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Digital Public Infrastructure for Climate:

The Missing Backbone for Climate Action

by Ronaldo Lemos and ITS Rio (www.itsrio.org)

This report was commissioned by **Ambassador André Corrêa do Lago**, President of COP30, and prepared by **Ronaldo Lemos,** Chair of the High-Level Technology Advisory Council to the COP30 Presidency, with the support of ITS Rio.

Executive Summary

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The world faces a **global climate emergency** of unprecedented scale, with the latest science confirming that over 3.6 billion people are already highly vulnerable to climate impacts. To meet this challenge, we must harness digital innovation in service of the climate agenda. This report proposes the creation of a **Global Digital Public Infrastructure for Climate (Climate DPI)** as a transformative, unifying platform for climate action. Climate DPI refers to the foundational digital systems, analogous to roads and power grids in the digital realm, that enable **transparent, interoperable and rapid coordination** across climate initiatives globally. By integrating digital identification, payment platforms, open data exchanges and other core digital "rails," a Climate DPI can dramatically accelerate climate mitigation and adaptation efforts.

The **strategic importance** of a unified Climate DPI lies in its ability to break down silos and fragmentation. Currently, many climate solutions and data systems are proprietary or isolated,

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hampering collective progress. A global Climate DPI would establish common standards and interfaces so that data, models, and financial mechanisms can seamlessly interoperate worldwide. This shared infrastructure promises **multiple core benefits**: greatly enhanced transparency in climate finance and carbon markets, real-time data for early warnings and disaster response, and the ability to coordinate actions across borders at unprecedented speed and scale. It also embodies inclusivity, ensuring all nations and communities, including those typically left behind by digital transformations, can participate in and benefit from climate solutions.

In summary, this high-level proposal envisions **Climate DPI as a public good** that will underpin global climate strategy over the coming decade. By learning from successful digital public infrastructure initiatives (such as the multi-layered "India Stack" in digital services) and climate data platforms (like GEO's Global Earth Observation System of Systems), we outline a blueprint for an open, modular Climate DPI.

Key components include an Earth observation data commons, real-time climate risk monitoring systems, digital platforms for climate finance (with robust verification technologies), and integration of Artificial Intelligence both **for climate** (to enhance climate solutions) and **for AI itself** (to ensure digital infrastructure is sustainable). The report recommends establishing international governance under the UNFCCC/COP framework to guide Climate DPI development, supported by an alliance of governments, technology partners, and civil society.

It also provides an implementation roadmap, from immediate pilot projects to full global deployment within 5–10 years, along with guidance on financing mechanisms (leveraging climate funds and public–private partnerships) and capacity-building initiatives.

Harnessing digital public infrastructure in this way can **turbocharge climate action**, making it faster, fairer, and more coordinated. The report concludes with concrete recommendations for COP30 to endorse and launch a Global Climate DPI initiative as a legacy project that can enable the world to meet the Paris climate goals through digital-age solutions.

1. Introduction

Context of the Global Climate Crisis:

Context of the Global Climate Crisis: The world is grappling with intensifying climate change impacts, from record-breaking heatwaves and wildfires to devastating floods and storms. Scientific assessments warn that the planet is not on track to limit warming to well below 2°C, and climate extremes are already causing hundreds of billions in annual losses. Climate change multiplies threats to food security, livelihoods, and global stability. **The urgency for action is clear.** We are at a tipping point where incremental measures are insufficient. Transformative approaches are required to rapidly reduce emissions, protect vulnerable communities, and build resilience. In this context, the global community is seeking innovative pathways to accelerate implementation of climate solutions. Climate COP30, marking the 10th anniversary of the Paris Agreement, has called for "*strengthening global governance to exponentially accelerate implementation*" of climate commitments. This means exploring new mechanisms that can overcome the fragmentation and slow pace of current efforts.

Strategic Role of Digital Public Infrastructure:

A promising avenue is the deployment of **Digital Public Infrastructure (DPI)** specifically for climate action. DPI refers to foundational, widely-accessible digital systems, akin to digital utilities, that enable society-wide functions such as identification, payments, data exchange, and communication. Over the past decade, DPI has revolutionized service delivery and inclusion in several countries. For example, *India's digital infrastructure* ("India Stack") combined a universal digital ID (Aadhaar) with interoperable payments and data-sharing protocols, inducting hundreds of millions into formal services and financial systems within a few years. These successes illustrate how DPI can rapidly achieve scale and equity by providing open, reusable digital building blocks. The question now is how to leverage the **power of DPI for the planet**, not just for economies. Digital infrastructure is increasingly seen as a **key enabler of climate action**, facilitating green innovation in energy, mobility, agriculture, disaster management and more. This report builds on that insight and makes the case that a dedicated Global Climate DPI can be a game-changer in responding to the climate emergency.

Objectives and Scope of this Report:

This High-Level Committee Report has been prepared for the COP30 Presidency to outline a visionary yet actionable proposal for a **Global Digital Public Infrastructure for Climate (Climate DPI)**. It provides: (a) a clear **rationale** for why a global Climate DPI is urgently needed, (b) a **conceptual framework** defining what Climate DPI entails and its essential components, (c) a review of **technologies and case examples** that illustrate how such infrastructure could function (drawing on leading initiatives like GEOSS, Copernicus, WFP's PRISM, UNDP's Digital X/Nature initiatives, etc.), and (d) a **global implementation roadmap** covering governance, development principles, financing, and capacity building required to bring Climate DPI to reality. The scope of the report is intentionally broad, spanning climate mitigation, adaptation, and finance, to emphasize an integrated approach. It is meant to guide high-level decision-makers, from Heads of State and ministers to international agencies and tech industry leaders, in understanding the potential of Climate DPI and in mobilizing the partnerships needed to build it. Ultimately, the report aims to secure endorsement at COP30 for launching a **unified Global Climate DPI initiative** as a cornerstone of international climate cooperation going forward.

2. Rationale: Why a Global Climate DPI?

Despite growing investments in climate solutions, today's efforts remain **fragmented and siloed**, limiting their effectiveness. There is a proliferation of climate data platforms, tracking systems, financing mechanisms, and tools developed by different entities, governments, NGOs, private firms, often using incompatible standards. **This fragmentation poses major challenges**: vital climate data is scattered or kept in proprietary silos, preventing a comprehensive understanding of risks; many climate technology solutions cannot "talk" to each other, hampering coordinated action. Climate finance flows are opaque, with disparate registries and methodologies reducing trust and efficiency. In short, we lack the *shared digital highways* needed for climate action at a global scale. Just as disparate computer networks coalesced into the interoperable internet, we now need to connect and harmonize the digital efforts for climate.

Limitations of Fragmented, Proprietary Approaches:

Fragmentation is exacerbated by proprietary systems. A significant portion of high-value climate and disaster risk information has historically been locked in closed models or held by private entities. For example, insurance companies long used proprietary catastrophe models accessible only to them, meaning governments and humanitarian actors often lacked critical risk analytics.

Similarly, many countries in the Global South do not have comprehensive digital records of their infrastructure or vulnerability, leaving huge data gaps in understanding climate risks. Where data exists, it may come in incompatible formats from different sources, or with restrictive licenses. All this results in delays and uncertainty. As the World Bank and UN have noted, without open access to key data sets, loss and damage estimates remain highly uncertain and planning is undermined. In climate finance, multiple standards and registries for carbon credits (voluntary and compliance markets) lead to **high transaction costs and concerns about double-counting or credit quality.**

Smaller project developers, especially in developing countries, struggle with the convoluted and costly processes for credit verification and cannot easily tap global carbon markets. These examples underscore that the status quo, a patchwork of digital systems, is insufficient to the task of rapid, globally-coordinated climate action.

Urgent Need for Timely, Coordinated Global Responses:

The climate crisis demands speed and unity of effort. Extreme events are hitting simultaneously across continents, and greenhouse gas emissions anywhere affect all countries. Yet current institutional mechanisms (e.g. UNFCCC processes) move slowly and often reactively. A Climate DPI can facilitate **real-time coordination and proactive action**. Imagine if scientists, governments and communities worldwide had a common operational picture of climate-related risks as they evolve, for instance, a dashboard where satellite data, ground sensors, and crowd-sourced reports are integrated and instantly accessible.

This could enable early warnings and swift resource deployment when disasters loom, transcending national boundaries. We saw a glimpse of this during the 2010 Haiti earthquake response, when volunteer mappers used open satellite imagery to rapidly update maps and guide relief efforts. However, that was an ad hoc solution. A standing global infrastructure could make such agility routine. Moreover, as countries implement their national climate pledges (NDCs), a global DPI could help **track progress and transparently share data**, fostering greater trust between nations. It can support what the COP30 President has called for: "rapid sharing of data, knowledge and intelligence" to strengthen climate cooperation.

In essence, a Climate DPI provides the digital backbone for the global public good aspect of climate action, ensuring that knowledge and tools are shared rapidly and equitably.

Learning from Success Stories:

There are promising initiatives we can build upon, which demonstrate the power of shared digital platforms in the climate and environmental domain:

GEOSS (Group on Earth Observations System of Systems):

This global effort links together earth observation systems from dozens of countries and agencies into a “system of systems”, enabling users to access diverse environmental data through a single portal. GEOSS shows how interoperability and common standards allow thousands of instruments (satellites, sensors, etc.) to be combined into coherent data sets for decision-maker. It offers a model for data sharing that a Climate DPI can emulate, ensuring data is accessible, of known quality, and interoperable across sources.

Copernicus Programme:

The EU’s Copernicus is the world’s most advanced civil Earth observation program, providing free and open data on climate and environment at a global scale. It transforms multi-source data (satellites, in-situ sensors) into operational services, from climate change monitoring to emergency management. Copernicus has proven the value of an open data policy: its high-quality satellite imagery and climate data sets are used worldwide, supporting everything from disaster response to urban planning, and it has fostered a thriving ecosystem of applications. A Climate DPI would amplify such benefits by federating Copernicus and similar systems into a truly global data commons.

WFP's PRISM (Platform for Real-time Impact and Situation Monitoring):

Developed by the World Food Programme, PRISM integrates satellite data on climate hazards with socio-economic vulnerability data into a **map-based risk monitoring dashboard**. It addresses the challenge that while data exists, it often fails to reach decision-makers in usable form.

PRISM makes climate risk information actionable by combining hazard indices (e.g. drought indicators from remote sensing) with maps of populations at risk. This enables earlier and better-targeted interventions, as demonstrated in countries where PRISM is used to trigger anticipatory social protection before disasters strike.

PRISM exemplifies how **integrating data and automating analysis** can improve climate resilience on the ground, a capability that Climate DPI would generalize and scale globally.

Ushahidi (Crowdsourced Crisis Mapping):

Ushahidi is an open-source platform that enables citizens to submit real-time reports (e.g. via SMS or web) during crisis, which are then geo-mapped to identify hotspots and needs. Initially created in Kenya for mapping election violence, it has since been used for various disaster responses, notably after the 2010 Haiti earthquake, when it helped map damage and rescue needs from thousands of text messages.

Ushahidi's success shows the power of **crowdsourced data and community engagement** in emergencies. Incorporating such citizen-driven input into a Climate DPI (for example, for monitoring local climate impacts or feedback on adaptation projects) would greatly enrich the information available to decision-makers, while also empowering communities with a voice in climate action.

Digital Climate Finance Platforms:

New initiatives are emerging to bring transparency and scalability to climate finance using digital tech. The *Climate Action Data Trust (CAD Trust),* for instance, is a blockchain-based metadata layer that connects multiple carbon credit registries to avoid double-counting and enhance trust in global carbon markets. Similarly, the **Digital for Climate (D4C)** working group, a coalition of UNDP, World Bank, UNFCCC, EBRD, and others, is developing a modular, interoperable digital ecosystem for carbon markets.

This involves digitizing methodologies, building digital MRV (Measurement, Reporting, Verification) systems, and using smart contracts to automate transactions, all coordinated through common standards. These efforts demonstrate that **climate finance can be vastly improved by digital infrastructure**, reducing costs, increasing integrity, and making it easier for capital to reach effective projects.

A Climate DPI would institutionalize these gains by providing common platforms for climate finance tracking, carbon credit issuance and exchange, and results-based climate funding.

NatureID and Digital Ecosystem Management:

UNDP's **Nature ID** concept illustrates DPI thinking applied to biodiversity and ecosystems. NatureID is envisioned as a public data exchange platform that integrates environmental, geospatial and socio-economic datasets to quantify the value of natural ecosystems. By doing so, it can unlock nature-positive finance (like **Payments for Ecosystem Services**, a possibility that Brazil has turned into legislation by means of Federal Law 14.119/2021) and improve transparency in how financial decisions impact nature.

For example, it could trace supply chains or corporate disclosures against deforestation data, or help indigenous communities register land rights digitally. This shows the potential of treating **data itself as critical infrastructure**, managing it as a public good so that innovators, governments and communities can build solutions atop reliable, shared data. Climate DPI would extend this principle across climate-related data, supported by concepts like **data philanthropy** (where private companies donate data for public use) to fill gaps.

In fact, partnerships brokered by UN Global Pulse have begun securing privately-held datasets (e.g. from telecom and tech firms) to aid climate resilience. Such data-sharing ethos needs to be scaled up through a formal infrastructure.

Importance of Interoperability, Open Standards, and Global Collaboration:

The common thread in all these examples is that **openness and collaboration multiply impact**. Whether it is open data from satellites, open-source software, or shared standards, making tools broadly accessible allows others to build further innovations and avoids reinventing the wheel. Interoperability, the ability of systems to exchange and make use of information, is essential for combining forces on a global scale. Digital public goods can "transform the way people collaborate on disaster and climate risk" when supported by global coordination and investment, as phrased by the World Bank. By explicitly designing Climate DPI as *open and interoperable*, we ensure that diverse stakeholders (governments, NGOs, companies, academia, citizens) can plug into it, contribute to it, and benefit from it. This fosters a network effect: the more participants use the shared infrastructure, the more valuable and rich it becomes.

Moreover, a globally interoperable framework reduces duplication, for instance, **countries can share modules or code for their climate information systems instead of each paying to develop separate ones**. It also means breakthroughs in one place (a new AI flood model or an innovative solar microfinance app) can be rapidly transferred or scaled elsewhere via the common rails.

Finally, focusing on interoperability and public-good standards is key to ensuring **equity**. It prevents proprietary lock-in by any one vendor and helps less-resourced actors leapfrog by using open solutions. In sum, global collaboration on Climate DPI, underpinned by open standards, is not just idealistic but pragmatic: it creates a foundation where the sum of climate action is greater than its parts, exactly what's needed to meet the climate challenge.

DPI Thinking Applied to Climate Finance:

A particularly urgent domain for DPI intervention is climate finance. Trillions of dollars need to be mobilized and efficiently allocated to mitigation and adaptation in the coming decades. However, the current system of climate finance is complex and often lacks transparency and trust. Here, adopting DPI principles, standardized digital rails for transactions and data, can greatly enhance the flow and oversight of climate funds. For example, consider carbon markets and credits: by developing **common digital protocols** for emissions accounting, project certification, and credit trading (as D4C is doing), we can make carbon markets more accessible and credible . Digital MRV systems using IoT sensors and satellite data can provide continuous verification of project performance (say, forest carbon sequestration) at lower cost than periodic manual audits. Smart contracts on blockchain can automate issuance of credits once predefined metrics are met and ensure a tamper-proof record of ownership and retirement of credits.

All these require interoperable designs agreed internationally, essentially a **"finance track" of Climate DPI.** Additionally, climate fund disbursements (e.g. from Green Climate Fund or adaptation funds) could be managed via a DPI layer, linking funders, implementing agencies, and beneficiaries with end-to-end transparency. For instance, a country's climate projects registry could be integrated with a global platform that donors or investors use to monitor results, thereby increasing accountability. The concept of *Climate DPI* explicitly includes such financial plumbing, recognizing that money flows are as critical as data flows for climate action. By treating climate finance platforms as public infrastructure (perhaps governed by multilateral development banks and the UN), we can break down the current fragmentation of climate finance and deploy capital where it's needed faster and with greater confidence in outcomes.

Data as DPI, Public Data Lakes and Governance:

Lastly, it is worth repeating the notion that **data itself must be treated as part of the infrastructure.** Climate DPI will involve large shared datasets, from global temperature records and emission inventories to granular local risk maps. Ensuring these datasets are curated, updated, and accessible with proper governance is a foundational task. This might entail establishing **public climate data trusts or lakes** where data from various sources (public agencies, research institutions, private sector sensors, citizen science) can reside with agreed standards and licensing. Innovations like **data trusts and data collaboratives** can facilitate sharing of privately held data under safe conditions (preserving privacy or competitive interests while making aggregated information available). Clear data governance frameworks will be needed to address issues of data sovereignty (especially for sensitive data like national resources or indigenous knowledge), perhaps by stipulating that data remains under the control of the contributor while being interoperable through common protocols. In summary, building the Climate DPI is not just a tech challenge but an institutional one: it requires global agreement on open standards and on treating key climate data and tools as *digital public goods* to be jointly built and maintained. The rationale for doing so is compelling: only through such unity can we leverage the full potential of digital age advancements to solve our shared climate crisis.

3. Conceptual Definition of Climate DPI

What exactly do we mean by a **"Climate Digital Public Infrastructure"**? This section provides a comprehensive definition and outlines the core elements that constitute a Climate DPI. In essence, a Climate DPI is a *holistic, multi-layered digital ecosystem*, composed of technology platforms, standards, and governance frameworks, that collectively enable **universal access to climate solutions and services**. It is "public" in that it is open, inclusive, and designed to serve the common good (much like an open road network), and it's "infrastructure", in that it provides stable, reusable foundations upon which countless climate applications can be built (much like an electricity grid powers diverse appliances or AI is becoming the foundation of "intelligence as infrastructure" for every human domain).

Comprehensive Definition:

Climate DPI can be defined as *the ensemble of interoperable digital systems and public-good platforms that facilitate global and national climate action across mitigation, adaptation, and finance.* It includes digital identification systems, data platforms, communications networks, and transaction systems specifically geared towards climate-related use cases. A Climate DPI would provide capabilities such as: reliably **verifying identities and assets** (for example, identifying project developers, verifying land ownership or stewardship for nature-based projects); enabling **secure and efficient transactions** (e.g. payments of climate funds, trading of carbon credits, disbursement of insurance payouts or green subsidies); and **sharing data and knowledge in real time** (from early warnings to best-practice templates for climate policies). These foundational services are analogous to the key components of many DPIs today, often summarized as digital *ID, payments, and data exchange*, but applied in context to climate needs. Importantly, Climate DPI is not a single application or database. It is a framework ensuring that all critical digital tools for climate can interconnect. It sets common **protocols, standards, and governance rules** so that various climate digital goods (satellite data portals, carbon registry platforms, etc.) can function as one integrated system from the user's perspective.

Essential Elements and Foundational Characteristics:

The Climate DPI can be thought of as having several **layers or modules**, each with specific functions, all built on top of robust digital infrastructure (broadband connectivity, cloud computing etc.):

Digital Identification Layer:

A system for unique identification of entities involved in climate action, this could be people (e.g. smallholder farmers receiving climate-smart agriculture payments), organizations (project developers, NGOs), or assets (land parcels, renewable energy installations). Leveraging national digital ID systems where available, or alternative community IDs, this layer ensures every stakeholder can be recognized and authenticated digitally. For example, a climate refugee could use a digital ID to prove eligibility for aid across borders. In carbon markets, project IDs and credits would have unique digital tags to track provenance. The key is interoperability: a digital ID issued in one country should be verifiable by systems in another (subject to agreements), much as passports work internationally. This provides the trust backbone for Climate DPI transactions.

Payments and Transactions Layer:

This consists of digital payment systems and smart contract platforms that enable the flow of climate finance. It would utilize or integrate with existing payment DPI (like instant payment systems, mobile money, etc.) to channel funds for climate projects, disaster relief, etc., efficiently and transparently. An illustration is how a national digital payments infrastructure can support quick disbursement of relief funds to disaster victims or pay farmers for ecosystem services . Climate DPI would embed climate criteria into these flows, for instance, automatically releasing a parametric insurance payout to farmers when a drought index (from the data layer) hits a trigger. With smart contracts, one can program climate finance agreements (like an agreement to pay for verified tons of carbon removed) that execute as soon as the conditions are met and verified by the system. Integration with blockchain or distributed ledger technology may be used for transparency and to prevent double spending or double counting of credits . The payments layer, in short, ensures **value exchange** (money, credits, tokens) can happen seamlessly to support climate outcomes. One concrete existing example is Stellar Aid Assist, a humanitarian payments platform developed by the Stellar Development Foundation to deliver cash assistance rapidly, securely, and transparently to people affected by crisis. Built on the Stellar blockchain network, it enables aid organizations to disburse funds directly to recipients' digital wallets or bank accounts, even in situations where traditional financial infrastructure is disrupted. Since its launch, it has been deployed extensively in Ukraine to deliver emergency humanitarian aid to civilians impacted by the war, allowing recipients to receive funds in minutes, convert them to local currency, or use them for digital payments. By using open blockchain rails and interoperable wallet standards, Stellar Aid Assist offers full transparency to donors and aid agencies, ensures traceability of funds, and minimizes administrative delays, key attributes in disaster and climate response contexts. It exemplifies how digital public goods can "*transform the way people collaborate on disaster and climate risk*" when supported by coordination and investment. It operates as a reusable, open infrastructure for crisis-related cash transfers, enabling different humanitarian actors to plug into the same payment and verification framework. Beyond Ukraine, the platform's design can be adapted for disaster relief in climate-vulnerable regions, integrating with early warning systems, national ID frameworks, or other Digital Public Infrastructure layers. In the Climate DPI's Payments and Transactions Layer, Stellar Aid Assist stands as a concrete and working example of how to channel funds rapidly across borders while maintaining trust and accountability. Its use of decentralized, transparent payment rails shows how technology can make humanitarian finance faster, more inclusive, and better aligned with climate resilience objectives.

Data and Information Exchange Layer:

At the heart of Climate DPI is an open federated **climate data infrastructure**. This layer includes standardized data formats, APIs (application programming interfaces), and data governance frameworks that allow disparate data sources to connect. It will host shared data repositories ("public data lakes") for climate, for example, repositories of satellite imagery and climate model outputs, but also libraries of climate adaptation solutions, or open datasets on emissions and climate risks. Through open APIs, innovators anywhere can plug into these datasets to create services (whether a smartphone app for farmers or an AI model for climate prediction). Crucially, this layer would enforce **open standards** so that data from one system can be readily combined with another. It builds on initiatives like GEOSS (brokering 150+ data catalogs via common protocols) and UN Data for SDGs platforms. Additionally, data exchange needs to be two-way: not only top-down from satellites or central databases, but also bottom-up from communities. Thus, the data layer would integrate citizen science and crowdsourced data (e.g. community weather observations via mobile phones, or indigenous knowledge) into the wider stream, with appropriate validation. A governance framework in this layer would set rules on data sharing, licensing, privacy (to protect personal or sensitive information), and quality assurance. The overarching principle: **data should be as open as possible and only as closed as necessary**, treating it truly as part of the public infrastructure.

Application and Services Layer:

On top of these foundational layers, the actual **climate solutions** or services operate, often developed by third parties (private sector, NGOs, government agencies, private foundations) using the infrastructure. This could include a wide array of digital public goods for climate: early warning systems, climate adaptation planning tools, carbon footprint calculators, renewable energy marketplaces, reforestation tracking apps etc. By using the common DPI layers, these applications can interoperate and scale quickly. For instance, a drought early-warning system app can pull data from the shared satellite data pool (data layer), authenticate users via the digital ID (ID layer) to send targeted alerts, and even trigger mobile payments to at-risk individuals as preparation support (payments layer). Another example: a carbon credit trading platform can use the DPI's registry module to ensure a carbon credit sold in one marketplace is flagged across all marketplaces (preventing double-sale), and use the common data layer to attach evidence (satellite images of forest cover) to each credit. Essentially, the Climate DPI doesn't replace individual climate tech initiatives, **it enables and connects them**. By providing common rails, it reduces development cost (each app doesn't need to build its own map or ID system) and increases impact (apps can work together, sharing data or transactions).

User Interface and Access Layer:

Finally, an often overlooked but critical element is ensuring *human access and inclusion*. The Climate DPI must be usable by and accessible to a wide range of stakeholders, including government decision-makers, scientists, businesses, and local communities (especially marginalized or vulnerable groups). This means investing in user-friendly portals and dashboards for the data (so that, say, a local planner can easily get the climate risk profile of their town), multilingual and culturally adapted interfaces, and support for low-tech access (e.g. USSD/SMS interfaces or community radio integration for those without smartphones, as it happens). It also means ensuring accessibility for people with disabilities in digital services. The **Programa de Comunicação Indígena** (Indigenous Communication Program) in the Brazlian portion of the Amazon forest illustrates how community radio serves as a vital tool to deliver health advisories, environmental updates, and other critical information across the Brazilian Amazon, especially within remote Indigenous territories. Spearheaded by Norte Energia in partnership with FUNAI and the regional Indigenous Health District (DSEI), the program broadcasts twice daily in multiple Indigenous languages spoken across 12 territories. It integrates traditional radio programming with outreach efforts like food and medicine distribution during crisis, ensuring essential messages reach communities that often lack internet access or reliable connectivity. It embodies the **low-tech access layer** of a resilient Climate DPI framework: it demonstrates how hybrid communication models, mixing analog radio with minimal digital support, can maintain inclusive, culturally appropriate engagement across climatically vulnerable and infrastructurally underserved regions. Integrating similar low-tech channels into Climate DPI ensures that climate and risk communications truly reach and serve all populations, even those beyond the reach of the internet.

Universal design

In effect, the Climate DPI should be designed with **a "universal design"** philosophy, analogous to how physical public infrastructure like buildings or transportation are made accessible. This layer may involve regional or national "front-end" platforms that connect to the global back-end infrastructure, providing customized experiences (for example, a national climate portal that draws on global DPI data but is in the local language and context).

In summary, Climate DPI can be visualized as a **stack** of interdependent layers: from infrastructure (connectivity, cloud) at base, through identity/payments/data as core layers, up to applications and user-facing services. Foundational characteristics across all layers include interoperability (common standards), **openness** (open-source software, open data as default), **scalability** (ability to handle increasing volume as more countries and users join), **security and privacy** (robust cybersecurity and data protection measures), and **adaptability** (modular design that can evolve with technology and local needs). This modular "ClimateStack" approach is inspired by models like the India Stack and the proposed EuroStack for European digital sovereignty, essentially modular, layered architectures that ensure different components work together towards a larger ecosystem.

DPI for Climate Solutions (Digital Public Goods Approach):

One of the pillars of Climate DPI is treating key climate software tools and models as **Digital Public Goods (DPGs)**. Digital public goods are open-source software, data, models or standards that are freely available for anyone to use, modify, and distribute. Applying this to climate solutions means that, for instance, core AI models for climate risk, or software for managing renewable energy grids, should be developed collaboratively and made open, rather than proprietary. This lowers costs for developing countries and encourages global innovation (people can build on each other's work). The UN and World Bank have actively promoted DPGs for climate and disaster risk management. Examples already exist: the Oasis Loss Modeling Framework (for climate-related insurance risk) is open-source, the OpenStreetMap data used in disaster mapping is a crowdsourced public good, and open data standards for climate (like NetCDF for climate model outputs) have been widely adopted. Under a Climate DPI initiative, there could be a formal program to identify, develop and deploy a suite of **"Climate Digital Public Goods"**, e.g., open-source tools for monitoring greenhouse gas emissions (perhaps building on NASA's OCO-2 satellite data, or Japan´s GOSAT-2, or yet, China´s TanSat), or an open-source platform for city-level climate risk assessment that any city can use as a base. A governance mechanism (possibly a Climate DPI Alliance) could certify certain solutions as DPGs and facilitate funding and community support for them. By embedding these into the infrastructure, we ensure no country or community is left unable to access cutting-edge climate solutions due to cost or licensing issues. Moreover, DPGs encourage *localization*, local tech communities can adapt global tools to their language and context, feeding improvements back into the global pool.

DPI for Climate Finance

We touched on this in the rationale. Here we define it as an integral part of the Climate DPI concept. This involves creating **common digital platforms and standards for climate finance flows.** One key element would be a Global Climate Finance Registry or clearinghouse that tracks climate-related projects and financing (grants, loans, carbon credits etc.) in a transparent manner. Building on efforts like the Climate Action Data Trust (which serves as a metadata ledger connecting carbon credit registries), the Climate DPI's finance component would ensure that information on climate funds and credits is interoperable across systems. For carbon markets, DPI would provide the backbone for *"standardized carbon credit certification."* In practice, this means harmonizing the way credits are issued and transacted: e.g., digitizing the methodologies of various standards (CDM, Gold Standard, Verra etc.) into software modules, so that any project can use a unified interface to get certified and issued a tokenized credit. These credits, recorded on a tamper-proof ledger, would include rich data (timestamp, location, methodology, verification evidence) that any exchange or buyer can query, increasing trust and fungibility. Smart contracts could enforce that a credit, once retired (used to offset emissions), is labeled as such across the network, preventing reuse. Beyond carbon markets, DPI for climate finance covers things like green bonds and sustainable finance. Imagine each green bond issued is tagged in a global registry that links to reported impacts (renewable capacity built, emissions avoided), investors and watchdogs could easily verify claims. Also**, climate finance mobilization** could be enhanced: for example, a Climate DPI platform might allow crowdfunding or retail investment into vetted climate projects globally, using digital tokens representing micro-shares in those projects, with all transactions governed by standard protocols. Underlying all this, DPI ensures that whether money flows through a bank, a mobile money app, or through a crypto token, it can be accounted for under common climate criteria. Governance-wise, this component would need involvement from financial regulators, multilateral development banks, and climate fund managers to set the rules. But once established, a DPI for climate finance can dramatically reduce inefficiencies, as funds will move through **interoperable digital rails** rather than getting stuck in bureaucratic or technical bottlenecks.

Data as DPI (AI-Ready Data Infrastructure & Data Philanthropy):

Finally, expanding on data as an infrastructure: the Climate DPI must ensure that data is not just available, but *actionable and AI-ready*. This means investing in data quality, metadata standards, and compute infrastructure so that AI and analytics can be readily applied. For instance, assembling **a public climate data lake** that hosts cleaned, standardized datasets (historical weather data, climate model projections, satellite imagery time series, socio-economic indicators, etc.) that are updated in real-time where possible. Providing cloud-based sandboxes where researchers or startups can apply AI models to this data without each having to download petabytes on their own. Essentially, **bringing computation to the data** as a shared resource. This will accelerate development of new insights, e.g., training an AI to predict crop failures or to optimize renewable energy storage can be done by anyone on common data, leading to diverse solutions. Furthermore, encouraging **data philanthropy** is key: many private companies hold valuable data for climate (like telecom data that can show mobility patterns relevant in evacuations, or retail purchasing data that indicates consumption patterns). A mechanism under Climate DPI could facilitate anonymized or aggregated sharing of such data for public good uses. For example, during extreme weather, telecom operators might stream mobility data into the DPI to help map evacuation or displacement in real-time (with privacy safeguards). Already UN initiatives have convened companies to pledge such data sharing for climate resilience. Climate DPI institutionalizes this by creating trust frameworks and perhaps legal safe harbors for data contributors, treating them as partners in a global resilience network. Additionally, *data governance* in Climate DPI would embed principles of fairness and sovereignty, for instance, ensuring communities that provide data (even inadvertently, like via satellites imaging their region) benefit from insights or have a say in usage. Concepts like **"data for development"** and open data licenses will guide this. In short, Climate DPI's data infrastructure is about turning the vast streams of raw data into a curated, accessible and intelligence-ready resource for humanity's climate response.

By articulating these components, climate solutions as digital public goods, climate finance rails, and treating data as critical infrastructure, we establish the blueprint of what a Climate DPI entails. It is merely an information system, nor just a fintech project, nor only an open-data initiative, but **all of these woven together** under a unifying architecture and governance focused explicitly on climate outcomes. This holistic approach is what sets Climate DPI apart and would make it a foundational enabler for myriad climate actions to succeed.

4. Technologies and Proposed Components

In this section, we delve into the specific **technologies and system components** that would form the Global Climate DPI, aligned with the conceptual framework above. We break this into sub-components for clarity, highlighting existing initiatives or prototypes in each domain that demonstrate feasibility. These components are envisioned to interoperate as part of the unified Climate DPI, but we discuss them separately for ease of understanding:

4.1 Earth Observation and Remote Sensing

A critical technology pillar for Climate DPI is **Earth observation**, the ability to monitor the planet's vital signs (atmosphere, oceans, land, biosphere) continuously and at high resolution. This provides the empirical foundation for climate action, from tracking deforestation to measuring greenhouse gas emissions or spotting emerging droughts. The Climate DPI will leverage and expand upon the rich suite of existing Earth observation systems to ensure *open, global coverage of climate-related data.*

GEOSS, A Global "System of Systems":

The Group on Earth Observations (GEO) has already laid groundwork by networking together national and agency observation systems into the **Global Earth Observation System of Systems (GEOSS)**. GEOSS exemplifies how to integrate heterogeneous data sources under common standards. It acts as a broker and aggregator, so that a user can, for example, search one portal and discover data from NASA, ESA, JAXA, national meteorological services, universities, etc. The **GEOSS Portal** provides a single access point to an immense range of earth data, imagery, weather data, disaster information, with an easy-to-use interface. The Climate DPI would use GEOSS as a backbone for its Earth observation layer. We will strengthen it further by promoting *common technical standards* (so thousands of instruments can indeed produce combinable data) and filling gaps in observation coverage (for instance, supporting new sensors in regions that lack ground monitoring). An idea is to formalize GEOSS within the Climate DPI governance, to ensure sustained support and integration with the other DPI layers (e.g., linking observation data directly to decision systems and finance triggers).

Copernicus and Open Satellite Data:

The **Copernicus Climate Change Service** and broader Copernicus program set a benchmark for freely accessible satellite data. Copernicus, with its Sentinel satellite fleet, offers continuous monitoring of land, oceans, and atmosphere, and crucially operates under a **full, free, and open data policy**. This has allowed countries worldwide to utilize European satellite data to meet their development and climate monitoring needs without prohibitive cost. Within Climate DPI, we envisage an **Open Satellite Imagery Repository** that includes data from Copernicus, but also NASA's missions, commercial satellites contributed via data philanthropy, and/or emerging players. The repository would present a unified catalog (building on GEO's efforts) where users can get multi-source imagery and derived products (like land cover maps, soil moisture etc.). In addition, services like the **Copernicus Climate Data Store**, which provides not just raw data but user-friendly tools and APIs for climate indices, would be federated into the DPI. This enables analysts anywhere to easily obtain historical climate trends or future projections for their region from trusted datasets. By relying on systems like Copernicus, the Climate DPI ensures the **continuity and quality** of Earth observation data; the EU's long-term commitment has proven vital to have consistent time-series (e.g., decades of imagery) which are needed for climate trend analysis. Furthermore, Copernicus is designed to support international initiatives such as GEOSS, reinforcing that Climate DPI's ethos of global sharing is already technically viable.

Open Access to Satellite Imagery & Environmental Data Sets:

The DPI would promote policies where satellite and remote sensing data collected with public funding are by default open access. This could be extended to certain privately-funded data under negotiated arrangements (for example, a company might release moderate-resolution imagery for public use after some time delay). Already, several satellite companies released imagery for free during major disasters (like SkySat images after the Haiti quake) to assist humanitarian efforts, we want to make such practices systematic rather than exceptional. The **public data lake** under DPI will host not only images but processed data layers: for instance, global forest cover and change maps (building on tools like Global Forest Watch), air quality and pollution maps, ice cover and glacier monitoring, etc. Combining multiple sources improves reliability, e.g., if one satellite is obscured by clouds, another might have a clear view. With an array of both *"eyes in the sky"* (satellites) and *"eyes on the ground"* (sensors in-situ, citizen observers), Climate DPI's Earth observation component will give a near real-time picture of the planet's health that is accessible to all countries. It will also ensure **historical baselines** are available: archives of remote sensing data going back decades to measure changes over time. These are crucial for things like establishing baseline emissions (for REDD+ forestry programs, one needs historical deforestation rates) or assessing climate trends.

In practice, this Earth observation pillar would power many specific applications: **near-real-time deforestation alerts** in tropical forests (triggering enforcement or finance for protection, something that organizations like INMAZON Institute in Brazil have been working to achieve), **glacier and snowpack monitoring** to predict water shortages**, urban heat island mapping** to guide city cooling efforts, and **agricultural index insurance** (where satellite-derived drought indices determine payouts). Another concrete example is Brazil's Cadastro Ambiental Rural (CAR), an environmental registry that uses satellite-based land verification to ensure lands enrolled for carbon credit projects indeed have forest cover. By integrating CAR's approach, Climate DPI can help other nations set up similar digital land registries for climate finance, essentially a Climate Action Registry that relies on satellite imagery and GIS to transparently validate climate actions. Through these means, Earth observation becomes a shared utility, no longer limited by the wealth or technology of individual nations, but a **global public asset** to safeguard the climate.

4.2 Real-Time Climate Risk Monitoring & Emergency Response

Climate change is boosting the frequency and severity of extreme events, be it hurricanes, floods, wildfires or slow-onset crises like drought and sea-level rise. An essential component of Climate DPI is a **real-time climate risk monitoring and emergency response system** that can help anticipate, prepare for, and manage these events in a coordinated way. This combines technology like IoT sensors and predictive analytics with platforms for information sharing and response coordination.

PRISM, Integrated Climate Risk Monitoring:

The World Food Programme's **PRISM** platform illustrates how to bring together hazard data and vulnerability information to guide action. PRISM uses geospatial data on things like rainfall anomalies, vegetation health (from satellites), etc., and overlays it with local socio-economic data (e.g., population, livelihoods) to produce risk maps. Through a simple dashboard, officials can see which areas are at greatest risk of drought impacts or flood exposure, often with a lead time to act. Within Climate DPI, we propose to generalize such capabilities as a **Global Climate Risk & Early Warning System**. This would be a multi-hazard system that ingests data from the Earth observation layer (satellite rainfall estimates, temperature forecasts, cyclone tracks), **IoT sensors** on the ground (like river level gauges, weather stations, air quality monitors), and crowd-sourced reports (more on that below), in order to continuously assess risks and issue early warnings. The system would be built on open standards like the **Common Alerting Protocol (CAP)** to ensure warnings can be disseminated widely (to mobile networks, sirens, media, etc.). It would also connect to social protection systems. For example, when a certain trigger is reached (say a drought index indicating crop failure in a region), the DPI could notify the payments system to disburse emergency cash to affected households (a concept known as forecast-based financing or anticipatory action).

Ushahidi and Crowdsourced Crisis Mapping:

A resilient climate response needs eyes and ears on the ground. The **Ushahidi** platform and similar tools (like the Red Cross's RC View or other crisis mapping apps) allow community members to send in reports, e.g., "bridge washed out here" or "people stranded on rooftops in this location", which are then visualized on maps in real time. This dramatically improves situational awareness in disasters, complementing official sensor data. Under Climate DPI, we would integrate a crowdsourced incident reporting system that can be deployed in any country. Likely, it would function via multiple channels: a smartphone app for those connected, SMS shortcodes for those with basic phones (Ushahidi began with SMS intake), and integration with social media for signal detection. Advanced NLP (natural language processing) could help filter and geolocate reports from platforms like Twitter or Facebook during a disaster. The DPI's identity layer could also authenticate or prioritize verified responders' messages to reduce misinformation. **Crisis mapping** data would feed into the same dashboards that officials use, ensuring that community-sourced intel is part of decision-making. For example, during floods, officials could see sensor readings of water levels alongside crowdsourced reports of which roads are flooded, giving a fuller picture. This empowers communities as active contributors to their own resilience, not just passive beneficiaries.

IoT Sensors and Cloud Infrastructures:

The proliferation of low-cost **IoT sensors** opens new possibilities for hyper-local climate and environmental monitoring. Climate DPI can promote and coordinate a network of such sensors, from weather stations and soil moisture probes in farms to flood gauges in rivers, air quality monitors in cities, and wildfire smoke detectors in forests. These can be connected via the Internet (or even via satellite IoT networks in remote areas) to the cloud data infrastructure. Because one challenge is that developing countries often have sparse ground observations (e.g., few weather stations), part of Climate DPI could be supporting deployments of robust, cheap sensors (there are projects deploying $50 weather stations based on Arduino/Raspberry Pi, for instance). The **cloud infrastructure** aspect means we need a scalable platform (likely leveraging global cloud providers or a federated cloud) to ingest and process the torrent of data coming in. This is where **predictive analytics** come in: the DPI can run AI models that analyze sensor data and forecasts to predict events like flash floods or heatwaves several days ahead, and automatically alert authorities and the public. In fact, **AI is increasingly central** to early warning: research shows integrated AI can improve multi-hazard early warning by analyzing meteorological and geospatial data for impact prediction. For example, AI can take a weather forecast of heavy rain and estimate which neighborhoods will likely flood based on terrain and drainage data, something Germany's Max Planck Institute is working on for Europe's flood warnings. The DPI should incorporate such AI models, making them available to all countries (possibly with customization according to local context).

Automated Early-Warning and Emergency Management:

Putting it together, the vision is that **whenever a climate-related threat emerges, the Climate DPI system will detect it, assess it, and help coordinate response** across stakeholders rapidly. Suppose a tropical cyclone forms and heads toward a coastline: the Earth observation layer provides satellite tracking of the storm, the predictive models estimate likely impact zones and populations at risk, the system automatically pushes alerts to those communities' phones in multiple languages, local governments and international agencies see the same information and can coordinate evacuation or pre-positioning relief (through a shared dashboard). If the country has parametric insurance or adaptive social protection, those financial instruments are triggered via the payments layer to release funds early. During and after the event, crowdsourced reports and drone imagery feed in to map damage in real time, directing rescue teams where needed most. All of this can be orchestrated via the **common platform** rather than ad-hoc communication. It essentially acts as the world's "climate emergency room," albeit decentralized, each country or region will have its interface, but data and tools are interoperable globally. Initiatives like **Ushahidi** in Haiti or **NASA's DISASTER program** during crises have proven the value of tech in emergency response. Climate DPI institutionalizes such capabilities universally.

It's important that this component also addresses **slow-onset crises** (like droughts, sea-level rise) and not just sudden disasters. For drought, for instance, we want the system to continually monitor rainfall deficits, groundwater levels, vegetation health (e.g., via NDVI from satellites) and send escalating alerts as drought conditions develop. The DPI can help convene coordination calls months ahead of an impending drought-induced food crisis, enabling early mitigation (like shipping in animal feed to prevent livestock die-offs, or adjusting planting schedules). In these cases, the emergency response is more about *early action and resilience building*, but the data and coordination needs are similar.

In summary, the Real-Time Monitoring & Response component of Climate DPI **uses technology as a force-multiplier for disaster risk reduction**. It harnesses data from everywhere (sky, ground, people) into a common operational picture and triggers timely actions. By doing so, it can save lives and reduce losses significantly. The UN has called for universal coverage of early warning systems, noting that currently half of countries lack them. Climate DPI is our vehicle to achieve that goal by means of COP30 and beyond, making sophisticated early warning a global public good available to all.

4.3 DPI for Climate Finance & Carbon Markets

Mobilizing and governing climate finance is one of the toughest challenges in meeting global climate goals. Here, we detail how a Climate DPI could directly support **climate finance flows and carbon market operations**, making them more transparent, efficient, and trustworthy. This spans innovations in carbon credit infrastructure, green investment platforms, and financial accountability tools.

Digital for Climate D4C) Initiative:

: The **Digital4Climate (D4C)** working group is a leading example of applying digital infrastructure thinking to carbon markets. As noted earlier, it's a collaboration of major stakeholders (UNDP, World Bank, UNFCCC, IETA, etc.) aiming to create a **modular, interoperable end-to-end digital ecosystem for carbon markets**. In practice, D4C is developing digital building blocks: tools for digitizing *carbon project methodologies,* systems for *digital Measurement, Reporting, Verification (D-MRV)* of emissions reductions, open-source *registry systems* for credits, and a *Climate Action Data Trust (CADT)* as a meta-layer linking registries. The **Climate DPI would incorporate these components** at its core for climate finance. For example, all carbon credit standards could plug into a common **Climate DPI Carbon Registry Network.** Credits issued by any standard body would be registered through CADT, which uses blockchain to create a decentralized, tamper-proof record. This ensures credits are unique and traceable (preventing double counting of the same emission reduction) and increases confidence for buyers and regulators. The CADT launched in late 2022 connects multiple registries. This momentum will be accelerated under Climate DPI. Ultimately, this means someone in, say, Brazil can develop a forest conservation project or an Enhanced Rock Weathering (ERW) project, and have them digitally verified and issued credits, and those credits can be seamlessly traded or used in Singapore or Germany with full transparency and compatibility.

Nature ID and Related Platforms:

Beyond carbon, climate finance increasingly looks at **nature-based solutions** and biodiversity (sometimes termed "nature finance"). The **Nature ID** platform concept from UNDP exemplifies how DPI can support these. As mentioned, Nature ID is a data exchange that quantifies ecosystem value, aiming to expand mechanisms like Payments for Ecosystem Services. Under Climate DPI, one can imagine a **Nature Assets Registry**, a sort of digital inventory of critical ecosystems (forests, wetlands, coral reefs) with unique identifiers and attributes like carbon stock, biodiversity index, communities dependent, etc. This would enable new financial instruments: e.g., *"Nature Credits"* for preserving or restoring ecosystems, or debt-for-nature swaps tracked via the platform. If a government or company invests in protecting a mangrove forest, the outcomes (like tons of CO_2 sequestered, or flood protection value) could be recorded and even tokenized, similar to carbon credits. DPI ensures such tokens or credits are standardized and **interoperable** globally (so a "nature credit" in one system is understood the same way elsewhere). It also ensures **traceability**, and supply chains could tap into the data to verify if commodities like timber or palm oil come from lands that are deforestation-free, for example. In a sense, Nature ID would provide the **data backbone for valuing natural capital**, which can then tie into financing (through sustainability-linked loans, PES schemes, etc.).

Transparent Blockchain and Smart-Contract Systems:

Blockchain technology can play a key role in climate DPI finance due to its transparency and decentralized verification features. Already, some carbon trading platforms are adopting blockchain to enhance trust in credits (for instance, Project Carbon by major banks uses blockchain to track voluntary credits). The Climate DPI would establish a **blockchain-based climate ledger** (or leverage existing ones) for tracking key transactions: carbon credit issuance/retirement, renewable energy certificates, climate fund disbursements and more. A practical case is the **Climate Action Data Trust:** it's built on distributed ledger tech to serve as a global metadata layer for carbon markets, avoiding double counting and boosting trust. By integrating CADT, the DPI can use blockchain to not only record transactions but also host **smart contracts** that automate climate finance. For example, a smart contract could hold a green bond's proceeds and release them to a project implementer only when satellite data and third-party reports (fed through oracles) confirm that milestones (like planting of X hectares of forest) are achieved. This kind of conditional disbursement ensures performance-based finance with minimal manual overhead. In insurance, a smart contract can automatically pay out to farmers when drought index crosses a threshold. **Satellite monitoring and blockchain** is a particularly powerful combo: initiatives plan to leverage both to ensure integrity of credits. In Singapore, the Climate Impact X (CIX) exchange has said it will use satellite data, AI, and blockchain together to ensure high-quality nature-based credits. That means, for instance, continuous monitoring of a forest via satellite to ensure it remains intact, with results logged on blockchain so that any buyer of those credits can see for themselves the forest condition over time. Climate DPI will mainstream such designs so that every carbon or environmental credit can be backed by verifiable data and code.

Standardized Carbon Credit Certification:

Interoperability in carbon markets requires some harmonization of standards. While there will always be multiple methodologies (for different project types, etc.), Climate DPI can facilitate a **common certification framework**. Under this, all credits, whether from a big registry or a community-based scheme, would carry certain core information fields and perhaps a rating of quality/integrity. The DPI might host a “credit passport” for each credit unit, containing its origin, methodology, verification log, etc. This could be akin to how electronic health records carry standardized info or how digital payment systems have common ISO message formats. The D4C approach indeed is to design each component (methodology digitization, MRV, registry, etc.) as **modular and standardized** so that mitigation activities can plug and play modules with minimal customization. This drastically lowers barriers for smaller actors (like community projects, Indigenous-led initiatives) to access carbon finance, correcting the current bias where only large projects can afford complex certification.

Moreover, standardized digital certification means **governments can integrate carbon markets into their climate targets** more easily. If each credit's details are transparent, a government can avoid double counting between its national inventory and voluntary market by checking the registry. The DPI could even help countries implement Article 6 of the Paris Agreement (international carbon trading between countries) by providing the digital infrastructure for corresponding adjustments and an international transaction log, functions currently under discussion.

In addition to carbon credits, **other climate finance flows** benefit from standardization: climate adaptation funding, for example, could have a digital tracking system where each dollar from a donor is tagged through to the project level with performance indicators. That way, global aggregation of climate finance progress (towards the $100B goal, for instance) can be more than just self-reported numbers, it can be a live dashboard showing funds committed, transferred, in use, and their impacts. The DPI, by being a neutral infrastructure, could be the repository of such information, giving confidence to all parties about where the money is going.

To illustrate the end-state: imagine an investor wants to support nature-based climate solutions. Through a Climate DPI-enabled platform, they could browse projects worldwide, each with standardized data on expected impacts, funding needed, credit potential, etc. They invest via digital tokens or direct transfers recorded on the ledger. As the project proceeds, the system streams updates, satellite images of the reforestation, sensor data on tree growth, community feedback via an app, and when outcomes are verified, carbon credits are issued to the investor's account automatically. The investor can then use or sell those credits, and any sale is likewise transparently recorded. Fees are minimal because many intermediaries (validators, registries, brokers) have been streamlined by the shared digital infrastructure. A small farmer cooperative could equally access this system to get funding for climate-resilient agriculture by proving their practices via data.

In summary, **Climate DPI for finance** aims to create a **trusted digital ecosystem for climate investments**. It tackles current difficulty points: lack of trust (by enhancing transparency and verification), high costs and slow pace (by automating processes with digital tools), and fragmentation (by uniting standards and data globally). By channeling more capital to real climate solutions and ensuring those solutions deliver what they promise, this component of Climate DPI is vital to turning financial commitments into tangible climate progress on the ground.

4.4 AI for Climate Resilience and Urban Adaptation

Artificial Intelligence (AI) stands to be a transformative tool in how we plan for and adapt to climate change, particularly in making our cities and communities more resilient. Climate DPI envisions integrating **AI-driven systems** to anticipate risks, optimize adaptation strategies, and support decision-making at all levels. This section focuses on AI applications for resilience and urban adaptation, where proactive measures can reduce harm from climate impacts.

Predictive Climate-Risk Modeling:

AI excels at finding patterns in vast data, a capability highly relevant for understanding complex climate risks. By feeding AI models with historical climate data, satellite observations, topography, land use, and socio-economic data, we can develop **predictive models** for events like floods, landslides, or urban heatwaves. For example, an AI model could analyze factors that led to severe urban flooding in the past (rainfall intensity, soil saturation, drainage capacity, building patterns) and learn to predict which neighborhoods will suffer most in a coming extreme rainfall event. Such models can vastly improve impact-based forecasting: not just predicting weather, but predicting **what that weather will do** to communities. A recent push in climate science is toward *multi-hazard early warning systems* that incorporate AI to integrate meteorological forecasts with vulnerability data for better impact prediction. Climate DPI will include an AI platform where models (including advanced ones like climate-informed neural networks or agent-based simulations for cities) can run on the common data and provide **localized risk forecasts**. These AI predictions could be served to city planners and emergency services via the DPI dashboard. For instance, 48 hours before a hurricane landfall, AI might be able to estimate down to city-block level which areas will likely experience infrastructure failure or power outages given the storm's intensity and the state of assets. That allows targeted pre-positioning of repair crews or proactive evacuations of vulnerable facilities like hospitals.

AI-Powered Early Warning and Proactive Adaptation Systems:

We've touched on early warnings in section 4.2, but here specifically, AI can extend warning systems by making them **anticipatory and adaptive**. One aspect is timing: traditional warnings often give hours or days notice. AI might help give **months or years notice** for slow-building risks. For example, AI applied to climate models and seasonal forecasts could predict a high likelihood of a severe drought season well in advance, prompting water rationing plans or crop adjustments proactively. Another aspect is personalization: AI could tailor alerts or guidance to specific demographics. Imagine an AI system that analyzes a heatwave forecast and identifies which city blocks have many elderly living alone (using census and health data), then automatically triggers community check-ins or cooling center transports for those areas. This kind of granularity and proactivity requires cross-data analysis that AI is suited for. In practice, AI-driven early warning might incorporate not just physical predictions but also behavioral and social data, e.g., using mobility data and AI to predict how an evacuation would flow and identifying choke points, then recommending adjustments in real time.

For **urban adaptation planning**, AI helps in exploring scenarios and optimizing interventions. Urban planning has to balance many factors, and climate change adds new uncertainties. AI can assist with "digital twin" models of cities, virtual replicas that simulate climate impacts under various measures. City planners could use AI to ask questions like: *if we add a green roof to 30% of buildings and increase permeable surfaces by X%, how much would that reduce flood risk or urban heat under different climate scenarios?* The AI can crunch through the combinations and identify high-impact adaptation strategies. Already, some cities are using AI to analyze infrastructure vulnerability or to site green infrastructure optimally. The DPI can mainstream these tools globally, so even smaller cities have access to sophisticated analysis. For example, an **AI-urban planning tool** could leverage satellite imagery (to see current land use), climate projections, and infrastructure maps to suggest where new parks or retention basins would yield the best flood mitigation benefit, something that might otherwise require expensive consulting studies.

Smart Green Infrastructure Planning:

A particularly promising AI use is in designing **nature-based solutions** and infrastructure that provide climate resilience benefits. AI algorithms can help optimize where to plant trees in a city to maximize cooling, or where to restore wetlands to absorb floodwaters. An interesting concept is "blue-green infrastructure", integrating water management with green spaces. AI can analyze topography, hydrology, and urban layout to propose networks of parks, greenways, and ponds that not only beautify a city but also act as sponges during heavy rains. Intelligent urban planning focusing on transit and limiting sprawl can cut emissions significantly while boosting resilience. The DPI's AI toolkit would thus also contribute to **mitigation** in urban settings (by shaping low-carbon, climate-resilient city designs). We could have AI recommending zoning changes: e.g., highlighting areas where building in a floodplain should be avoided or where higher density along a transit corridor would reduce car dependence and also allow more land to remain as green space.

A real-world success that hints at this is how some municipalities used AI to optimize traffic flow which reduced congestion (and emissions) and in some cases improved air quality in heatwaves. On a larger scale, **AI for resilient infrastructure** might involve predictive maintenance, AI models using sensor data to predict when a bridge or power line might fail due to extreme heat or storm stress, so that preventive fixes can be done. Climate DPI can incorporate those models into asset management systems for utilities and public works globally.

Case Example, AI Early Warning in Europe:

The Max Planck Institute's recent research shows how AI could aid early warnings for extreme weather impacts. They highlight that AI can achieve high spatial and temporal resolution in predictions and also consider social dimensions (like how warnings are communicated and perceived). Their approach aims not just to warn of a flood, but to identify exactly where damage will be particularly severe and suggest measures to minimize it. Early warnings should provide info on how society can adapt, e.g., indicating where floodplains could reduce damage or where settlements might need relocation. This is a philosophical shift from reactive to preventive. Climate DPI's AI capabilities would strive to implement this philosophy globally. For instance, an AI system in the DPI might flag that a certain coastal community will face untenable flood risk by 2050 and even suggest an adaptation pathway (e.g., build a seawall vs. facilitate a managed retreat) along with cost-benefit analysis. These are decisions that involve policy, but AI can greatly inform them.

AI in Community Resilience:

It's important to note that AI is not only for big agencies, through DPI, even communities can leverage AI insights. One could envision a local government or NGO logging into a DPI portal where an AI-driven "Resilience Advisor" helps interpret climate data and plan. For example: *"We* *are seeing more frequent droughts affecting our region's agriculture. What are the best crops or practices to adopt?"* The AI, trained on global knowledge and local data, could answer with tailored suggestions, drawing on both scientific research and analogues from other places. This democratizes expertise which is currently limited to a few consultants or institutions.

In conclusion, integrating **AI for resilience and adaptation** into Climate DPI means every country and city can benefit from state-of-the-art analytical and predictive tools. These tools would continuously improve (machine learning models get better with more data, which DPI provides abundantly). By embedding AI in our climate infrastructure, we move toward a future where adaptation decisions are data-driven, proactive, and optimized for maximum protection of lives and property. It helps us stay a step ahead of climate threats, rather than scrambling after each disaster. Of course, we will ensure these AI systems are used ethically, transparently, and with human oversight, they are there to assist human decision-makers, not replace them, and their recommendations would be explainable to build trust.

4.5 AI for Climate (Mitigation)

While the previous section dealt with AI for adaptation and resilience, here we focus on how AI can support **climate change mitigation**, reducing greenhouse gas emissions and enhancing sinks. AI can be a powerful ally in optimizing energy systems, industrial processes, agriculture, and other domains to cut emissions, as well as in helping design smarter climate strategies. The Climate DPI will integrate AI solutions that assist in everything from tracking emissions to guiding precision low-carbon interventions.

AI-Supported Climate Mitigation Strategies:

One area is **emissions tracking and accounting**. Traditionally, compiling greenhouse gas inventories is laborious, relying on national statistics and periodic reporting. AI can help automate and refine this process by analyzing proxy data in real time, for instance, using satellite imagery to estimate emissions from power plants or AI on traffic camera feeds to gauge transport emissions in a city. A notable example: researchers have used AI with satellite data to detect methane leaks from oil and gas operations far more quickly than before. Under DPI, countries and even non-state actors could have access to an AI tool that constantly monitors key emission sources (energy, transport, deforestation, etc.) and provides up-to-date estimates, helping them course-correct policies and also offering transparency (could feed into the Global Stocktake under the Paris Agreement). The **Foundation for Climate Restoration** reported on using AI and supercomputing to quantify emissions at granular levels, like from individual farms. If one can do that, then targeted measures (like improving fertilizer efficiency on those specific farms) become possible. Essentially, AI can highlight the worst emitters or the biggest opportunities for reduction, functioning like a climate *diagnostic tool*.

Precision Agriculture and Land-use:

Agriculture and land are critical for sequestration**. AI in precision agriculture** can reduce emissions and environmental impact by optimizing fertilizer use, water use, and increasing yields on existing land to avoid deforestation. For example, AI-driven systems can tell farmers the exact amount of fertilizer needed in each part of a field, reducing nitrous oxide emissions (a potent GHG) and runoff. AI can also power early warning for crop diseases and pests (reducing crop losses, thus the need for land expansion). The DPI's agri-tech modules could include AI services that analyze local weather, soil sensors, and crop models to give millions of farmers personalized advice for climate-smart farming. *Precision livestock farming* with AI can also cut emissions by monitoring animal health and diet (healthier animals emit less methane). In forestry and land use, AI could aid in identifying optimal areas for reforestation or restoration that would maximize carbon sequestration and ecosystem co-benefits.

Energy Systems Optimization:

The energy sector is undergoing a transformation with renewables, and AI is a key enabler for managing the complexity of new grid systems. AI can predict energy demand, manage the charge/discharge cycles of battery storage, and dynamically balance loads, all of which allow more renewable energy to be integrated reliably. Under DPI, **smart grid management AI** could be offered especially to developing countries setting up renewables-heavy grids, to avoid them needing legacy fossil backup. For example, an **Unified Energy Interface (UEI**) concept, including open protocols to enable energy sharing. AI would be central to such an interface, forecasting production from solar panels, scheduling when electric vehicles charge or feed back to grid etc. If done right, these optimizations lead to major emissions cuts by squeezing out inefficiencies. AI applications across food, energy, and transportation could collectively cut global emissions by a significant margin, one study estimates up to 5.4 billion tonnes CO_2 per year by 2035 in an ambitious scenario, as pointed out by Systemiq in collaboration with the Grantham Research Institute on Climate Change and the Environment at the London School of Economics. That's roughly the US's annual emissions, a huge potential contribution from AI-driven efficiency and innovation.

Industrial and Supply Chain Efficiency:

AI is also revolutionizing manufacturing and supply chains in ways that reduce emissions. Smart sensors and AI on factory floors can minimize waste, predict maintenance needs (so machines run optimally), and even discover new process improvements. For example, AI might find a way to produce cement or steel with less energy by tweaking certain steps (some AI systems have already helped design more efficient chemical catalysts). In supply chains, AI can optimize logistics, trucks taking optimal routes, cargo loads maximized, cutting fuel use. Retail giants use AI for inventory management which can indirectly cut waste (and thus emissions from producing goods that would be wasted). The DPI could encourage these practices by sharing knowledge of best-in-class AI solutions and maybe even providing baseline tools for smaller industries.

Carbon Removal and Geoengineering Research:

: If we look at future mitigation, AI might also assist in researching and scaling **carbon dioxide removal (CDR)** techniques, whether natural or technological. For nature-based CDR, AI can measure carbon uptake in soils or forests via remote sensing. For tech-based like direct air capture, AI can improve the design and operation to be more energy-efficient. Even nascent ideas like reflecting sunlight (geoengineering) can be studied with AI models simulating climate response more accurately. While geoengineering is controversial, should the world ever consider it, AI would be important in modeling complex outcomes. The DPI can be a space where such high-end modeling is done openly, with global participation, to ensure transparency in potential drastic measures.

Case Example, AI Reducing Carbon in Sectors:

A report by LSE and others *(Green & Intelligent: role of AI in climate transition)* identified that using AI in **food, electricity, and transport** could yield enormous cuts. In food, AI-informed precision farming could save fertilizer and reduce land conversion (0.9–1.6 $GtCO_2e$ per year by 2030 in some cases). In electricity, better grid management and predictive maintenance can allow more renewables (potentially 1.8 $GtCO_2e$/year cut). In mobility, AI for route optimization, autonomous vehicles (if electrified), and traffic control can reduce emissions significantly. The Climate DPI would incorporate the lessons of such studies and foster the deployment of these AI applications worldwide. For instance, not every city can develop its own advanced traffic AI system, but DPI could support a shared open-source solution that any city can adapt (with local data input) to reduce congestion and emissions.

AI and Policy Making:

Another facet, AI can assist policymakers by analyzing complex data and suggesting effective interventions. For instance, an AI could simulate how different policy mixes (carbon pricing, subsidies, regulations) might play out in terms of emission reductions and economic impact, given a nation's specific context. Think of it as a policy simulator for climate decision-makers. While these are advisory tools, they can greatly enhance the strategic planning of mitigation, helping avoid unintended consequences and identifying high-leverage actions.

To conclude, **AI for climate mitigation** within DPI is about embedding intelligence into all our climate-related systems, energy, agriculture, transport, industry, to drastically improve their efficiency and lower their carbon footprint. The goal is a **"smart low-carbon transformation"** of society. It's important to note, to fully realize this, the DPI must also ensure equitable access to AI (so developing countries benefit, not just those with AI research labs) and address the energy use of AI itself (which leads us to the next section, ensuring AI and digital systems are green). But evidence suggests that if guided well, AI can be one of climate action's biggest enablers, slashing billions of tons of emissions while also often saving money (efficiency tends to pay for itself). Climate DPI will make these AI solutions part of the global public infrastructure, accelerating their adoption and sharing the benefits broadly.

4.6 Climate for AI (Sustainable AI Infrastructure)

As we deploy AI and digital technologies to fight climate change, we must also **ensure the digital infrastructure itself is sustainable and climate-friendly.** This section covers the flipside: aligning AI and ICT with climate goals, sometimes phrased as "Climate for AI" (creating conditions where our AI and tech development does not harm the climate, and ideally is powered by renewables and efficient hardware). With the explosion of data centers, machine learning computations, and digital devices, the ICT sector's carbon footprint is a concern. Climate DPI will **champion green computing standards, renewable energy use in tech, and sustainable practices for digital infrastructure.**

Green Computing Standards:

One approach is establishing and adopting rigorous standards for energy efficiency and climate neutrality in computing. The **Climate Neutral Data Centre Pact** in Europe, for example, brings major cloud and data center operators together with commitments to ambitious efficiency targets and 100% renewable power by 2030. Initiatives like these can be internationalized. Under Climate DPI, we propose developing a set of **Green Digital Infrastructure Principles** that all participating entities (governments, tech companies) agree on: e.g., new government data centers must meet best-in-class PUE (Power Usage Effectiveness) ratings; procurement of IT equipment must consider lifecycle emissions; encourage reuse and recycling of hardware (circular economy for electronics to reduce e-waste). We could tie climate finance or incentives to these standards, for instance, offering lower interest green financing for countries upgrading to efficient, climate-friendly digital infrastructure.

Renewable-Powered Data Centers:

Data centers are the backbone of digital services and also heavy energy consumers. Leading tech firms have made bold pledges: Google's data centers aim for 24/7 carbon-free energy by 2030 ; Microsoft pledges to be carbon-negative (removing more carbon than it emits) by 2030 . Climate DPI will facilitate sharing of knowledge and possibly joint investment to bring **renewable energy to all digital infrastructure**. This could entail, for instance, aggregating demand for clean power from many smaller data centers or telecom networks and negotiating supply from renewable projects. It can also involve **geographical load distribution:** since digital workloads can sometimes be shifted between data centers, AI might dynamically move tasks to locations where renewable electricity is currently abundant (some companies already do this to follow the sun or wind), such as Brazil. The DPI's cloud architecture could incorporate such algorithms to always maximize use of green power. Moreover, **innovative cooling solutions** to reduce energy use (like using ambient cold air, or liquid cooling, or situating data centers in cool climates or even underwater) can dramatically cut the energy overhead of cooling servers. These could be codified into recommended practices and supported by R&D sharing. Countries like Brazil and Singapore, for instance, are developing technologies for tropical datacenters. For developing countries expanding digital infrastructure, leapfrogging to green data centers from the start is ideal, the DPI initiative could provide expertise or even modular designs for "green cloud in a box" setups powered by solar, etc.

Sustainable Digital Technologies and AI Frameworks:

AI training, especially for large models, can be extremely energy-intensive. We need to mitigate that. Researchers and organizations are already working on **Green AI**, focusing on improving the energy efficiency of AI algorithms and hardware. Climate DPI should include guidelines that AI solutions used in climate action are themselves optimized for efficiency: for instance, using model distillation or specialized chips to run AI with lower power. It can encourage publishing the energy cost of AI models (some conferences now require reporting of compute resources used). It can also promote using AI to *optimize itself*, e.g., AI that manages data center cooling as mentioned, or scheduling tasks to minimize peak load.

Another point is **embedding lifecycle analysis** in digital tech: making sure when we deploy millions of IoT sensors or new devices, we consider the materials, the manufacturing impact, and end-of-life recycling. The DPI could help create a **Global E-Waste Management Platform** tying producers, recyclers, and consumers to ensure electronics used for climate purposes (and beyond) get properly recycled or repurposed. Many components of renewable tech (batteries, solar panels) and digital tech have finite materials. A circular approach helps both reduce emissions and resource strain.

Sustainable AI Infrastructure. Example:

One concrete measure is requiring that any new algorithms or software in the DPI be cloud-optimal and energy-aware. For example, if someone runs a big climate model or AI training, the DPI system could nudge them to run it at a time or place where renewable power is plentiful (like mid-day if solar is big in that grid). Or even better, **power the AI infrastructure with renewables on-site:** some data centers have solar panels or wind co-located, or use waste heat to warm nearby buildings, increasing overall efficiency. By sharing case studies, like a Scandinavian data center that uses cold outside air for cooling and whose waste heat warms homes, DPI can help replicate these globally.

Green Software and Networks:

Beyond data centers, think about the software and networks. Code can be written to be more efficient (using less CPU cycles). There is a green software movement encouraging developers to consider energy as a resource to conserve. The DPI could provide tools for developers to estimate the energy impact of their code and highlight greener alternatives. On networks, as 5G and IoT expand, ensuring those networks use energy-saving modes, and base stations are solar-powered or have smart sleep cycles, etc., can cut telecom energy use significantly.

Reducing Deployment Footprint:

Climate DPI as a global effort will involve deploying servers, devices, etc. We should commit to offset or minimize those emissions. For anything we can't reduce, maybe a part of DPI funding goes to carbon removal to truly make the whole system net-zero or net-negative. Additionally, where possible, leverage existing infrastructure instead of duplicating, for example, use cloud services that already exist and are green, rather than every country building separate servers.

Digital Public Infrastructure as a Climate Policy Tool:

Interestingly, focusing on sustainable digital infrastructure can itself become part of climate policies. Countries might include in their climate action plans a section on greening the IT sector (since it's a growing contributor). The DPI initiative can support them by providing a clear framework and technical assistance to do so. Also, digital solutions, if widely adopted, likely increase electricity demand (data centers, devices), but if that demand is met renewably and efficiently, it can synergize with the growth of clean energy markets.

As an outcome, we envision the **global AI and digital ecosystem in 2030 to be largely powered by renewables, and operating at high efficiency with minimal waste.** Data centers might be consuming more absolute energy because digital usage grows, but nearly all of that energy is clean, and the services they provide (like optimizing everything else) have a multiplier effect on emissions reductions across sectors. Initiatives like the *Climate Neutral Data Centre Pact* are establishing those rigorous standards today, and successes like companies already achieving carbon-neutral or even carbon-negative operations prove it's doable. Climate DPI will amplify and propagate these best practices, making green standards **the norm worldwide** rather than the exception.

In short, "Climate for AI" ensures the virtuous cycle: we use AI to help climate, and we align AI's growth with climate sustainability. This mutual reinforcement is crucial so that our solution (digital transformation) doesn't become a new problem. By proactively greening the digital revolution, Climate DPI not only helps mitigate climate change through tech, but also exemplifies the broader shift to sustainability in all infrastructure as envisaged in the Paris Agreement and SDGs.

5. Global Implementation Framework

Having outlined what a Climate DPI entails in terms of components and technologies, we now turn to **how to implement it globally**. This is a multi-faceted challenge: it requires international coordination (no one country can build a global DPI alone), careful design principles (to ensure openness, inclusion, security), alignment of diverse stakeholders, and integration with public policies. In this section, we propose a framework for global implementation, including governance structures, development and deployment principles, alliance-building, architectural approaches, incorporation into public policy, and capacity building for sustained impact.

5.1 International Governance

Implementing a Global Climate DPI calls for a strong **international governance** mechanism to steer the vision, ensure equity among participants, and maintain interoperability and standards. We propose a governance model anchored in the UN climate process (COP) but involving a broad set of partners.

Coordinated Oversight by COP30 and UN Frameworks:

We suggest that COP30 formally endorse the creation of a **Global Climate DPI Taskforce or Commission**, which will operate under the umbrella of the UNFCCC (United Nations Framework Convention on Climate Change). This high-level body would provide political mandate and oversight, signaling that Climate DPI is a globally agreed priority. It could report annually at COP meetings on progress. The COP30 President's recent call to strengthen global climate governance resonates here, he noted current efforts are fragmented and suggested exploring innovative governance approaches to empower rapid data and knowledge sharing. **A COP-sanctioned DPI framework is precisely such an innovation.** The UNFCCC and Paris Agreement bodies currently lack the mandate to implement digital infrastructure (as President Corrêa do Lago points out), so establishing a new instrument (a work programme or a subsidiary initiative) would fill that gap.

International Advisory and Technical Committees:

Under the Taskforce, we envision two supporting bodies: **an International Advisory Board** comprising senior representatives of governments (on a rotating regional basis), international agencies (UNDP, UNEP, WMO, World Bank, etc.), and non-state stakeholders (civil society, indigenous representatives, youth, private sector); and **a Technical Steering Committee** of experts in relevant fields (digital tech, climate science, data governance). The Advisory Board would ensure that the diverse interests and perspectives are heard, for example, making sure a small island state's needs for early warning systems are prioritized, or that principles of climate justice and data sovereignty are respected. The Technical Committee would handle the nuts-and-bolts of designing standards and architectures (subdivided into working groups e.g. on data standards, on digital ID integration, etc.). These bodies together can craft the blueprint and updates for the DPI, somewhat akin to how internet governance has bodies like ICANN or W3C for web standards.

Membership Criteria, Interoperability Protocols, Data Standards:

To make the DPI truly global yet also manageable, countries and organizations would "opt in" to participate. One might draw an analogy to the **Open Government Partnership** or similar, a voluntary coalition with certain commitments. **Membership criteria** could include agreeing to the core open principles of the DPI, committing to implement enabling policies (like open data policies, use of standards domestically), and contributing (financially or in-kind expertise) to the common effort. On the technical side, one first task is to define the **interoperability protocols and data standards** that all participants will adhere to. These will cover things like data formats for climate data (building on existing standards like ISO climate data standards, WMO standards for meteorological data, etc.), API specifications for how systems talk to each other, cybersecurity protocols for protecting sensitive data, and so forth. A useful strategy might be to adopt and extend existing standards rather than invent new ones wherever possible, to leverage what's already widely used. This governance body will likely need to negotiate some sticky issues: e.g., how to handle data that might be sensitive for national security (some countries consider certain satellite data sensitive), or how to respect **data sovereignty** (each nation's control over its data) while still pooling information globally. MOUs or event Treaties can clarify that sharing under the DPI does not infringe sovereignty but is for mutual benefit, with safeguards on use. The UN General Assembly might even play a role here, as President Lago suggested debating new governance models at that level. And certainly, a UN resolution could bless the Climate DPI and outline its basic principles.

Role of a UN Climate Change Council:

Brazilian President Lula proposed creating a **UN Climate Change Council** to help implement commitments. If such a council is established, it can also serve as a political steward for Climate DPI, ensuring it aligns with broader climate strategies and facilitating high-level problem-solving (like mobilizing funding or resolving international disputes over the system's use). Whether through that or via an extension of existing bodies (like making the Paris Committee on Capacity Building partly oversee digital capacity, etc.), we need a champion at the top level.

In summary, the governance structure for Climate DPI should marry **political legitimacy with technical capability**. It should be inclusive (all countries should have a voice, especially climate-vulnerable nations), but also agile (able to iterate technical standards faster than typical UN negotiations pace). One way to achieve agility could be to start with a coalition of the willing (countries that are ready to pilot the DPI components), formalize governance for that coalition, and keep it open for others to join as they become ready, eventually aiming for universal participation like the Paris Agreement.

5.2 International Governance

Building Climate DPI is not just about what we build, but how we build it. To ensure the infrastructure is effective, inclusive, and trusted, we need to adhere to key principles during development and deployment. We outline principles in areas of technology choice (open-source, standards), accessibility, and ethics.

Open-Source Technology and International Standards:

A foundational principle is that Climate DPI will be built predominantly with **open-source software** and will promote **open standards**. This aligns with DPI philosophy globally, openness ensures transparency (anyone can inspect the code for fairness or flaws) and avoids vendor lock-in, allowing countries to adopt without hefty licensing fees. Open-source also encourages a global community of developers to contribute improvements, which is ideal for something as broad as climate action. For instance, if the DPI includes a certain platform (say for managing carbon credits), its codebase should be open under a permissible license, and hosted in a public repository (with security best practices followed). We already see moves like UNDP hosting D4C's code on GitHub. International standards (like ISO, WMO, IEEE standards) will underpin interoperability. By committing to standards from the start, we ensure different modules and national systems can talk to each other. One example: adopt ISO 14064 for GHG accounting in any carbon management module, or using the OGC (Open Geospatial Consortium) standards for geospatial data services so maps and spatial data can integrate across platforms.

Accessibility, Universal Design, and Adaptability:

The DPI must be **accessible to all user groups**. This means user interfaces will follow universal design guidelines (e.g., support screen readers for visually impaired, use clear language for non-experts). The content should be multilingual, given we aim for global reach, key interfaces likely in the 6 UN languages at least, and easily localizable for others. The systems also need to account for varying levels of internet connectivity: a robust DPI will offer offline modes or low-bandwidth options (perhaps via SMS or radio bridging, as mentioned) for communities with limited connectivity. We have to avoid a scenario where only high-tech urban centers benefit and rural or underprivileged communities are left out. Otherwise, the DPI could inadvertently widen gaps. Therefore, **equity** considerations will be front and center. Adaptability refers to customizing solutions to local needs. Each country can adapt the modules to its context, e.g., integrate the digital ID module with its national ID, plug its local languages and data sets into the AI models. The DPI architecture will be modular to allow this (see section 5.4 on ClimateStack). We will also encourage co-creation: local developers and stakeholders should be involved in tailoring and improving the solutions, rather than it being a one-size-fits-all import.

Privacy, Transparency, Ethical Data Use

Given the sensitivity of some data (personal data in vulnerability databases, or land ownership details, etc.) and the power of AI, we must bake in strong **data privacy and ethical guidelines**. The DPI governance can establish a *code of conduct or data ethics charter*. For personal data, principles of the EU's GDPR or similar frameworks may be instructive (purpose limitation, consent, right to access, etc.). Privacy-by-design techniques will be used, e.g., data minimization (only collecting what's needed for climate purpose), anonymization or aggregation when sharing data widely (like sharing mobility patterns without personal identifiers). There will likely be **systematic legal and privacy checks** for the DPI components, an example from D4C governance: they specifically list code of conduct, legal/privacy checks, IP issues as areas to manage. Transparency is also key: decisions made by AI or automated systems in DPI (say, allocating funds or prioritizing areas for help) should be explainable and open to audit. For instance, if an AI model labels certain communities as high-risk and triggers certain actions, the basis for that should be documented to avoid biases or misinterpretation. We also want transparency of operations: the DPI's development process and finances should be open to scrutiny by participants, perhaps annual independent audits or open dashboards showing how funds are used, how data is flowing (without compromising security).

Security and Cyber Resilience:

This is an important principle, the systems must be secure against cyber threats. Climate data and systems could be targets (imagine a malicious actor altering data to cause panic or to hide their pollution). So DPI design will include strong encryption for data in transit and at rest, authentication measures (leveraging the digital ID layer), and a security governance (like a CERT team specifically for DPI). Given global coverage, it's critical to ensure resilience, redundancy in servers, backups, failsafe modes if part of network goes down (like a natural disaster ironically shouldn't knock out the warning system completely).

By adhering to these principles, we ensure the rollout of Climate DPI is **trusted and widely accepted.** The success of any public infrastructure depends on public trust, especially true for digital ones where issues of privacy or exclusion can cause backlash. If we can establish from day one that Climate DPI operates openly, respects rights, and invites collaborative improvement, it will garner the broad support needed for longevity.

5.3 Global Tech Alliance for Complementary Solutions

No single entity can provide all the pieces of Climate DPI. It requires harnessing the strengths of different players in the tech ecosystem. Here we propose creating a Global Tech Alliance for Climate DPI, a coalition of technology companies, cloud providers, service integrators, research institutions, and private foundations, dedicated to supporting and interoperating their solutions for the climate cause.

Alliance Involving Cloud Providers, Managed Service Providers, Global Tech Companies:

Major cloud providers (Amazon AWS, Microsoft Azure, Google Cloud, etc.) have enormous infrastructure and services that could be leveraged for Climate DPI (and many have their own climate initiatives). Similarly, telecommunications firms can aid with connectivity and IoT deployment, and hardware companies can contribute sensors and devices. By forming an alliance, we invite these actors to **align their offerings** with the DPI's needs rather than working in silos or at cross-purposes. For instance, they might agree on providing cloud credits or hosting for developing nations' climate data under certain terms, or ensure their IoT platforms support the common data standards of DPI so devices can plug into the global system easily. An alliance also fosters sharing of innovation: a tech company that develops a great AI model for flood prediction could share it through the alliance for others to adopt (perhaps even open-sourcing it as a digital public good, as some have done with COVID tools).

One key goal is **reducing deployment inefficiencies through interoperability and complementarity**. Often, multiple companies may offer similar services (like mapping platforms or data storage), which could lead to duplication if each country or project chooses differently and they don't talk to each other. With alliance coordination, they could ensure systems can exchange data (like agreeing on an API standard). If one company builds a platform for, say, climate-smart agriculture advisory, and another has a rural connectivity solution, the alliance can pilot integrated offerings (so the advisory service works even on basic phones through the telco's USSD services, for example). This complementarity is crucial especially in developing regions, where you want a package solution (connectivity, cloud, application) delivered efficiently.

Shared Technology Ecosystems to Avoid Fragmentation:

The Alliance could work like **a marketplace of climate digital solutions** that all adhere to DPI rules. Countries or organizations looking for solutions could come to the alliance pool and mix-and-match modules knowing they will fit together. Also, the alliance members would commit to avoid proprietary lock-in of climate data, e.g., if a certain company's satellites collect data, they commit to sharing core data openly (perhaps with basic cost recovery) via the DPI network, not siloing it. We've seen similar alliances in other domains: e.g., the ***Global Alliance for Vaccines and Immunization (Gavi)*** where pharma companies, governments, and NGOs coordinate on immunization. Here, it's for climate tech.

Additionally, a global tech alliance could coordinate **capacity-building** contributions (like training programs, tech support) by tech companies. Many companies have corporate social responsibility projects for environment. Aligning them under the DPI umbrella can direct their efforts where most needed and avoid overlaps. For example, multiple companies might be willing to help set up data labs in developing countries, through the alliance they can coordinate so every region gets support without some being over-targeted and others neglected.

The alliance also provides a forum to discuss **standards and innovations**. Tech companies are often ahead in developing new tech, through the alliance, they could propose new features to integrate into DPI (like a new satellite product or AI tool) and get feedback from the global community early, then iterate in a collaborative way. It's essentially bridging the gap between corporate R&D and global public sector needs.

From a governance perspective, this alliance would likely liaise with the DPI's formal governance. Possibly, the alliance is akin to a *private sector advisory group* to the main DPI initiative. It can convene regularly, share progress, make joint pledges (like at COPs, companies might collectively announce how they're supporting Climate DPI with in-kind resources or aligning product strategies).

Example, CODES & AI for the Planet:

We actually have emerging multi-stakeholder groups like the **Coalition for Digital Environmental Sustainability (CODES)**, which is co-championed by UNDP, or the **AI for the Planet Alliance** that bring together tech entities around environmental issues. These can be built upon or integrated into the wider alliance. They demonstrate appetite among tech players to coordinate on environment issues. The DPI alliance would be more implementation-focused (less about advocacy, more about delivering interoperable solutions).

Interoperability & Reducing Inefficiencies Example:

If ten countries all need a climate data platform, it's inefficient if ten different integrators each build one from scratch, possibly incompatible. Instead, the alliance might support a *white-label climate platform* that can be adapted to each but has core modules standardized. Companies can then focus on customizing or adding value on top rather than reinventing base layers. It's better business for them too, they can offer services on a stable base rather than compete on making the base itself (a bit like how companies innovate on the internet rather than each making a new internet).

Public-Private Partnership at Scale:

This alliance essentially formalizes a global public-private partnership for climate digital infrastructure. Each sector brings what it does best: the public side sets the mandate, ensures equity and public good orientation. The private side brings efficiency, innovation and investment. Academia and civil society bring domain knowledge, oversight, and community connection. This multistakeholder approach is a recipe for effectiveness.

In summary, the **Global Tech Alliance** ensures that the immense capabilities of the tech sector are marshaled in a coordinated, non-duplicative way to serve Climate DPI objectives. It aligns incentives by creating shared value: companies see new markets and goodwill, countries get cutting-edge tech faster and cheaper, global goals are advanced. It's a win-win approach crucial to scaling up quickly, because climate timeframes are tight and we cannot afford years of fragmentation or proprietary battles that slow progress.

5.4 ClimateStack: Modular DPI Architecture

To implement the Climate DPI effectively across diverse contexts, a **modular, layered architecture** is essential, one we dub the **"ClimateStack," inspired by the success of IndiaStack and proposals like EuroStack for digital sovereignty.** This subsection outlines how ClimateStack would be structured in layers and modules, providing flexibility and scalability.

Inspired by EuroStack and Other Layered Frameworks:

The idea of a "stack" is to break down a complex system into layers, each providing certain functionality and able to interface with the others through defined protocols. The EuroStack concept envisions an EU-wide digital infrastructure built on common platforms, data spaces, standards, etc., to ensure interoperability and sovereignty. We apply a similar philosophy globally for climate: a stack with defined layers (as touched upon in section 3 with identity, payments, data, etc.). ClimateStack's layers might be:

Infrastructure Layer:

This is the foundation, the physical and network infrastructure (data centers, cloud services, networks) that the DPI runs on. It would involve both global cloud backbone (through the alliance with cloud providers) and national infrastructure. Key aspects here are computing power, storage (for big data like satellite archives), and connectivity (broadband, mobile, satellite internet especially for remote areas). We ensure at this layer that green principles are applied (energy efficiency, etc., per section 4.6).

Core Data/Service Layer:

This corresponds to core "protocols" or utilities, digital ID system, payments rails, data exchange middleware, earth observation data hub, AI models repository, etc. Think of it as the set of **common services** any climate application can call upon. For instance, a climate finance app can call the payments API to disburse funds or the ID API to verify a user, or a mapping app can call the geo-data API to retrieve latest satellite imagery. This layer includes data catalogs (with metadata standards), interoperability middleware (like the GEOSS broker concept, which might be part of this). This is the heart of interoperability, so designing it modularly is key. Each module can be developed somewhat independently (e.g., the digital ID module could be built by one team and the satellite data integration module by another), as long as they adhere to open and interoperable interfaces.

Application Layer:

On top of the core services, the application layer comprises specific end-user applications or sectoral solutions. For example, a climate-smart agriculture advisory app, an urban heatwave alert mobile app, a carbon credit marketplace web portal, a national climate dashboard for policy makers, all these are applications that utilize the core services beneath. This layer is where innovation by various parties (governments, startups, NGOs) happens, customizing to local needs. Because they use the common layer, they don't need to solve identity or data integration from scratch. They focus on functionality and user experience. If built modularly, someone could compose an application by assembling several modules from a library (like Lego blocks, as UNDP's puts it: "DPI to Lego blocks").

User Interface Layer:

Sometimes considered part of application, but we can separate to emphasize multi-channel access. This ensures that the services are delivered via web, mobile apps, SMS, voice assistants, radion networks etc., with localized languages and appropriate UI/UX for different users (citizens vs. analysts vs. officials).

Each layer has defined **APIs and standards** for interfacing with the layer above or below. For instance, the data layer might expose an API for retrieving climate indicators, which the application layer calls. Or the payments layer has an API for initiating a payment to a verified ID.

Layered, Modular Framework Ensures Flexibility and Scalability:

The big advantage of modules is **replaceability and upgradeability**. If a better technology comes along for, say, digital identity (or a country wants to use its own), as long as it adheres to the interface specs, it can be swapped in without breaking the whole system. It also means pieces can be added over time. Perhaps initially not all envisioned modules are ready; we might start with a few core ones and add others in medium-term. The EuroStack proponents mention the need for common services and guiding principles like interoperability, decentralized structures, etc., which we echo. A modular system can also scale horizontally, if one module (like data storage) needs expansion, we add more servers or cloud instances without affecting other modules. If usage skyrockets in one country, it can locally scale that component.

Example of Modular Use:

Suppose a country has already a good national meteorological system but lacks a carbon registry. It could plug its meteorological data feed into *the ClimateStack* data layer (so others can use it too, and it receives global data to augment its info), but for carbon, it could adopt the DPI's carbon registry module entirely. Another country might have a payments system but no digital ID. The country might integrate their payments but adopt the DPI's federated digital ID solution to identify farmers in a climate subsidy program.

EuroStack-like Approach for Integration:

EuroStack calls for a fully integrated digital ecosystem for Europe with transnational structures. ClimateStack similarly implies *some transnational digital infrastructure*. We will host certain global services centrally (e.g., GEOSS portal is a central global service, or CAD Trust as a global service). At the same time, we incorporate a **federation**, meaning each country might run instances of some modules (like a national data platform that connects to the global one). This is similar to how the internet has central protocols but distributed servers. The ClimateStack might have, say, a Global Climate Data Catalog plus national nodes that sync with it. This layered structure allows distribution and at the same time respects that some data or processes may stay national for policy reasons (but metadata or results shared globally).

Modularity Aids Participation:

Countries can adopt ClimateStack gradually, module by module, depending on readiness. If a country already has part of the stack in place, they just ensure compatibility and integrate it. If not, they deploy the reference module provided by the DPI. It's akin to how countries adopted elements of IndiaStack, some started with digital ID, then added payments, and so on.

Security and Maintenance:

Each module can be maintained/upgraded by either different teams or designated hubs (one country or institution can lead the development of one module on behalf of all). This spreads the work and expertise needed. It also isolates issues: a bug in one module can be fixed without needing to overhaul others. However, we need strong coordination to ensure modules keep compatible as they evolve (an **architecture review board** under the technical governance group would oversee changes).

Analogy with IndiaStack:

IndiaStack, which revolutionized India's digital ecosystem, had multiple layers: presence-less layer (Aadhaar ID), paperless layer (digital documents, eSign), cashless layer (UPI payments), and consent layer (data sharing framework). ClimateStack similarly might have a **Data layer (public data goods), Service layer (APIs like identity, payments), Solution layer (like digital MRV for carbon, or digital verification for adaptation projects)**, and a **Consent/ethics layer (ensuring proper data sharing)**. By naming and structuring these clearly, stakeholders know where to contribute and what to adopt.

Summary:

ClimateStack provides the blueprint that ties everything together. It ensures that while lots of moving parts are developed by different actors (public agencies, private companies via the alliance, etc.), they all fit neatly into a predetermined architecture. This drastically **reduces the complexity** of global deployment, because everyone sees how their piece connects to the whole. It's akin to constructing a building with a clear architectural plan, contractors may handle different parts, but the blueprint ensures it becomes one building, not a disjointed mess. Our building is a global climate resilience and action infrastructure, and **ClimateStack is the blueprint that will make it a reality**.

5.5 Global DPI Strategy as Public Policy

For Climate DPI to truly take root and be sustainable, it must be embraced as a core element of public policy in nations around the world, not just as a one-off project or external system. In this section, we discuss how integrating Climate DPI into national climate strategies and digital strategies can be achieved, and what policy instruments can facilitate its implementation. We also highlight the need for global policy alignment.

DPI as Core National Climate Policy Strategy:

Countries should start seeing **digital public infrastructure as a strategic asset for climate action**, the same way they consider power grids systems crucial for national well-being. This means including Climate DPI initiatives in national climate change plans (NDCs or National Adaptation Plans) and infrastructure development plans. For instance, a country updating its NDC in 2025 could add a section: “We will deploy a National Climate Digital Platform (as part of global Climate DPI) to enhance transparency and effectiveness of our mitigation and adaptation actions.” This could even be one of the measures by which they meet targets (e.g., by improving data, they identify 10% more emissions reductions opportunities, etc.). Similarly, national adaptation plans could list establishing early warning systems via DPI as key goals. There is precedent: countries often **mention improving meteorological services** or data systems as part of adaptation needs. **Now we frame it in DPI terms.**

Policymakers should view spending on digital infrastructure for climate not as a tech luxury but as a climate necessity, akin to building sea walls or funding renewable plants. Politically it can serve both modernization goals (digital transformation) and climate-proofing the nation. Investing in DPI strengthens a country’s resilience by reducing barriers to essential services, and climate services can be among those. Ministries of Environment and of Technology/Telecom need to collaborate on joint programs (which historically have not so far usually intersected).

Steps and Policy Instruments for Strategic Implementation:

To adopt Climate DPI at policy level, several steps and instruments come into play:

Legislation /Regulation:

Governments might pass laws or regulations mandating open data for climate, interoperability standards adoption, or recognizing digital versions of documents (like digital MRV records as legally valid). The Open Government Partnership is a useful analogy here. For instance, a regulation that all climate projects receiving public funding must register in the national climate DPI database (to ensure transparency and linking to international systems). Or, a data-sharing policy that allows private telecom data to be used by government for climate risk analysis under certain conditions (addressing data philanthropy as policy).

Institutional Setup:

Assign a lead agency or task force domestically to implement Climate DPI. Some countries might integrate it into their e-government agency's mandate or set up a special Climate Innovation Unit. The policy may define roles: meteorological service for data feeds, central bank for the payments link, etc. It ensures cross-sector collaboration.

Funding and Incentives:

Include budget lines for Climate DPI in climate finance proposals and domestic budgets. Governments can offer incentives (tax breaks, grants) to companies that align with DPI standards or contribute (for example, telecom companies that expand coverage for early warning systems could get some support). They could also tap into international climate finance, the Green Climate Fund or Global Environment Facility might fund enabling technology, so writing strong proposals that tie DPI to concrete outcomes will be needed. The report can encourage multilateral climate funds to explicitly create windows for digital infrastructure projects.

Policy Alignment with Global Standards:

The national policies should align with the global guidelines set by DPI governance. If global governance says "we recommend using X data standard for inventories," national policy should reflect that, instructing agencies to adopt X. Aligning yields easier integration and access to global support. There may be a need for new types of policy as well: e.g., a **climate data governance policy** ensuring that critical datasets (like building infrastructure maps, emissions data from industry, etc.) are collected and updated as digital public goods. The UN DRR and others encouraged strategies to promote open-source and interoperable software in government, climate policy can adopt that approach too.

Recommendations for Global Policy Alignment and Adoption:

Internationally, organizations like UNDP, World Bank, etc., can help by issuing guidance notes or toolkits to governments on incorporating DPI into climate strategies. For instance, the **Digital Public Goods Alliance** and others might provide frameworks. The policy alignment also extends to ensuring climate finance *mechanisms* encourage DPI. For example, the Article 6 rules (carbon trading) under the Paris Agreement could encourage use of common digital infrastructure for transparency, that aligns nations to invest in it rather than separate systems.

One key recommendation is to treat **DPI as climate adaptation capacity.** If the UNFCCC and donors start counting robust information systems and early warning as adaptation efforts (which they are), it will push more investment there. For mitigation, robust digital MRV is key to higher integrity markets, policy should mandate that no credits get approval without going through digital MRV (where available).

Finally, aligning globally means peer learning. We can incorporate a peer review or peer assistance mechanism under which countries share policy experiences implementing DPI (like how OECD does peer reviews on digital government, or the Paris Agreement's transparency framework fosters sharing of how policies are working). If one country faces a barrier (legal or institutional), others that solved it can advise. This communal progress will accelerate overall adoption.

In sum, making **Climate DPI a public policy priority** means weaving it into the fabric of climate governance at all levels, backing it with laws, budget, and oversight. When countries start "owning" it, setting targets like "100% of population covered by climate digital services by 2030", then we'll know it's truly embedded in policy. That's the endgame: the DPI is not a project, but an ongoing public service and strategic infrastructure, much like the power grid or education systems, nurtured and advanced continually by policy.

5.6 Capacity Building & Technology Transfer

For many countries, especially developing nations, a key challenge will be the **capacity to implement and utilize** the Climate DPI. We must ensure robust capacity building and technology transfer mechanisms so that all countries, regardless of their starting point, can fully participate in and benefit from this global infrastructure. This section outlines approaches for human and institutional capacity development, cross-country collaboration, and public-private partnerships to drive effective DPI deployment and use.

Global Training and Technical Capacity-Building Programs:

A Climate DPI Academy or capacity program could be established, possibly led by institutions like UNDP or UNITAR. It would offer training in multiple languages and formats (online courses, workshops, on-site trainings) on various aspects: how to set up national climate data platforms, using DPI tools for disaster management, maintaining digital systems, data analysis skills, etc. We need to train both the technical implementers (software engineers, data scientists) and the end-users (planners, emergency responders, project managers) in these new digital tools. For example, meteorological service staff might need training to integrate AI models into their forecasting workflow. Local government officials might need training to interpret early warning dashboard information and take action.

Capacity-building must be continuous, not one-off. A **Climate DPI Knowledge Portal** should be kept with updated tutorials, code libraries, documentation, case studies of successful implementation. We might also implement a global helpdesk or peer network (if a country has an issue deploying a module, they can reach out to experts in another country or at the central team for help). The concept of **"Triangular" cooperation** can be leveraged: many developing countries have innovated relevant solutions (like Ushahidi from Kenya, MapBiomas in Brazil, etc.), and their experts can train others. UNDP's mention of scaling up digital solutions via south-south cooperation aligns here, for instance, if an African country has a great community climate informatics program, share it with peers via DPI channels.

Cross-Country Collaboration and Knowledge Sharing:

Building on that, creating communities of practice around each component can help share knowledge. For instance, a network of "Climate DPI Data Managers" from each country that meet virtually to share experiences on data governance, or a network of "AI for climate practitioners" exchanging models and tips. Annual or biannual global forums (maybe alongside COPs or separately) could convene practitioners to showcase progress, troubleshoot challenges, and foster collaboration. We might incorporate this into existing climate-related capacity frameworks, like the Paris Committee on Capacity-Building (PCCB) which could host sessions on digital capacity for climate.

Partnering with established engineering bodies such as the World Federation of Engineering Organizations (WFEO), IEEE, ASCE, and Engineering for Change can enable technical and operational expertise needed for deployment. These organizations maintain global networks that connect engineering institutions, universities, and professional societies, providing ready-made channels for knowledge transfer. For example, WFEO's committees on disaster risk management and environmental engineering can convene multi-country working groups to adapt DPI modules for diverse geographic and climatic contexts. IEEE's standards-setting processes can help harmonize interoperability protocols across national deployments, ensuring that systems built in one country can seamlessly integrate with those in another. Through these collaborations, countries can avoid duplicating effort, shorten deployment timelines, and align their technical choices with proven global best practices.

Beyond standards and technical design, these partnerships also facilitate **hands-on, peer-to-peer technical assistance**. Initiatives like Engineering for Change's fellowship programs or ASCE's collaborations with national engineering associations can be mobilized to embed experts in-country for system rollout, training, and troubleshooting. This approach supports **triangular cooperation**, allowing engineers and practitioners from countries that have successfully implemented specific DPI components, such as digital MRV for carbon markets or IoT-based early warning systems, to directly mentor teams in other nations. Such exchanges not only transfer knowledge but also build trust, creating a shared sense of ownership over the infrastructure. By structuring this collaboration around professional engineering networks, the Climate DPI can become a living, evolving system, continuously improved by contributions from diverse actors, while maintaining a coherent, interoperable core that serves the collective climate mission.

We should also facilitate **technology transfer** from more advanced to less advanced contexts. That includes not just software but hardware (some countries might need provision of sensor equipment, servers, etc.). International partnerships can sponsor equipment for LDCs or small islands (like providing a package of weather stations or computing clusters for climate data). There are precedents like WMO's programs to donate weather equipment or UNESCO's support for establishing data labs.

Public-Private Partnerships (PPPs) for Effective DPI Deployment:

PPPs can be very valuable in capacity building. For example, a tech company might volunteer experts to help a country configure the DPI systems (similar to how some companies deploy teams for humanitarian tech missions). We can have a "surge" roster of tech professionals, akin to how humanitarian agencies have rosters of experts deployable after disasters. Here, they'd deploy to set up systems or train local teams. Also, companies can invest in local digital innovation hubs focusing on climate (some nations have innovation labs, we can orient some to climate and DPI). These hubs could incubate local startups or solutions that plug into DPI, simultaneously building local expertise and customizing solutions.

Education and A
cademic Involvement:

Over the medium term, incorporate climate informatics and digital public infrastructure topics into university curricula. If universities produce more graduates who understand both climate and digital, that sustains capacity. International research collaborations can be encouraged (e.g., a network of universities working on open climate solutions, feeding into DPI as digital public goods, or students contributing to open-source development as part of projects).

Local Empowerment and Community Training:

Capacity building shouldn't stop at national officials. Many climate actions occur at community level. We should include programs to train community leaders, NGOs, and local users. For instance, train Red Cross volunteers and local government staff on using crowd-mapping tools or early warning apps integrated with DPI. Or train farmers' cooperatives on how to make use of climate advisories from DPI data. UNDP's mention of empowering local actors with novel data, citizen science, knowledge sharing resonates, DPI can disseminate knowledge widely but people must know how to act on that knowledge.

Measuring Capacity Progress:

We might develop some metrics or maturity models. For example, assessing a country's climate digital capacity before and after DPI involvement, number of trained personnel, frequency of data use in planning, etc. This helps target capacity efforts where needed most and justify funding.

Technology Transfer Mechanisms:

Possibly formalize something like “Digital Climate Technology Transfer Initiative” under UNFCCC (similar to the framework that exists for clean energy tech transfer). This could ensure developing countries get the necessary tech. Patent or IP issues for climate tech might arise, but since DPI pushes open-source, we mitigate a lot of that. However, if some advanced AI model is proprietary, we'd encourage making a version available to poorer countries (maybe via license or CSR donation).

Role of International Finance in Capacity:

Implementation grants from bodies like the GEF or Adaptation Fund can include budgets for training and tech transfer. Ensuring those available funds include digital capacity is important. The Joint SDG Fund has funded some digital initiatives. Climate funds should too.

Peer Example:

A success example is WMO's work on multi-hazard early warning where they pair up met services from developed and developing countries for training and system setup. We can emulate that across the board: e.g., Estonia (famous for digital governance) might partner with some countries on digital ID for climate beneficiaries. India could share how they built their DPI (like how Aadhaar and UPI might inspire climate analogous systems, e.g., KYC for carbon credits to avoid double registration).

In summary, the motto for capacity building **is "Leave no one behind"** digitally. All countries, communities, and sectors need to have the skills and tools to use Climate DPI effectively. Otherwise, the infrastructure could be world-class but underutilized. By investing in human capital and institutional know-how, we ensure the DPI truly results in *actionable* climate benefits. And by encouraging technology sharing, we speed up the deployment globally rather than each place reinventing the wheel. Over time, the goal is self-sufficiency, local tech ecosystems flourish around the DPI, creating a virtuous cycle of innovation and capacity.

6. Cost Estimates and Financing Model

Building a global Climate DPI is a significant undertaking that will require substantial investment. This section outlines **cost estimates** for developing and maintaining the infrastructure, and proposes a **financing model** to mobilize funds from various sources and ensure long-term sustainability. All figures at this stage are high-level estimates to guide discussion. Detailed costing would follow feasibility assessments.

Comprehensive Budget Estimates:

Based on analogies with large-scale digital and climate initiatives, we can begin to frame the magnitude of investment needed. The **digital infrastructure component** (hardware, software development, cloud services, etc.) for a global platform linking nearly 200 countries over a decade could run in the order of several **billion US dollars**. For context, the EU's EuroStack transformation (focused on EU digital independence) was estimated at approximately €300 billion over ten years, but that includes massive industrial investments like semiconductor plants. Climate DPI, being more about software, data, and less about hardware, would be far less. A rough comparison might be India's digital ID and payments infrastructure which cost a few billion to roll out nationwide. If we consider global scale, including supporting many lower-income countries with tech upgrades, a preliminary ballpark could be **$1–2 billion** initial investment over 5 years to set up core systems and support national implementations, followed by ongoing operational costs perhaps on the order of a few hundred million per year (for data updates, cloud hosting, staffing global coordination, etc.). Additional investments may be needed at country level for complementary infrastructure (like sensors, local data centers), which could be another few billion spread across countries, potentially integrated into their climate project budgets.

To break it down:

Global Coordination & Platform Development:

establishing governance bodies, designing and building core modules (identity integration, data exchange, AI services, etc.), global cloud infrastructure, could be around $300-500 million initially.

National Implementations Support: : say we aim to help approximately 100 developing countries implement DPI components (with hardware, localization, training) at an average of $5-10 million each (some less, some more) = $500-800 million.

Earth Observation & Data Systems: : expanding satellite data access, building data centers or storage networks, leveraging existing climate observation instruments, could be a few hundred million. Though satellites can be very expensive, we should rely mostly on existing ones and account for the costs in ground segment and analysis tools.

Capacity Building & Change Management: training programs, technical assistance = maybe $100-200 million over a decade (a lot of training could be done leveraging existing budgets of agencies like UNDP, but some dedicated funds help scale it).

Contingency and Innovation Fund: A buffer for emerging needs or to seed innovative solutions = e.g. $100 million.

Summing these rough figures we land around approximately $1.5-2 billion initial across first several years.

It is worth noting that while these numbers are large, they are not unreasonable compared to other climate expenditures. For comparison, a single large infrastructure project like a major sea wall or a coal plant transition can cost billions. Here we are building a system potentially benefiting all sectors and countries. Also, preventing climate damage via better info can save multibillion costs down the road (for example, better early warnings can greatly reduce disaster losses).

Financial Requirements for Long-Term:

Long-term, after initial development, an ongoing **sustainable funding mechanism** will be needed. If we treat Climate DPI as global public infrastructure akin to how global health or humanitarian efforts are funded, we could anticipate needing something like $100-200 million per year beyond 2030 for continued operations, expansions and updates. This would cover continuous improvements (like updating AI models, adding new technologies), operational cloud costs (though hopefully allying with cloud providers might donate a portion), and supporting countries that need help in using the system. That is relatively small compared to, say, the over $100 billion/year climate finance that developed countries have pledged to mobilize. Directing a fraction of climate finance to enabling infrastructure yields high leverage on the effectiveness of the rest

Potential Funding Sources:.

International Climate Funds:

The Green Climate Fund (GCF), Global Environment Facility (GEF), Adaptation Fund, etc., can allocate portions of their funding to Climate DPI projects. They often fund capacity building and technology for MRV and adaptation planning. GCF, which has $10+ billion pledged, invest say $200 million specifically in global digital infrastructure that will benefit all projects by improving data and efficiency. Similarly, multilateral development banks (World Bank, regional development banks) could incorporate DPI into their climate investment portfolios, especially in financing digital components of their climate projects.

Bilateral and Multilateral Aid:

Many developed countries provide climate-related aid and also digital development aid. We could see a coalition of donor governments fund a trust fund or a dedicated program for Climate DPI. E.g., countries like Germany, UK, France, Japan, China, etc., might chip in via development agencies or through joint initiatives like Mission Innovation (for climate innovation) or the Climate Ambition Agenda. A target could be raising an initial pool of a few hundred million from such donors, possibly announced at COP30 or similar as part of global solidarity on tech transfer.

Public-Private Partnerships and Philanthropy:

Major tech companies and philanthropies (such as the Gates Foundation, Rockefeller Foundation, etc.) could contribute. We already see involvement: the DPI for People & Planet challenge was partnered with Gates Foundation, BCG, etc. Philanthropic capital could fund high-risk or innovative parts of DPI. Tech companies might provide in-kind contributions worth significant sums: free cloud credits (Microsoft, Google have pledged carbon-related computing grants in the past), engineering manpower, discounted hardware. The private sector might also invest if there is some return model, but given DPI is public-good oriented, we might rely more on CSR and philanthropy than expecting profit-driven investment.

Domestic Budgets and Co-financing:

Each country should ideally invest some of its own resources (especially middle and high-income countries). This ensures local buy-in. They might allocate budget for hardware upgrades or staff for the DPI. Perhaps we require co-financing: e.g., a funding model where for every $1 from international source, the national government or private sector provides $0.3 (or more for richer countries). Some large emerging economies might fund a lot themselves and even contribute globally (for instance, India or China might incorporate some of their systems or share data at their own cost because it benefits them too in leading).

Climate Markets and Innovative Finance:

It's conceivable to tap carbon market revenues (like a small levy on trades or an "ITMOs fee" under Article 6 that goes to funding transparency systems). The UNFCCC's adaptation fund gets a share of proceeds from carbon credits. Similarly, a tiny fraction of voluntary market transactions could be voluntarily directed to DPI upkeep since it greatly enhances market integrity. Innovative finance might also include green bonds specifically for digital climate infrastructure or integrating it into resilience bonds. A precedent for sustainable financing of a global digital public good can be seen in the **Internet Society (ISOC) model**, where the stewardship of the *.org* domain through the Public Interest Registry generates a stable revenue stream reinvested into global internet development, capacity building, and policy work. Another instructive example is **the World Intellectual Property Organization's (WIPO) Madrid System for the International Registration of Marks**, where revenues from registration and renewal fees directly fund the administration and expansion of the global IP framework. Both models show how mission-aligned services can generate predictable funding that sustains critical infrastructure without reliance on intermittent donor support. The Climate DPI could adopt a similar approach, creating a **self-financing loop** by applying a micro-levy to climate-related transactions—such as a fractional fee on Internationally Transferred Mitigation Outcomes (ITMOs) under Article 6, voluntary carbon market trades, or other verified climate services. This mechanism would ensure that the very activities benefiting from the DPI's transparency, interoperability, and verification functions contribute to its upkeep. Over time, this could become a primary funding stream, guaranteeing that the Climate DPI remains robust, up-to-date, and universally accessible, while insulating it from the volatility of short-term grants and political budget cycles.

Sustainable, Long-Term Financial Support Strategies:

To avoid donor fatigue or short-termism, we could institutionalize funding streams. For example, perhaps a portion of the international climate finance goal (say 1-2%) is earmarked for enabling data/technology infrastructure. If $100B/yr materializes (as per developed countries' pledge), 1% would be $1B/yr, more than enough for DPI upkeep. This could be formalized through COP decisions or through development banks' policy.

Another strategy: after initial heavy investment, the system might yield cost savings in other areas (e.g., streamlined MRV reduces cost of carbon credit issuance, early warnings reduce humanitarian aid needed). These savings can be quantified and a share reallocated to fund the system, a kind of "prevention pays for itself" model. For instance, countries could agree that money saved from reduced disaster losses (which is tricky to allocate though) or efficiency gains in climate projects could be partly reinvested in keeping the data systems state-of-the-art.

Private Sector Models:

Some services might generate revenue. For instance, while basic data is free, value-added services (like specialized analytics for a corporation's risk management) might be provided at a fee by third parties, who then contribute some of profits to maintain the underlying infrastructure that they use. We have to be careful here: we don't want to privatize essential data, but a hybrid model where open data is base and premium analysis is a paid market could indirectly sustain an ecosystem.

Global Fund or Trust Mechanism:

We might set up a **Climate DPI Fund** managed by an institution (like a World Bank trust fund or UN Multi-Partner Trust Fund) where various contributors can pool money and allocate according to an agreed work-plan. This ensures coordination and that one country can support another via a common fund rather than bilateral scatter.

Conclusion on Financing:

The overarching message is **that investing in Climate DPI is cost-effective**. The costs, while in the billions, are a tiny fraction of global climate investment (which needs trillions for mitigation and adaptation). And it amplifies the impact of those trillions by reducing waste, targeting actions better, and building trust (which encourages more investment). Thus, the financing aspect can be that every dollar spent on climate digital infrastructure could unlock or save multiple dollars in climate outcomes. It is worth emphasizing also how it supports transparency and accountability for climate finance, donors often like to fund projects that improve oversight.

We will refine these estimates as the initiative progresses and ensure transparency in cost usage, to maintain donor confidence. The financing plan should also have an exit or evolution strategy: initial heavy subsidy shifting over time to more self-sustaining or integrated budgets (especially as developing countries grow their own economies, they can bear more of the maintenance cost later).

7. Implementation Roadmap

We have laid out the vision, components, and frameworks for a Global Climate DPI. Now we present a time-bound roadmap for implementing this vision, broken into short-term, medium-term, and long-term phases. This roadmap outlines key milestones and deliverables at each stage, recognizing that building such an infrastructure is a progressive journey requiring iterative development, scaling, and refinement over a decade.

Short-term (1–2 years): Initiation and Pilots

Governance Establishment (by COP30 and immediately after):

In the next year, formalize the governance structure. COP30 (2025) should pass a resolution or decision establishing the Climate DPI initiative, mandate the formation of the International Taskforce/Steering Committee, and invite participation from nations and partners. By mid-2026, these bodies (Advisory Board, Technical Committee) should be operational, with terms of reference and initial workplans. A small secretariat (possibly hosted by UN Climate Change or a partner like UNDP) would be set up to coordinate.

Global Standards and Protocols Development (Year 1):

The technical working groups will immediately start drafting the **interoperability standards** for Climate DPI (data formats, API specs, security protocols). By end of 2026, we aim to publish a first edition **"Climate DPI Standards and Guidelines"** document for use by all participants. This would incorporate existing standards or adapt them, and where gaps exist, propose new ones.

Launch of Priority Pilot Projects (2025–2027):

Identify a set of pioneer countries or regions to pilot key components. For example:

- A group of climate-vulnerable developing countries (maybe an island state like Fiji, a least developed country like Nepal, etc.) volunteer to pilot the **real-time risk monitoring and early warning system** integration. By 2026, they deploy PRISM-like dashboards linking local data to global satellites.
- A couple of countries with active carbon markets (e.g., Chile, Senegal under Article 6, etc.) pilot the **Digital Carbon Registry & CAD Trust integration**, issuing some credits

through the new digital workflow. Aim to demonstrate by 2027 that a transaction can go from project to international trade purely through DPI modules.

- A major city or two (perhaps one in the global north, one in global south, such as Rio de Janeiro) pilot the **AI for urban climate resilience** component, setting up smart planning tools for heatwaves and floods by 2027, and share results.

These pilots will yield lessons on technical adjustments and capacity needs. Crucially, by showing early wins, they build momentum and confidence

Initial Data Integration (2026–2028):

Early in the process, begin integrating existing global data systems. By 2027, we want the Climate DPI portal to provide one-stop access to some **low-hanging major datasets**: e.g., a global climate data catalog combining WMO's weather data exchange, key satellite data from NASA/ESA (through GEOSS), and a repository of Nationally Determined Contributions (NDCs) and other climate plans. Even if it's basic at first, having a functioning portal demonstrating interoperability of, say, 10 major databases will be a tangible outcome.

Capacity Building Kickoff (2025–2027):

Stand up the training program. By 2026, host at least one international **training workshop** or "hackathon" in each region to familiarize tech communities and climate practitioners with the DPI tools available (maybe using what's developed from pilots). Also develop e-learning modules by end of year 2. Aim to have at least 500 people trained (undar a "train-the-trainer model") by 2027 across various countries.

Medium-term (3–5 years): Scaling and Integration

Scale Implementation to Global Adoption (2028–2030):

Based on pilot successes, roll out Climate DPI components to a wider set of countries. The target could be that **by 2030, at least 100 countries have adopted core DPI modules** (like participating in the global climate data network, using digital MRV for their climate reporting, etc.). This will be facilitated by regional deployment teams. For example, Africa could have a regional support center (maybe at African Union or UNECA) helping African nations integrate DPI, similarly for Asia, Latin America. These regional hubs can coordinate with the global team.

Full ClimateStack Deployment (by 2030):

By year 5, aim to have the **ClimateStack architecture implemented** in a comprehensive way. This means the majority of layers and modules described are live: e.g., a functioning global digital ID interoperability for climate (or at least the framework for it linking major national IDs, such Aadhaar in India, or Gov.br in Brazil), a live global climate finance tracking system (with at least the multilateral climate finance flows on board), and an operational AI-driven early warning system accessible to all. In EuroStack terms, this is when our "digital ecosystem for interoperable services" is in place. Milestone could be, for instance, the **Global Climate Risk Early Warning Service** is used by 80 countries and covered, say, 1 billion people with improved warnings by 2030 (in line with the UN's call to ensure everyone is protected by early warnings).

Policy Integration and Institutionalization (2028–2030):

By 5-year mark, many countries should have institutionalized DPI in their climate governance. We expect to see, by 2028, multiple updated NDCs referencing use of Climate DPI to enhance ambition or MRV, countries establishing permanent units for climate tech in environment ministries, etc. Possibly by COP32 or COP33, have a special report showcasing how Climate DPI improved transparency in the first Global Stocktake (which happens 2028), e.g., **countries could submit parts of their reports via the DPI platform.** Another marker is that UNFCCC processes may formally integrate DPI outputs (like using the CAD Trust data for their Article 6 database or using DPI for the transparency framework reporting tools).

Mid-term Evaluation and Tech Upgrades (around 2029):

Conduct a comprehensive review in year 5 to assess what's working and what needs improvement. Use this to plan next innovations (maybe integrating more IoT networks or deploying new AI algorithms that emerged). Tech is fast-moving, so by 2030 we might incorporate, say, next-gen climate models or quantum computing outputs for climate into the DPI, those possibilities keep it cutting-edge.

Global Adoption of Standards (2028):

Hoping that by this time, major emitters and data contributors are on board with standards, e.g., the G20 or others endorse the Climate DPI standards for MRV, meaning pretty much global emissions tracking moves to the new digital norm, or WMO might embed DPI's data sharing approach in its global systems. Another milestone could be that the private sector widely uses DPI: e.g., supply chain platforms using DPI nature data to ensure deforestation-free sourcing by 2030.

Long-term (6–10 years): Universal Deployment and Evolution

Universal Deployment by 2035 (target):

The goal is that within about a decade**, every country and key stakeholder** is plugged into Climate DPI in some form. That means even the smallest and least developed have access (through capacity building and support) to early warning info, to digital climate finance systems, etc. We might set a concrete target: by 2035, 100% of countries have put in place national climate information systems interoperable with the global DPI. Or 90% of global population is covered by advanced climate services enabled by DPI. "Universal" also means multiple sectors: not just environment ministries, but agriculture, energy, urban planning sectors in countries are regularly using DPI data and services in their work.

Technology Upgrading and Maintenance:

Long-term success will require continuous modernization. Maybe by 2030s, new tech like next-generation Earth observation (like hyperspectral satellites, constant monitoring constellations) or advanced sensors (cheap climate sensors everywhere, or widespread citizen science via smartphones) will come. The DPI must integrate these. We might foresee by 2030, ubiquitous mobile and connectivity (like everyone having climate apps linked to DPI). If computing becomes more decentralized (edge computing, etc.), DPI architecture might adapt too (maybe more processing happens locally but with global syncing). Also, cybersecurity will need constant updates as threats evolve.

Sustained Funding and Operations:

By year 6-10, financing hopefully transitions to more routine channels (e.g., part of UNFCCC budget or regular contributions by countries similarly to how some environment treaties have trust funds). The alliance with private sector might also move to a maintenance mode where they provide at-cost services to keep it running. Ideally, many components might become self-sustaining, e.g., after initial funding, the cost to maintain digital systems might be taken up by countries themselves because they see the value.

Integration with Other Global Goals:

Over a decade, we likely find synergies with other digital public goods efforts (health DPI, etc.). By 2035, there's an integrated approach where digital infrastructure serves multiple SDGs at once. Climate DPI could merge with or inform systems on disaster risk reduction or sustainable development more broadly. In essence, by the end of this roadmap, *digital public infrastructure for climate should just be part of how the world works on climate*, not a special project.

Outcome Targets in 10 years:

We should define success metrics to hit by 2035:

- Drastically improved climate outcomes: e.g., **30–50%** improvement in the accuracy of climate risk prediction,

40% faster disaster response times, and **20–25%** increase in climate finance reaching local levels due to efficiency gains. For instance, by 2035, the average warning time for extreme events in vulnerable countries could improve by **50%,** for example, from 24 hours to 36 hours, potentially saving **USD 3–16 billion** in annual losses and preventing thousands of fatalities.

- Transparency: all countries' emissions and climate actions are tracked in near real-time on open platforms, boosting trust in global efforts.

- Public engagement: DPI tools used by citizens in, say, at least 50 countries for participatory climate monitoring or decision-making.

These targets can be refined, but having them will guide the long-term push.

To implement this roadmap, we will create detailed project plans for each phase and monitor progress. Flexibility is key: if some tech or pilot doesn't work, pivot quickly (hence the initial pilot approach to test things). But the guiding timeline ensures that we keep momentum, a known risk is initiatives stall after pilot phase. We must avoid that by securing commitments (e.g., lock in medium-term funding upfront, get political commitments for scale-up once pilots prove concept).

Ultimately, by following this roadmap, we anticipate that by the early 2030s, the climate community will have at its disposal a powerful, integrated digital infrastructure that was only a conceptual idea in 2025. Given the urgency, we aim for an even faster timeline for Climate DPI adoption.

8. Impact Assessment & Showcase Success Stories

To demonstrate the value of the Global Climate DPI, we will track **key impact metrics** and highlight early **success stories** where the DPI approach has tangibly improved climate action. This allows continuous assessment of effectiveness and also helps build political and public support by showing real-world results.

Metrics for Measuring Effectiveness, Transparency, Resilience:

The impact of Climate DPI can be measured across several dimensions:

Climate Action Effectiveness:

Metrics could include improved emission reduction outcomes or adaptation results directly attributable to DPI. For example, an increase in the number of high-quality climate projects funded due to streamlined digital MRV and transparency, or additional emissions avoided because AI optimization reduced energy waste. We might quantify how the data/tools influenced decisions: e.g., **150–300 million tons CO_2 emission reductions** were identified and executed via the DPI-enabled system by **2030**, or **1,500–3,000 additional communities** have implemented adaptation measures guided by risk analytics from DPI.

Transparency and Accountability:

We can measure how much climate finance and action is now transparently tracked. For instance, the **percentage of climate finance flows recorded in the DPI system** (aiming for a high percentage of international climate finance and carbon market transactions by some date). Or the number of countries that improved their transparency scores in UNFCCC reporting thanks to DPI (e.g., more complete reports, submitted on time, etc.). Another metric: reduction in discrepancies or disputes in reported data, if DPI fosters common data usage, reports from various sources converge. The Climate Action Data Trust, for instance, can show how many double-counting incidents were prevented or how many registries are connected .

Resilience and Response:

A key measure: **lives saved or losses averted** due to better early warnings and disaster response. This is a classic metric for early warning: e.g., increase in lead time of warnings, or decrease in mortality rates from climate-related disasters after system implementation. We could also measure response speed (time for aid to reach after a disaster triggers, comparing with baseline). The **coverage of early warning** is another metric, e.g., “By 2030, X% of population in climate-vulnerable regions have access to DPI-enabled multi-hazard early warnings” (with the UN target being 100% coverage). Also, **community engagement** metrics: how many citizen reports or crowdsourced data points have been integrated (a measure of how participatory the system is).

Efficiency and Cost Savings:

Metrics such as reduction in transaction costs for carbon credits (if verifying a project used to cost $100k and now with digital MRV it's $20k, multiply by number of projects, that's savings), or administrative time saved for national reporting (perhaps measured by surveys or audit of process steps eliminated). Efficiency leads to more projects being viable (thus increasing climate action). We could observe an uptick in the number of registered projects from developing countries in carbon markets after DPI introduction (because barriers lowered).

Innovation and Co-benefits:

Soft metrics like the number of new applications built on the DPI by third parties (indicating a thriving ecosystem), or user satisfaction surveys by government officials or communities using DPI outputs.

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Now, to make it concrete, we present a few **highlighted success cases** that exemplify the DPI's benefits, some of which might be hypothetical but based on plausible outcomes of the current pilot programs and early adoptions:

Success Case 1: CAD Trust and Brazil's Monitoring Systems

In 2022, the Climate Action Data Trust (CAD Trust) was launched through a partnership between the World Bank, the International Emissions Trading Association (IETA), and the Government of Singapore. CAD Trust is a public, blockchain-based metadata layer that connects participating carbon credit registries. Its purpose is to improve transparency and reduce the risk of double counting by providing standardized reference data on the issuance, transfer, and retirement of credits. While CAD Trust does not itself issue credits or record every climate finance transaction, it serves as an integrity backbone that can be integrated with other digital systems to strengthen trust in climate markets.

Brazil operates a national rural environmental cadastre, the C*adastro Ambiental Rural* (CAR), alongside advanced satellite-based forest monitoring programs run by INPE, such as PRODES for annual deforestation estimates and DETER for near real-time deforestation alerts. These systems provide verified geospatial information on land use and forest cover, which is used for environmental enforcement and policy implementation. These existing tools demonstrate the potential for a Digital Public Infrastructure (DPI) approach. If connected through interoperable standards, CAR and INPE's monitoring platforms could support high-integrity, transparent MRV for nature-based climate projects, with public access to verifiable data that can improve accountability and market confidence.

Success Case 2: Ushahidi, Community-Driven Crisis Mapping in Disaster Response

Ushahidi is an open-source platform first developed in Kenya in 2008 to map reports of post-election violence. Since then, it has been used globally for disaster response, human rights monitoring, and civic engagement. One of its best-documented early disaster applications was during the **2010 Haiti earthquake**, when volunteers and humanitarian organizations used Ushahidi to crowdsource and map thousands of SMS, email, and social media reports about trapped individuals, medical needs, and damaged infrastructure. The live maps were accessed by the U.S. Marine Corps, the UN, and NGOs, and credited with enabling faster response in specific cases, such as rerouting search-and-rescue teams when reports indicated blocked roads or collapsed buildings.

In humanitarian crises such as **Cyclone Idai** in Mozambique in 2019, Ushahidi was also deployed by local and international actors to collect on-the-ground reports of flooding, displacement, and urgent needs. These inputs, often sent via SMS or low-bandwidth internet connections, were aggregated into public maps that responders could consult alongside satellite imagery and official data. The combination of community reporting and geospatial tools improved situational awareness, particularly in areas where communications infrastructure had been disrupted. While there is no public record of Ushahidi being formally embedded in a national DPI or increasing early warning lead times, its track record demonstrates that integrating citizen-sourced, geolocated information with official disaster management systems can enhance coverage, fill information gaps, and support more inclusive and responsive crisis coordination.

These success stories, covering transparency (CAD Trust and CAR) and disaster response (Ushahidi) **showcase the multifaceted benefits** of the Global Climate DPI. They turn the abstract concept into human and economic outcomes: forests preserved, lives saved, emissions reduced, communities empowered, technology greened. Each story also provides a template that can be replicated and scaled to other contexts, which is how DPI momentum will grow.

The overall impact assessment approach is thus to keep a **portfolio of metrics and stories**. The numbers give breadth (global scale improvements), the stories give depth (on-the-ground meaning). This combination will be reported regularly, maybe an annual "State of Climate DPI" report or dashboard available publicly, reinforcing accountability of this initiative to its objectives.

9. Risks and Implementation Challenges

Implementing a Global Climate DPI is ambitious and not without risks and challenges. We must proactively identify these potential hurdles and devise strategies to mitigate them. Key categories of challenges include technological barriers, political and institutional issues, capacity gaps, and ensuring inclusivity and security. Addressing these upfront increases the likelihood of successful deployment and adoption.

Technological Barriers (Digital Divide and Local Constraints):

Not all countries have the same digital infrastructure readiness. Some low-income regions have limited internet connectivity, power supply issues, or outdated IT systems. There's a risk that without careful attention, the Climate DPI could exacerbate the **digital divide**, leaving data-poor countries behind. For example, if sophisticated AI tools require high bandwidth or computing power, some places might struggle to use them effectively. **Mitigation strategies:**

- Invest specifically in connectivity and basic infrastructure for least developed countries as part of DPI (e.g., satellite internet for remote areas to ensure they can send/receive climate data).

- Design "lite" versions of tools that can run on low-spec devices or offline as needed (for instance, SMS-based interfaces for early warnings, or providing analysis results in low-bandwidth formats).

- Phase the implementation, starting with solutions that have lower requirements, then ramping up as infrastructure improves.

- Align with broader initiatives like the or the World Bank's digital development programs, to dovetail improvements in general digital infrastructure with DPI rollout.

Local constraints also include environment extremes (sensors can get destroyed by disasters) and maintenance difficulties (a high-tech system installed in a remote area might fail if no local technicians can fix it). **Mitigation:** robust, field-tested hardware for sensors, decentralizing data holdings (so if one server goes down others cover, including offline fail-safes like local storage that syncs later). Also, building local maintenance capacity as part of training.

Another tech risk is **interoperability difficulties,** integrating many systems is complex and could face technical bugs or mismatches. Our find-and-fix approach through pilots and a strong technical steering group will help. Ensuring rigorous testing, open standards, and not over-complicating initial versions is important. We should avoid scope creep that tries to do everything perfectly at once (which could lead to delays or systems that are too complex to use).

Political and Institutional Challenges (Data Sovereignty, Cooperation):

Climate data and information can be politically sensitive. Governments may worry about sharing data openly, e.g., emission data might affect trade or diplomacy, disaster data might cause image concerns. There's risk of **reluctance to share** or even active resistance if DPI is seen as impinging sovereignty. For instance, some countries might balk at a global system tracking their NDC progress, fearing external pressure or loss of control . Similarly, establishing a governance that balances power among nations is tricky, developing countries might fear it will be dominated by developed countries or tech corporations, while developed ones might worry about IP or security.

Mitigation:

- Emphasize that **countries retain sovereignty over their data;** DPI is a cooperative network, not ceding ownership. For sensitive data, provide options like sharing aggregated or anonymized data. Build trust via pilot successes, showing that data sharing leads to mutual benefits not punitive actions.

- Possibly negotiate **data-sharing agreements** under the UN that clarify usage: e.g., climate data shared via DPI cannot be used for sanctions or unrelated purposes.

- Use diplomatic channels: involve foreign ministries early to address such concerns, and secure buy-in through climate negotiations (like how MRV was sensitive in climate talks but eventually accepted with capacity support and flexibility).

- Highlight success of analogous systems (e.g., how sharing public health data in pandemics helped all, drawing parallels that global problems need global data sharing).

- Provide opt-ins and phased approach: maybe countries start by sharing less sensitive data first, see benefit, then expand.

- Institutionally, ensure governance bodies have fair representation (like equal footing for developing countries, possibly leadership roles or hosting of some DPI nodes in South). If countries feel ownership (e.g., an African data center, a Latin American coordination hub), they will be more cooperative.

Another political risk: priorities might shift with administrations, a supportive government might be replaced by one less interested in climate or digital openness. We must institutionalize DPI into civil service and maybe legal frameworks, so it's resilient to political changes (to a degree). Also, broad stakeholder support (academia, public) can create bottom-up pressure to continue such initiatives.

Financial Sustainability and Commitment Risks:

If funding doesn't materialize as hoped or is short-term, projects could stall. Some developing countries might be concerned about ongoing costs of maintaining systems (especially once donor support ends). **Mitigation:** incorporate financing in climate finance flows, build capacity so maintenance cost is manageable (maybe using open source avoids license fees), and demonstrate cost-benefit such that governments choose to allocate budget to it as a priority because it saves money elsewhere (like early warning systems have huge cost-benefit ratios). We also plan for a robust financing scheme in section 6 to try to secure sustainable funds.

User Adoption and Behavior:

Technology is only as good as its use. There is a risk that stakeholders (whether government analysts or local communities) might not readily adopt the new systems, due to inertia, lack of trust in data, or difficulty in using tools. For instance, local farmers may not trust AI advisories at first or officials might still rely on legacy spreadsheets instead of a new platform. **Mitigation:**

- **User-centered design:** involve end-users in design and testing to ensure tools meet their needs and are user-friendly.
- Demonstrate quick wins (if a mayor sees an AI prediction come true and damage averted, they'll trust it more next time).
- Provide change management support, training as mentioned, and maybe assign "digital climate champions" in institutions to advocate internally.
- Build trust via transparency: if an AI model recommends something, give explanation (as we plan to ensure explainability).
- Cultural factors: in some communities, blending traditional knowledge with tech can ease acceptance (e.g., show how early warnings align with indigenous warning signs to complement rather than override).
- Also, make sure to highlight and reward positive usage, e.g., a city that used DPI well gets recognition (this could spur others to follow, nobody wants to be left behind on something successful).

Climate and Environmental Risks:

: Ironically, climate hazards themselves threaten the infrastructure (power outages, floods could knock out comms). This is recognized: we design resilient networks (e.g., backups, distributed cloud). Also, the urgency and unpredictability of climate impacts mean we must be agile; if a major unforeseen climate emergency arises, DPI must adapt (like incorporate a new hazard type quickly). Our modular approach should help with rapid updates.

Political Will and Geopolitics:

The global nature means geopolitics could intrude, e.g., US-China tech tensions might impede cooperation on a global system, or conflict zones might not participate. Also, in some countries, political will for climate action is low, so prioritizing climate DPI might not happen domestically. We partially address this by embedding in global climate agreements (countries feel some obligation under Paris framework, especially as global norms shift). Getting major powers on board early is crucial; if one big player stands aside, it can create fragmentation (like separate systems or refusal to share certain data). Through diplomacy and showing mutual gain, we aim to avoid that. Possibly even position Climate DPI as a non-political humanitarian/technical collaboration which might be insulated from some geopolitical rivalries (like how scientists often kept cooperating even when governments clashed).

Ensuring Participation and Avoiding One-Size-Fits-All:

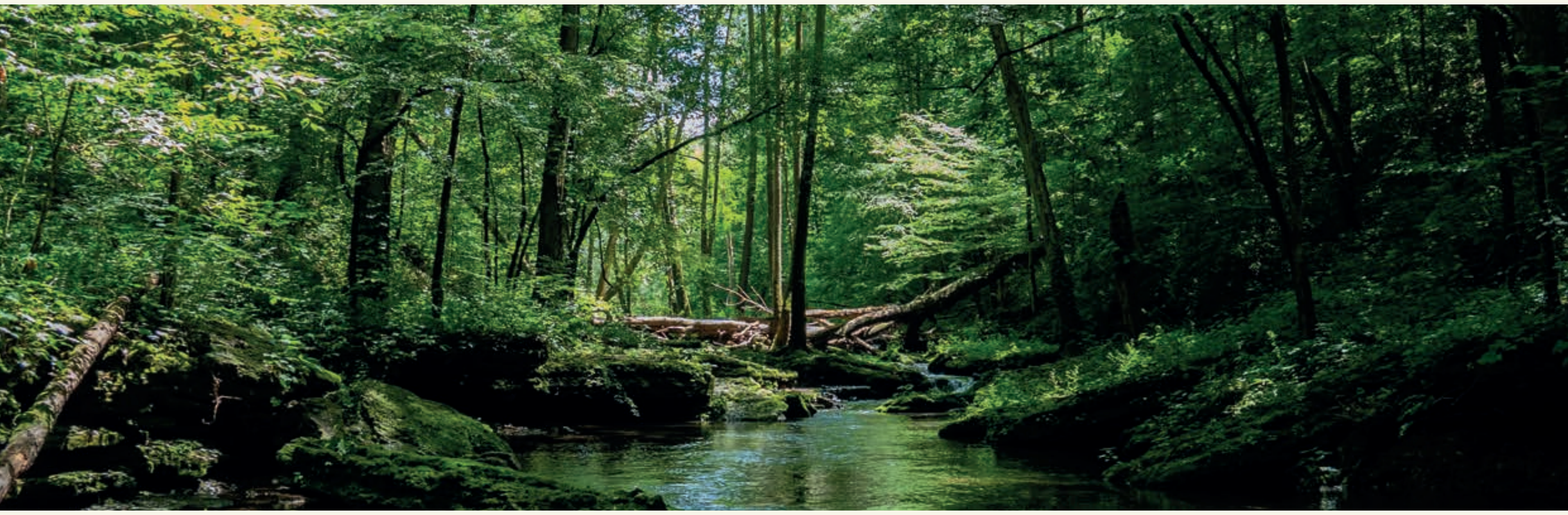
There's a risk that global solutions overlook local context, causing either irrelevance or resistance. We must allow localized customization (which we do via modular ClimateStack) and encourage innovation from everywhere, not just top-down. Additionally, if some stakeholders (like local communities or private sector) are not involved in design, they might later find it doesn't suit them. So our multi-stakeholder approach (CODES, alliance) is meant to mitigate by involving all voices in development.

Mitigating Inertia and Building Momentum:

A meta-challenge is inertia, global processes can be slow. We mitigate by setting clear short-term outputs to keep momentum (like the roadmap steps). Success stories themselves help mitigate risk: they build a constituency of supporters who will advocate for DPI. We should publicize wins and also honestly confront challenges in an iterative improvement spirit, not let problems fester.

In conclusion, while the challenges are real, from technology gaps to political hesitancy, none are insurmountable with careful planning, inclusive approach, and robust support. The risk of not building Climate DPI is arguably greater: continued fragmented and inadequate climate responses . By anticipating issues, we turn many of them into design features (like building security and privacy in, focusing on capacity building to reduce tech gaps, ensuring governance fairness to address sovereignty). The motto could be **"build trust at every step",** trust in the tech, trust between participants, trust from end-users. With trust, many challenges (data sharing, adoption, sustained support) become much easier to manage.

10. Conclusions & Recommendations



In the face of an accelerating climate emergency, this high-level report has outlined a bold vision: the creation of **a Global Digital Public Infrastructure for Climate (Climate DPI).** Through detailed analysis, case studies, and a clear roadmap, we have shown that Climate DPI is not only technologically feasible, but strategically indispensable to achieve the speed, scale, and coordination required for effective climate action.

Reinforcing Strategic Importance:

At its core, Climate DPI represents a paradigm shift in how the world confronts climate change, moving from fragmented efforts to a unified, information-rich, and collaborative approach. Just as physical infrastructure (roads, grids) enabled economic development in the 20th century, *digital public infrastructure* will enable climate-resilient development and deep decarbonization in the 21st century. By investing in Climate DPI, nations collectively build a foundation that amplifies **transparency, fos-**

ters trust, and accelerates innovation in climate solutions. It leverages modern technology, satellites, sensors, AI, blockchain, in service of our most pressing global goals, making climate action faster, fairer, and more effective. Importantly, it treats knowledge and data as a global public good, aligning with the ethos that climate change is a common challenge requiring unprecedented cooperation.

We conclude that Climate DPI is a **game-changing enabler:** it will help close information gaps that hinder decision-making, reduce transaction costs that slow finance, and link stakeholders from the grassroots to the global level in a common ecosystem. Without such infrastructure, efforts will remain piecemeal and suboptimal. With it, we unlock the potential for exponential progress, be it mitigating emissions through smart systems or saving lives via early warnings.

Key Recommendations:

To realize this vision, we put forward the following major recommendations for endorsement and action at COP30 and beyond:

1. Establish a Unified Global Climate DPI Framework under COP30:

COP30 should formally launch the Climate DPI initiative, adopting a decision that endorses the concept and sets up the governance structures (Taskforce/Steering Committee) as described. This provides the political mandate and urgency to move forward. The framework should outline roles (for UN agencies, multilateral banks, countries, private sector) and basic principles (open standards, inclusivity, etc.) so all parties have a clear directive. Early support from a broad coalition of countries will signal strong commitment..

2. Make DPI a Core Component of National Climate Policy:

We urge all nations to integrate digital public infrastructure into their climate strategies and policies. This means including actions like “develop climate data platform” or “leverage digital MRV for emissions” in NDCs, National Adaptation Plans, and climate finance proposals. Governments should treat spending on climate information systems and digital tools as critical investments on par with physical adaptation measures. By COP31 or COP32, countries could be asked to report on how they are utilizing DPI capabilities in implementing the Paris Agreement, thus cementing it as a recurring agenda item.

3. Form a Global Tech Alliance for Interoperability and Innovation:

As recommended, convene the alliance of technology providers and research institutions to formally coordinate contributions to Climate DPI. This alliance should be operational within a year and produce a commitment charter (e.g., agreeing on sharing data and APIs). It will significantly reduce duplication and ensure that even proprietary innovations can plug into the public infrastructure for maximum benefit. COP30 can invite the private sector to announce such commitments.

4. Adopt the ClimateStack Modular Approach in All Deployments:

We recommend that all parties implementing climate-related digital systems adopt the ClimateStack architecture (layered, with defined open interfaces) to guarantee compatibility. Concretely, this means: when a country builds or overhauls a climate information system or registry, it should use the DPI’s standards and modules instead of bespoke, incompatible ones. International funders should require, as a condition, alignment with ClimateStack to avoid isolated systems. This ensures each new investment strengthens the collective infrastructure.

5. Center Climate Finance and Certification on DPI Systems:

We call for a **DPI-centered approach to climate finance**. All major carbon market transactions and climate fund disbursements should, by 2030, be processed through or recorded in the global DPI framework (for transparency and efficiency). Bodies governing carbon markets (like the Article 6 Supervisory Committee) should coordinate with the D4C working group to use the digital infrastructure for their operations. Similarly, multilateral climate funds should integrate their project tracking databases with DPI, perhaps using the Climate Action Data Trust for meta-data. We also recommend developing **global standards for digital carbon credit certification** through the DPI so that carbon markets worldwide converge on high integrity practices. In summary, let DPI be the backbone of a transparent climate finance system, increasing investor confidence and accountability.

6. Launch Comprehensive Capacity Building and Knowledge Transfer Programs: :

As an immediate step, create the capacity building program (or network of centers) dedicated to Climate DPI. By COP31, there should be a clear plan and funding allocated for training thousands of climate and IT practitioners in developing countries. Donor countries and institutions should support scholarships, regional technical support hubs, and exchange programs to ensure everyone can use and maintain the DPI. The recommendation is to tie this with the Article 11 (Capacity Building) workstream of the UNFCCC to give it formal backing.

7. Secure Financing through Innovative and Sustained Mechanisms:

As detailed, we recommend establishing a multi-partner trust fund or similar for Climate DPI, aiming to raise the estimated budget (e.g., $1-2 billion initial). Parties and donors at COP30 should announce contributions to kickstart it. Additionally, consider dedicating a portion of existing climate finance commitments to digital infrastructure, for instance, GCF could earmark 5% of its portfolio for cross-cutting enabling tools like DPI, which will amplify the rest of its investments. Over the long term, explore self-financing elements such as minimal fees on certain transactions (ensuring they don't impede participation) to help cover maintenance. The key recommendation is that the international community treats this as a shared investment with high returns, and thus co-funds it generously.

8. Implement Immediate Post-COP Action Steps:

Finally, to maintain momentum after COP30, we propose a 12-month action plan:

- Within 3 months: first meeting of the governing Taskforce, adoption of Terms of Reference.

- Within 6 months: selection of pilot countries and launch of pilot project implementation (with funding allocated).

- Within 9 months: release of the first set of standards and a prototype of the global climate data portal.

- At COP31: present a progress report including live demonstrations from pilots (e.g., a dashboard showing real climate data from multiple nations, or a test of the carbon registry network) to show delegates the DPI in action.

These concrete steps will ensure that the decision at COP30 quickly translates into on-the-ground progress.

In conclusion, the Climate DPI initiative is a visionary yet practical proposal that aligns technological opportunity with climate necessity. It offers an infrastructure for unity and trust in a challenge often marked by division and skepticism. By approving these recommendations, COP30 can leave a lasting legacy: the empowerment of current and future generations with the digital tools to safeguard our planet.

The path ahead will require resolve, resources, and collaboration at levels perhaps unprecedented, but the payoff is a world where climate decisions are informed by the best data, climate actions are coordinated and transparent, and all people have access to life-saving and livelihood-boosting climate services at their fingertips. In short, Climate DPI can help turn climate promises into tangible progress. We urge the global community to seize this opportunity, committing to build and sustain this digital lifeline for our planet.