized the need for Nature ID to reconsider how we value and relate to nature. This encompasses the idea that ecosystems have more than just tangible value, and the importance of respecting ecosystems' intangible, cultural and spiritual value. Revaluing ecosystems is also reflected in the need to shift from a cost-oriented model to an asset-oriented model for valuing nature and biodiversity. The current economic system externalizes the social and environmental costs of decision-making, and Nature ID could help monitor and integrate these costs in decision-making.

Firstly, the potential for making use of the existing resources available, not duplicating efforts or reinventing the wheel. Connected to this was responding to the need for harmonizing across initiatives and systems. There is an abundance of different work happening in parallel. How might Nature ID help move towards common standards? Participants identified the opportunity for developing collaborations between geospatial data experts and the DPI community to strengthen the Nature ID concept and identify ways the system could be valuable.

Secondly, the need for meaningful engagement to ensure Nature ID responds to needs and interests of land custodians. Designing for inclusion, as well as anticipating and addressing challenges: Addressing governance gaps, ensuring informed consent (FPIC lifecycle), and mitigating potential misinformation and disinformation of Indigenous knowledge ecosystems. Nature ID must aim to foster trust and inclusivity by prioritizing Indigenous Peoples and local communities leadership. Collaborative governance: Emphasis on Indigenous Peoples and local communities engagement and complying with data sovereignty and governance while addressing concerns about commodifying nature. Nature ID could complement strengthened legal and policy frameworks, including support for rights-of-nature litigation.

COP 29 Event Azerbaijan , November 16, 2024

This event explored how a Nature ID as DPI might facilitate coordinated action among multiple stakeholders to drive progress on climate and biodiversity goals at the national level, enhance climate transparency, increase access to green finance, and address climate change-induced vulnerabilities. The event explored the potential value of Nature ID and identified critical preconditions, as well as potential governance frameworks, data standards and policy infrastructure to enable Nature ID. Speakers included H.E. Laurent Tchagba (Minister of Water and Forests, Cote d'Ivoire), Henrique Dolabella (Head of Rural Environmental Registry, Government of Brazil), Sahar Albazar (Member of Parliament, Egypt), Gilmar Navarrete Chacón (Director of Environmental Services of the National Forest Financing Fund, Costa Rica), Ynsa Traore (Technical Advisor, Government of Côte d'Ivoire), Akanksha Sharma (Head of Climate Tech, GSMA), Bjorn-Soren Gigler (Head of Digital and Green Twin Transition, GIZ Germany) and Reina Otsuka (Digital Lead for Climate and Nature, UNDP).



Participants raised the need for Nature ID to address agriculture systems given their role in driving deforestation globally. They also raised the importance of supporting local livelihoods as well as preserving biodiversity. The challenge of cross-border data exchange and governance was raised, as the default for most legal frameworks is to restrict data sharing. Participants from Brazil and Costa Rica highlighted the ongoing development of systems to integrate environmental and socio-economic data as sources of learning for Nature ID. They also raised the potential value of sharing data between civil society and government as a function of Nature ID.

Annex 2. Business cases for green DPI

Business case A. Ensuring transparency and traceability in carbon markets and climate finance

Fulfilling reporting requirements related to implementing NDCs commitments requires significant capacity to gather, verify and interpret historical emissions data and significant technical capabilities to produce forward-looking scenarios that can inform policy. Building trust and credibility in climate-related reporting often requires working through complex technical challenges. Data is frequently scattered across multiple repositories, stored in varying formats and subject to inconsistent quality checks. The process is further complicated by frequent updates to international guidelines, evolving methodologies, and the need for specialized technical skills. Together, these factors create friction and inefficiencies, making it difficult for countries to align their reporting practices with the Enhanced Transparency Framework of the Paris Agreement and other related frameworks.

A DPI approach can help streamline this landscape through the development of reusable components. By centering on principles of interoperability, modular design, and open standards, DPI frameworks can integrate DPGs that can build the capacity for data collection, verification, and sharing, as well as reporting functions.

Adopting a DPI approach to support climate transparency encourages a holistic ecosystem of climate data tools and services that work in concert, each reinforcing the other's reliability and utility. By linking national registries, international transparency platforms, and verification mechanisms into a cohesive digital environment, the entire reporting process can become more manageable. This can enable seamless data sharing from point of collection to global monitoring platforms. This integrated approach can help reduce the administrative burden on governments, build trust among stakeholders, and support more informed climate action.

Because DPI principles emphasize integration and adaptability, countries can incorporate new platforms or methodologies with relative ease. For instance, following the completion of the Article 6 framework around market mechanisms, or as IPCC reporting software updates its methodologies, a DPI approach means those enhancements can be integrated without overhauling entire systems. Continuous maintenance and security updates can be managed in a more predictable, stable manner. Technical support extends beyond initial setup, cultivating long-term ownership and user engagement. The result is a more resilient, future-proof infrastructure for climate transparency—one that can readily incorporate new technologies, accommodate emerging standards, and ultimately, make the complex task of reporting more accurate, efficient and comprehensible.

The common requirements for fulfilling Paris Agreement obligations creates a need that can be fulfilled by the deployment of standardized digital solutions. However, these solutions can also enable other valuable functions. The Digital For Climate (D4C) Working Group, an informal collaboration mechanism between the World Bank, UNFCCC, European Bank for Reconstruction and Development (EBRD), European Space Agency and UNDP, have been coordinating country support between the organizations to accelerate an end-to-end digital ecosystem for carbon finance. For example, the National Carbon Credit Registry DPG, developed by UNDP, provides a flexible, interoperable registry system. It can be tailored to a country's unique policies and governance structures, while aligning with international data models and platforms. Through a standard RESTful API, the registry connects with other systems, ensuring that carbon market data is not locked in a single tool. This enables different actors to verify, track, and audit carbon offsets from issuance to retirement. Interconnectivity reduces the likelihood of inconsistencies, missing data points or duplication. It can also enable automation for identifying anomalies, generating insights and reporting.

The Climate Action Data Trust (CAD Trust), developed by the World Bank and IETA, further illustrates the potential for DPI architectures to enable cross-border and cross-sectoral data sharing. By employing a common data taxonomy and blockchain technology, CAD Trust facilitates peer-to-peer connection across different registries. This allows for harmonizing underlying data, provides visibility into and across registries, and safeguards against double counting of mitigation outcomes. CAD Trust's capacity to surface publicly available information on mitigation outcomes, track their lifecycle, and ensure data integrity aligns naturally with the DPI vision. It demonstrates how transparency can be strengthened when tools share a common language and infrastructure—enabling information to flow across multiple jurisdictions and platforms with minimal friction.

Business case B. Enabling nature-positive incentives

Current economic models rarely reward conservation and biodiversity protection. For example, farmers and local communities often face strong financial incentives to convert nearby forests and forest patches on their land into agriculture fields to increase production and hence, increase household income.

Nature-positive incentives—such as PES, biodiversity credits, and sustainable food system traceability—offer a set of mechanisms for supporting local efforts towards global nature and biodiversity conservation targets. Providing financial compensation in exchange for maintaining the benefits of natural ecosystems is one way to recognize their value while recognizing the critical role that farmers, local communities and Indigenous Peoples play in stewarding ecosystems. PES can support local livelihoods and help align market forces with environmental objectives. However, realizing robust PES frameworks is not without its challenges.

Identifying who should be rewarded, what metrics best represent the value of nature and biodiversity, and how to verify the reported benefits are all complex challenges that must be resolved for PES to be effective. For instance, a single location can provide multiple overlapping ecosystem services, such as carbon sequestration, soil health and biodiversity. However, incentives have traditionally delivered rewards based on performance in stewarding one value (e.g., forest cover, carbon), oversimplifying the diversity of critical ecosystem functions. The use of singular metrics risks painting an incomplete or misleading picture of ecosystems' value and complexity. Approaches that fail to consider interdependencies between biodiversity, water quality, soil fertility and other ecological indicators may inadvertently incentivize behaviors that degrade holistic ecosystem health over time. Monitoring ecological indicators at scale, verifying compliance with environmental standards, and ensuring compensation for stewardship rely on transparent, accessible and reliable data.

Effective technical solutions to these challenges will rely on rethinking how data is sourced, managed and shared. Nature positive incentive schemes can leverage the increasing availability of remote sensing data from different sources. For example, processed satellite data provide an increasingly detailed and geographically comprehensive record across a variety of indicators including land cover,[60] land use change, and emissions.[61] However, currently data is often fragmented and stored in different databases associated with specific programs, purposes or regions. This fragmentation stifles opportunities to scale successful initiatives or adapt them to new regions or ecosystems.

Adopting a DPI approach can support the development of coherent, scalable and trustworthy systems that enable PES. DPI can serve as the middle layer in an overarching software 'stack' (see Figure 8) that sits between diverse data inputs and an array of applications and services. Microservices connected to this middle layer could validate land boundaries, analyze deforestation patterns, and generate insights that inform payment disbursements. DPI could link land registries with payment platforms and environmental datasets, improve traceability for farmers, enable granular ecosystem assessments, make it easier to verify ownership claims, and direct resources to frontline communities. Building shared architecture can reduce the need for repetitive data manipulation across services. By linking georeferenced environmental, socio-economic and administrative data, DPI can help clarify who should be rewarded for their ecosystem stewardship.

Overcoming these challenges requires that digital solutions be inclusive and trustworthy. Early and continuous stakeholder engagement can support their design. For example, throughout the development of a DPG to support sustainable coffee production free of deforestation in Colombia, Costa Rica, and Ecuador, UNDP has been engaging with government agencies, NGOs, cooperatives, small landowners and private sector entities. This engagement has taken the form of consultations and collaborative design. By actively involving small farmers, this participatory process helps refine the DPG approach, build trust in the system's outputs, and increases the likelihood that solutions will be widely adopted and continuously improved. This approach also ensures that this digital solution better responds to on-the-ground realities and values.

Business case C. Addressing climate change induced vulnerabilities and risk

Responding to climate hazards presents an escalating demand on public sector capacity that can strain public services and increase the need for cross-departmental and cross-sectoral collaboration and information sharing. However, a lack of access to timely data and a lack of interoperability across different data systems can make coordination more difficult. Weather forecasts, public health registries, infrastructure maps and socio-economic indicators are often administered in parallel by different public and private sector organizations, creating 'siloing' that can reduce their collective value for climate disaster preparedness and response.

Countries are increasingly turning to digital infrastructure to support climate resilience building by consolidating data from different sources and enabling coordinated action. For example, Malawi's Modernized Climate Information and Early Warning Systems (M-CLIMES), supported by UNDP, integrates real-time climate monitoring with geospatial analysis, allowing public agencies to predict and mitigate floods and droughts more effectively. M-CLIMES was later used as a platform to deliver information and training for farmers to increase climate resilience in the agricultural sector (PICSA initiative). Similarly, Indonesia's PRISM platform combines geospatial tools with data analytics to monitor landslides and floods, offering precise, actionable insights to local governments and communities. These examples of distributed experimentation and deployment demonstrate the potential for digital systems to integrate diverse types of information, to better understand how they affect climate risks and be able to foster climate resilience.

Adopting a DPI approach to systematize and scale these approaches represents a potentially transformative opportunity to build climate resilience. Serving as an interoperability layer, DPI can increase access to environmental, social and administrative data to bridge gaps between public and private stakeholders and communities. For example, during a heat wave or cyclone, DPI-enabled systems could combine geospatial data with health and infrastructure data to share information on hospital and cooling centre capacity, identify vulnerable populations, and enable targeted resource allocation. Linking regional rainfall forecasts with crop yield models and population vulnerability data could help ensure that resources are equitably allocated to the communities most at risk.

Integrating data on climate hazards with existing DPI also has the capacity to support innovative financing models and anticipatory action for disaster resilience. Integrating early warning systems and payment systems can facilitate rapid disbursement of relief funds or incentivize climate adaptation measures through targeted subsidies. For example, integrating real-time data on river water levels, developing a standardized rapid response framework, and leveraging an existing digital payments system enabled a coalition of local and international partners to provide anticipatory relief to communities impacted by seasonal flooding in Bangladesh. This proactive support was delivered far more efficiently than conventional aid, and was associated with higher long-run welfare than for traditional reactive disaster responses.[62] This capability highlights the potential for holistic information assembled and shared through a DPI approach to act as a comprehensive infrastructure layer that not only helps predict and respond to risks but can also support more nimble and efficient responses to climate disasters. The same infrastructure could further support parametric insurance, public health initiatives and more.

DPI could also be configured to support regional collaboration to address transboundary climate hazards, as illustrated by the challenges faced in the Lake Tanganyika region in East Africa. Shared by Burundi, Democratic Republic of Congo, Tanzania and Zambia, the region is experiencing increasing risks of climate hazards, including droughts and extreme rainfall, which jeopardize water security and agricultural productivity.[63] Efforts by regional organizations like the East African Community (EAC) and the Nile Basin Initiative highlight the potential for developing integrated systems. A DPI framework could enable real-time data sharing across borders, integrating hydrological data with socio-economic indicators to inform coordinated responses. If configured as a shared digital infrastructure, DPI configured to enable cross-border data sharing could enhance both the predictive capabilities and the resilience of countries facing shared climate challenges. However, building this cross-border functionality within a DPI architecture would likely involve additional political, legal and administrative complexity.

Deploying DPI to support climate resilience is not without challenges. Building interoperability at a technical level can require modifying legal frameworks to enable secure sharing of sensitive data. Additionally, building interoperability between data sources and services will require additional technical and administrative capacity. The capacity to manage complex, integrated systems is often limited, particularly in resource-constrained settings. The inclusivity of the services that leverage DPI is also important: for example, marginalized communities may be more difficult to reach via digital channels.

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