# Catalysing Climate Solutions: A Framework for Identifying DPGs for Climate Action

Digital Public Goods Alliance

# Catalysing Climate Solutions: A Framework for Identifying DPGs for Climate Action

Digital Public Goods Alliance

**Authors**

Kirti Pandey and Ruth Schmidt
With support from Lea Gimpel and Jameson Voisin

# Acknowledgements

This report was developed through extensive collaboration, stakeholder consultations, and expert reviews.
The authors gratefully acknowledge the valuable insights and contributions of the following individuals and organisations, whose time, expertise, and perspectives greatly informed the development of the Climate DPG Framework.

# Interviewees

**Climate Change AI:** Lynn Kaack
**FAO:** Maria Camila Gomez, Sergio Bogazzi, Zhongxin Chen
**GeoPrism:** Nathan McEachen
**GIZ:** Pascal Ripplinger
**Google Research:** Alex Diaz, Kevin Brege
**ITS Rio:** Fabro Steibel
**Mozilla Foundation, Green Screen Coalition:** Lisa Gutermuth
**Norad:** Per Fredrik Ilsaas
**Open Sustainable Technology:** Tobias Augspurger
**PATH Digital Square:** Heidi Good, Linda Taylor
**MGI Brazil Services:** Giovanna Aguiar
**UNDP India:** Vedant Rastogi
**Ushahidi:** Daniel Odongo
**WRI:** Dimitris Mentis

# Survey Respondents & Consultations

**BISA, CIMMYT:** Prasun Kumar Gangopadhyay
**CDPI:** Tanushka Vaid
**Creative Commons:** Cable Green
**Gates Foundation:** Tanner Lewis
**GIZ:** Julia Finck
**Mozilla Foundation:** Mehan Jayasuriya
**Plurall.cc:** Raphael Pouyé
**The Earth Genome:** Mikel Maron
**UNFCCC:** Moritz Weigel
**CTCN:** Valentin Rudloff

# DPGA Secretariat Review Team

Liv Marte Nordhaug, Lucy Harris, Ricardo Mirón, Bolaji Ayodeji, Amreen Taneja, Max Kintisch

# Contents

# Executive Summary

# Executive Summary

Climate change demands solutions that can rapidly meet local and global needs while being inclusive, cost-effective and scalable. Digital public goods (DPGs) are open-source software, open standards, open datasets, open AI systems, and open content collections that adhere to privacy and other applicable laws and best practices, do no harm by design, and help attain the Sustainable Development Goals (SDGs). They are freely adoptable and adaptable, enabling community engagement and local ownership compared to proprietary systems.

Recognising the urgency of the task and the potential of DPGs, the DPGA included climate action as a strategic target in its 5-year strategy (2023-2028). Subsequently, the DPGA Secretariat launched a dedicated Call for Collaborative Action in early 2025 to explore how the potential of DPGs for climate action can be seized. The **DPGs for Climate Action** call focuses on identifying, supporting, and scaling transformative open solutions that strengthen climate monitoring, mitigation, and adaptation.

## Report Findings and Framework

Drawing on input from over 20 organisations, the report presents a **layered identification funnel** to link open-source digital solutions to measurable climate outcomes.

### Climate Identification Framework

| | |
|---|---|
| Layer One | The DPG Standard (open-source, do no harm by design, etc). |
| Layer Two | Climate Alignment (intent or proven impact). |
| Layer Three | Infrastructural Approach (modularity, maturity, interoperability). |
| Layer Four | Climate Outcomes (linking digital metrics to measurable results like emissions avoided or resilience gains). |

### Key Insights from Testing the Framework through a Mapping Exercise

| | |
|---|---|
| **Mitigation-Focused DPGs** | "By design," as in intended for climate action, making them easier to discover - for example **Energy Access Explorer**, **National Carbon Credit Registry**. |
| **Adaptation/ Resilience DPGs** | Frequently emerge through outcome-based relevance; their multi-purpose nature means a broad scoping process is essential to avoid missing them - for example, **Ushahidi**, **Energy Access Explorer**, **National Carbon Credit Registry**. |
| **Monitoring DPGs** | Excel in interoperability and data trustworthiness. For example, Global Forest Watch, **GeoPrism**. |
| **Cross-Cutting Lesson** | Interoperability and open standards are crucial for scaling all climate DPGs. |

# Conclusion and Call to Action

This report presents an initial, jointly developed framework for identifying Climate DPGs. It will be presented at COP30 in Belém, Brazil, and maintained and evolved further by the DPGA Secretariat in close cooperation with the expert community.

The DPGA Secretariat will use the Climate DPG Framework as a guidance tool to identify and assess existing and future DPGs, in order to develop a collection of climate DPGs featured in the DPG Registry.

## Calls to Action for the International Community

- **Identify** and nominate additional DPGs and open-source solutions.
- **Open source** proprietary technologies with climate relevance.
- **Use the Climate DPG Framework** when building and designing new open-source climate tech.
- **Mobilise financing** to advance Climate DPGs.

# Introduction: The Case for a Framework to Identify Climate DPGs

# Introduction: The Case for a Framework to Identify Climate DPGs

## What Are Digital Public Goods?

Digital public goods are open-source software, open datasets, AI systems and content collections that comply with privacy and safety best practices while accelerating progress on the Sustainable Development Goals (SDGs)[1]. This definition is operationalised through the **DPG Standard** – a set of nine indicators that are used to determine whether or not open-source software, open datasets, open AI systems, and open content collections are digital public goods.

## Why Develop a Framework to Identify DPGs for Climate Action?

The urgency of climate change demands inclusive, scalable, and cost-effective solutions that can be rapidly deployed worldwide. Digital public goods have the potential to play an essential role in developing and deploying such solutions. As freely available, open-source resources, DPGs inherently encourage community participation and ensure local ownership, a key advantage over closed-source, proprietary systems. The **DPG Registry** already contains a number of digital solutions that self-reported climate relevance by indicating alignment to SDG 13. However, to guide funders and implementers, it is essential to understand which products are highly-relevant to climate targets. The framework introduced in this report attempts to do exactly that, by introducing a layered approach to identifying such potential and existing high-relevance DPGs.

In order to be considered a climate DPG we propose that solutions should be either intentionally designed or evidenced through proven impact, to support climate mitigation, adaptation, and/or monitoring. In addition to their climate action fit-for-purpose design or documented impact, solutions should also be built in a way that allows for reuse and interoperability with a larger digital infrastructure. This can be for example through modularity, reusable functionalities, adherence with open standards and other features that support scale through cost-effectiveness, and interoperability.

Digital public goods are enhancing cost-effectiveness, interoperability, and accessibility in climate action. FAO's tools, such as the Hand-in-Hand platform and the Digital Service Portfolio, contribute directly and indirectly to sustainable agricultural practices by providing data and knowledge for better decision-making. With ten certified DPGs, FAO's experience shows that DPG certification strengthens visibility and collaboration across ecosystems, complementing the technical foundations that enable scale and impact.

— Zhongxin Chen and Sergio Bogazzi, IT Officers, FAO

[1] UN Secretary General's Roadmap for Digital Cooperation.

Applying such a framework to identify the most relevant existing DPGs and encourage the creation of new ones can potentially increase the visibility of critical datasets, provide tools that can be localised to different regions, and foster collaboration across governments, civil society, researchers, and the private sector.

At a time of large cuts to open climate science and data, and with COP30 bringing together the international climate community, the moment is now to launch the framework and lay the foundations for a collection of climate DPGs that inspire and accelerate climate action across domains and geographies.

## Product Owners' Perspective on How to Advance Collaborative Climate Action

The two examples that follow illustrate how existing and potential DPGs are designed to enable high relevance for climate impact in practice.

**Brazilians Rural Environmental Registry (RER), supported by SICAR, is evolving into an open-source DPG that monitors forest code compliance and advances climate-relevant policies, including rural credit and environmental service payments. By developing modular, open components, RER is creating tools adaptable for diverse environmental and land management needs - from forest monitoring and restoration planning to integration with national systems like gov.br. This flexibility enables evidence-based decision-making, promotes sustainable land use, and scales climate action from enforcement to mitigation and resilience.**

**— Giovanna Aguiar,
Co-ordinator, CAR, MGI Brazil**

**An open-source, modular DPG supporting climate-compatible energy transitions, Energy Access Explorer democratises access to energy data and analytics, reducing reliance on proprietary systems. Communities contribute to the technology, enabling repeated adaptation across energy, agriculture, and clean cooking use cases.**

**— Dimitris Mentis,
Global Lead, Energy Access Explorer, WRI**

These examples illustrate how DPGs empower communities, improve decision-making, and support sustainable transitions.

# Identification Framework: A Layered Funnel for Identifying Climate Collection DPGs

# Identification Framework: A Layered Funnel for Identifying Climate Collection DPGs

Based on consultations with funders, policymakers, implementers, and product developers, the following framework sets out four layers that will help identify promising digital solutions for a Climate DPG Collection.

### Key Objectives of the Climate DPG Framework

- Distinguish highly relevant DPGs for climate action from other DPGs.
- Provide additional information and a point of reference for policymakers and funders in evaluating investments.
- Guide developers in embedding climate priorities into digital solutions.

We have integrated examples and quotes from relevant recognised and potential DPGs and organisations as part of describing the various parts of the framework.

In addition to the following layers, we also propose additional beneficial criteria criteria which would enhance the relevance, impact and sustainability of a potential climate DPG. The additional criteria can be found in Annexure 3.

Layer One

## The Digital Public Goods Standard

All digital public goods, regardless of sector, must first comply with the DPG Standard, which includes nine baseline indicators:

#### Relevance to SDGs

Must demonstrate alignment with advancing the UN Sustainable Development Goals.

#### Use of Approved Open Licenses

OSI-approved licenses (for software), Creative Commons (for content), Open Data Commons (for data). Encouraged: CC-BY, CC-BY-SA, CC0; accepted: CC-BY-NC, CC-BY-NC-SA.

#### Clear Ownership

Asset ownership must be clearly defined and documented.

#### Platform Independence

No restrictive mandatory dependencies; open alternatives must exist.

#### Documentation

Clear technical, functional, and/or content documentation enabling reuse.

#### Mechanism for Extracting Data

Non-PII data must be exportable in non-proprietary formats.

### Adherence to Privacy & Applicable Laws

Compliant with privacy regulations and relevant laws.

### Adherence to Standards & Best Practices

Designed with recognised standards and principles.

### Do No Harm by Design

Must proactively prevent harm:

- **Data Privacy & Security:** Protect PII and prevent misuse.
- **Inappropriate & Illegal Content:** Policies for detection, moderation, reporting, and removal.
- **Protection from Harassment:** Safeguards for users/contributors, especially minors.

These requirements form the baseline criteria for a solution to be considered a DPG, including those for climate action.

Layer Two

## Climate Relevance

A **climate DPG** should be a digital solution with a direct and demonstrable connection to vital work in **climate mitigation, adaptation, resilience, monitoring, or reporting**. This essential **climate relevance** is established by showing that the solution's impact and/or:

### Inherent to the Design

The solution was intentionally engineered to tackle a specific climate challenge. This can be assessed by demonstrating a solution's contribution to SDG 13 on climate action targets, (see Annexure 2 for a comprehensive list):

**13.1:** Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries.

**13.2:** Integrate climate change measures into national policies, strategies and planning.

**13.3:** Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning.

### A Proven Outcome

The solution has generated measurable and verifiable climate-relevant results in at least one implementation, regardless of the developers' original intentions.

### Examples

#### Solutions that were intentionally designed and developed to address climate challenges

**VAYU**, supported by the Lacuna Fund for Climate, uses citizen scientists and IoT sensors to collect hyperlocal air quality data. This data, processed with AI, identifies pollution sources and risk zones, enabling regulatory actions that contribute to **climate mitigation** by reducing emissions and strengthening climate governance. **DiCRA (Digital Crop Resource Atlas)** applies open data and analytics to promote **climate-smart agriculture**, enhancing adaptation and resilience by helping farmers and policymakers make informed land-use decisions.

#### Solutions that have proven climate-relevant outcomes

**Ushahidi**, initially created for crisis mapping, has been adapted for climate resilience applications - such as flood and drought response systems - improving early warning, coordination, and community adaptation capacity. **OpenStreetMap (OSM)**, while designed for open geospatial collaboration, has become a critical input for disaster risk management and post-event recovery in climate-vulnerable regions, with measurable improvements in emergency response and infrastructure planning.

In both these cases the initial pass of this layer will be complemented by a more comprehensive assessment of positive climate impacts in layer four.

Layer Three

## Infrastructural Approach

This layer focuses on intended reusability as modular, interoperable, and infrastructural solutions. As such, this implies that a solution has adaptability and scalability across diverse geographies and use cases, alongside extensibility that facilitates the integration of other solutions.

## Technical Criteria

These represent the core technical and design requirements that make a digital solution **highly relevant and capable of serving as shared infrastructure for climate action.**

### Modular Architecture & Reusable Design

#### Rationale

Climate challenges are diverse, ranging from renewable energy siting to flood risk and much more. A climate DPG must be flexible enough to adapt to different geographies and contexts without being re-engineered. Modular components should be flexible for independent updates, replacement, or extension of components (e.g., microservices architecture).

#### Features

**Modular design, open APIs, use of open schemas:** Modular architecture with open APIs and plug-in components that allow integration of new tools, data layers, or services, including semantic tools such as knowledge graphs[2] that connect datasets and enhance interoperability across domains.

#### Examples

**Energy Access Explorer** integrates localised datasets (e.g., solar resource maps, demographic data) for applications in energy, agriculture, and clean cooking; **RER** incorporates configurable modules that enable customisation and integration of local data and services (e.g., satellite imagery, existing land tenure data).

#### Implication

Increases reusability across contexts, reduces duplication, and enables adaptability across local, national, and global systems - aspect of turning climate-related software, content, and data assets into shared digital infrastructure for collective climate action.

> **The Energy Access Explorer was designed with modularity from the outset, based on stakeholder input to address ecosystem limitations. As a geospatial data management and analysis system, it can be adapted for use cases beyond energy - such as clean cooking and agriculture. For example, it was leveraged to build the Clean Cooking Explorer, which has since been integrated back into the Energy Access Explorer.**
>
> **— Dimitris Mentis,**
> **Global Lead, Energy Access Explorer, WRI**

### Product Maturity

#### Rationale

Climate action is long-term; digital solutions must be too. Many pilots collapse because they lack maintenance models or clear ownership. A mature digital solution ensures **product maintenance and continuity in advancing climate-relevant outcomes**, even as local contexts and climate needs evolve.

#### Features

**Governance**

Clear governance and contribution models that ensure responsibility for product development and decision making.

**Development Roadmap**

Current development stage (emerging, growing, mature), feature stability, clarity, and viability of future development roadmap.

---

[2] McEachen, N. and Lewis, J.: Enabling Knowledge Sharing by Managing Dependencies and Interoperability Between Interlinked Spatial Knowledge Graphs, Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci., XLVIII-4/W7-2023, 117–124. doi.org/10.5194/isprs-archives-XLVIII-4-W7-2023-117-2023, 2023.

**Technical capacity for support/deployment:**

Availability of expertise, documentation, training, and commercial support for implementation, customisation, and maintenance.

**Scalability, performance, and reliability:**

Architected for large volumes and users without performance degradation; high availability and disaster recovery mechanisms.

**Shelf readiness:**

Code quality and coverage, containerisation, robust DevOps pipelines, QA testing, and automation.

### Example

Ushahidi thrives as an open-source platform because it is well-documented, user-centered, and supported by an active global community enabling applications such as crowd-sourced information for disaster response.

### Implication

Promotes continuity, ensures that tools evolve with changing climate needs, and fosters trust from funders and governments.

> **Ushahidi is a DPG that empowers communities affected by climate change and other crises, particularly those with limited resources or technical knowledge. The platform incorporates workflows to manage unstructured data, with features such as translation - including AI support for low-resource languages - geolocation of reports, and clustering to identify themes, all readily accessible to low-resource communities. Ushahidi thrives by working through local champions and community structures, and being recognised as a DPG has opened doors with donors and expanded opportunities for collaboration.**
>
> **— Daniel Odongo,**
> **Director of Product, Ushahidi**

## Advanced Data Management & Interoperability

### Rationale

Climate action depends on integrating multiple data sources - satellite imagery, sensor data, socioeconomic indicators - into a coherent, actionable picture.

### Features

Structured using open metadata standards across humanitarian data exchange, health data, and geospatial / Earth observation standards (e.g., schema.org, DCAT) to enable adaptation, translation, and thematic expansion across humanitarian, health, and geospatial domains to support adaptation, localisation, and thematic expansion.

Built on open schemas and interoperable data formats (e.g., HDX, FHIR, DCAT, GeoJSON, STAC) to ensure compatibility and integration with national and international data systems.

### Examples

**GeoPrism** enables integration of spatial datasets from different domains (e.g., agriculture, health, disaster response) into a unified knowledge graph.
Platforms such as the UNDP Climate Promise Knowledge Hub curate and organise climate-related reports, guidance, and case studies using standardised metadata (e.g., schema.org), improving discoverability and reuse across sectors.

Open platforms such as HDX or World Bank Climate Datasets use standardized schemas and APIs to connect national and international climate reporting systems (e.g., UNFCCC).

### Implication

Prevents data silos, reduces duplication, and ensures decision-makers can rely on comprehensive evidence for policy and action.

> GeoPrism was developed as a common geo registry - a single source of truth for geographic data, including location identity, classification, geometry, and relationships to other geographies. This approach enables automated data integration across multiple DPGs and national spatial data infrastructures, ensuring consistency even as geographic boundaries change over time
>
> — Nathan McEachen,
> Product Owner GeoPrism, CEO, TerraFrame

Layer Four

## Measuring Climate Outcomes

In the last layer, for DPGs to completely fulfill Climate Framework's requirements, they are assessed against specific impact-criteria across mitigation, adaptation, and/or monitoring:

### Mitigation

Quantifiable reductions in GHG emissions (e.g., through renewable energy adoption, energy efficiency gains, or avoided deforestation).

### Adaptation & Resilience

Measurable improvements in community resilience, such as increased early-warning coverage, reduced crop losses, or improved water management.

### Monitoring & Data

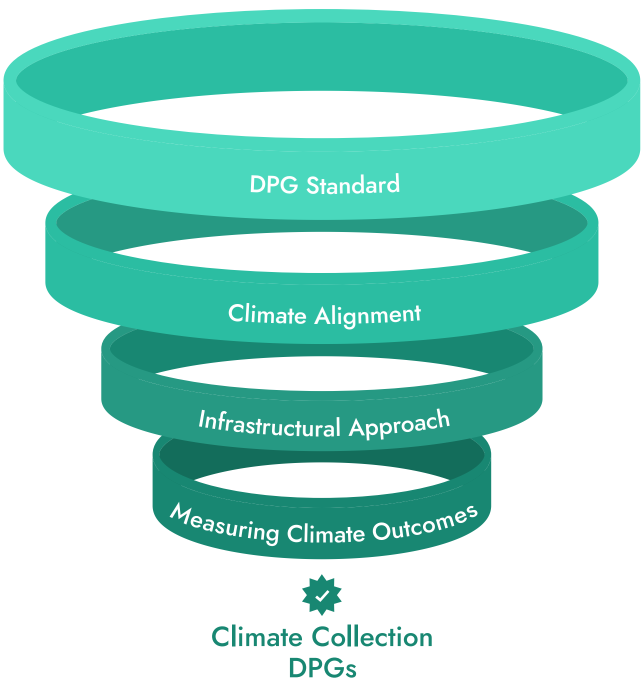
Enhanced availability, accessibility, and interoperability of climate-relevant data, evidenced by uptake in policymaking or community planning.

Impact measurement should combine **technological outcomes** (e.g., data processed, systems integrated) with **'real-world' outcomes** (e.g., emissions avoided, lives protected, livelihoods strengthened). This dual lens ensures that Climate DPGs are not only technically sound but also deliver tangible climate benefits, whether they were originally designed for climate purposes **(by-design relevance)** or have proven outcomes over time **(outcome-based relevance)**.

For a detailed mapping of the DPG Climate Framework's metrics, including **core, domain-specific, and enabling criteria**, see **Annexure 4**: Climate DPG Metrics Table and MRV Alignment. This table links each criterion to national and global MRV (Measurement, Reporting, and Verification) systems, NDCs (Nationally Determined Contributions), IPCC (Intergovernmental Panel on Climate Change) datasets, sectoral reporting, and provides guidance on measurement, verification, and reporting.

We acknowledge the inherent difficulty in consistently tracking and verifying outcomes for DPGs. Therefore, we propose that the DPGA Review Team request solutions to submit evidence of impact, such as case studies or impact reports, which will be self-reported by the climate DPG product owner, and not additionally verified by the DPGA. This approach allows for the inclusion of valuable evidence without imposing an undue burden for product teams.

### Climate Identification Framework
A Layered Funnel Approach



# How to Apply the Framework

01

### Identification Tool

The DPGA Secretariat will use the Climate DPG Framework as a starting point to build a dedicated Climate DPG Collection that other ecosystem stakeholders can use to discover climate-relevant solutions and motivate the nomination of new climate-relevant open-source solutions as DPGs.

02

### Benchmarking

Climate DPGs can be compared against each other, as well as against other climate solutions, using this framework, strengthening best practices and expectations.

03

### Investment Guide

Funders can use the Climate DPG Collection and the framework to prioritise investments. Developers can align their architecture and development process to meet the layer criteria, in order to ensure higher climate relevance of their solution and/or appeal to potential funders.

04

### Gap Identification and Sourcing of Innovation

Having a collection of of DPGs that have been assessed against the Climate Framework will make it easier to identify where there are gaps and allowing for the creation of new solutions to be catalysed.

# Mapping of Potential DPGs That Meet the Climate DPG Framework

# Mapping of Potential DPGs That Meet the Climate DPG Framework

The following illustrates how potential and existing DPGs can deliver measurable impact across the three main climate domain – **1. mitigation, 2. adaptation & resilience, and 3. monitoring & data**. Each example meets one or more of the criteria outlined in layer three of the Climate DPG Framework: **modularity & reusable design, product maturity, and advanced data management & interoperability**.

They also represent varying stages of maturity and design intent. Some (e.g., Climate TRACE, **Energy Access Explorer**) were purpose-built for climate impact, while others (e.g., **Ushahidi**, **OpenStreetMap**) have demonstrated emergent climate relevance through their application in adaptation and resilience contexts. Not all examples meet every characteristic, but each shows sufficient alignment and demonstrated impact to be considered a potential Climate DPG.

## Mapping Against the Main Climate Domains

### Mitigation

| Name | DPG Status | Description | Characteristics |
|---|---|---|---|
| Climate TRACE | Potential DPG; Software Category | Tracks global GHG emissions in near real time using satellite imagery and AI, enabling targeted and transparent emission reductions. | Modular architecture, product maturity, advanced data management and interoperability; real-time monitoring, transparency, global scalability. |
| Energy Access Explorer (EAE) | Verified DPG; Software Category | Integrates open geospatial datasets to identify opportunities for renewable energy deployment, reducing reliance on fossil fuels and expanding clean energy access. | Modular design, open geospatial data integration, interoperability; measurable impact on energy access planning. |
| OpenLCA | Potential DPG; Software Category | An open life-cycle assessment tool that helps industries measure carbon footprints and adopt circular, low-emission practices. | Interoperability, open methodologies; Reusable design; measurable impact on emissions. |
| OpenSolar | Potential DPG; Software Category | Provides open software for designing and managing solar installations, lowering costs and accelerating clean energy transitions. | Open-source design, modular components, interoperability with local energy datasets; measurable energy deployment outcomes. |

## Adaptation & Resilience

| Name | DPG Status | Description | Characteristics |
|---|---|---|---|
| AquaCrop-OS | Potential DPG; Software Category | Models crop yields under variable water and climate conditions, supporting adaptation strategies in agriculture. | Open modeling, research interoperability, modular design; adaptation alignment, scenario testing for agriculture. |
| DiCRA | Verified DPG; Software Category | Offers open-access datasets to guide climate-smart agriculture, supporting farmers in adapting to drought and shifting weather patterns. | Open data, interoperability; product maturity; adaptation alignment, local relevance, measurable agricultural outcomes. |
| OpenStreetMap | Verified DPG; Open Data Category | Provides open geographic data for planning evacuation routes, flood defenses, and resilient infrastructure. | Interoperability, modular data structures; open collaboration, reuse, measurable impact on resilience planning. |
| Ushahidi | Verified DPG; Software Category | Enables community-led crisis mapping and disaster response, strengthening local resilience during floods, cyclones, and other climate shocks. | Modular workflows, product maturity; user-centric design, local adaptability, measurable resilience outcomes. |

## Monitoring & Data

| Name | DPG Status | Description | Characteristics |
|---|---|---|---|
| GeoPrism | Verified DPG; Software Category | Integrates diverse spatial datasets into an open knowledge graph for climate and development monitoring, improving coordination and traceability. | Modular architecture, interoperability (knowledge graph); reusable across sectors, measurable climate monitoring outcomes. |
| Global Forest Watch | Potential DPG; Software Category | Delivers near real-time monitoring of forest cover and deforestation through open satellite data and visualization tools. | Modular design, data interoperability; transparency, monitoring alignment, measurable deforestation and emission reduction outcomes. |
| World Bank Climate Datasets | Potential DPG; Open Data Category | Offers open datasets on climate risks and projections, supporting evidence-based research and policymaking. | Data interoperability, open access; global reach, policy alignment, measurable impact on decision-making. |

# Mapping Against the Complete Assessment Framework

Building on the previous examples, the following mapping tests the complete framework to explore how specific promising digital solutions align with the four layers - from the foundational DPG Standard to measurable outcomes. This analytical view highlights the technical, design, and governance features that distinguish each as a high-relevance climate solution. Outcome indicators in layer four for each potential Climate DPG have been conceptually mapped to relevant SDG targets and indicators, as outlined in the SDSN Indicators and Monitoring Framework (2015). While these digital solutions metrics are often more granular and operational than national-level SDG indicators, they align with the broader goals of mitigation, adaptation, resilience, and climate monitoring.

## Mitigation

| Name | Layer One DPG Standard Compliance | Layer Two Tests for Climate Relevance | Layer Three Infrastructural Features | Layer Four Outcomes |
|---|---|---|---|---|
| Climate TRACE | Potential DPG; Software Category | **Relevance Alignment:** Emissions monitoring (by-design).<br><br>**Technical Enablement:** AI + satellite analytics.<br><br>**Scalability:** Global sectoral coverage. | Modularity (AI/ satellite modules), interoperability (open data formats, MRV standards); user-centered dashboards, sustainability via coalition support. | **Mitigation & Monitoring:** % of GHG emissions tracked, sectoral granularity, policy actions informed. |
| DiCRA | Verified DPG; Software Category | **Relevance Alignment:** Climate-smart agriculture (adaptation, by-design).<br><br>**Technical Enablement:** Geospatial analytics & advisory modules (monitoring).<br><br>**Scalability:** Localised modules across regions. | Modularity (localised advisory integrable with various multilingual interfaces), interoperability (open geospatial schemas and API based integration), technical maturity; user-centric advisory, trust via local adoption and management by NABARD (apex development bank for rural and agricultural sectors in India) ensuring clear institutional ownership. | **Adaptation & Monitoring:** % farmers adopting climate-smart practices, crop losses reduced, hectares under improved management. |

| Name | Layer One DPG Standard Compliance | Layer Two Tests for Climate Relevance | Layer Three Infrastructural Features | Layer Four Outcomes |
|---|---|---|---|---|
| Energy Access Explorer | Verified DPG; Software Category | **Relevance Alignment:** Renewable energy planning (by-design).<br><br>**Technical Enablement:** Siting & demand modeling.<br><br>**Scalability:** Global deployment potential. | Modularity (spatial analysis tools- multi-criteria overlays, filters and buffers for configurable planning), interoperability (open APIs, schemas), technical maturity (cloud- hosted architecture for scalable deployment); user-centric interface, sustainability via multi-stakeholder partnerships, trust via UNDP/SEforALL backing. | **Mitigation & Resilience:** MW of renewable capacity enabled, % households with clean energy, emissions avoided. |
| GeoPrism | Verified DPG; Software Category | **Relevance Alignment:** Integrated climate monitoring (by-design).<br><br>**Technical Enablement:** Cross-sector data integration.<br><br>**Scalability:** National & international datasets. | Modularity (spatial knowledge graphs), interoperability (open schemas/cross-sector data protocols), maturity (version-controlled knowledge graphs, dataset definitions & hierarchy management); user-centric dashboards, national and international coverage. | **Monitoring:** # of datasets harmonized, % increase in interoperability, national reporting systems integrated. |
| Global Forest Watch (GFW) | Potential DPG; Software Category | **Relevance Alignment:** Forest protection & climate mitigation (by-design).<br><br>**Technical Enablement:** Near real-time alerts & analytics.<br><br>**Scalability:** Global forest monitoring. | Modularity (forest monitoring modules / near real-time alerts), interoperability (GeoJSON/STAC), technical maturity (cloud-hosted, scalable pipelines); user-friendly dashboards with offline data collection feature, sustainability via global uptake. | **Mitigation & Monitoring:** Hectares of forest protected, $CO_2e$ sequestered, policy interventions triggered. |

| Name | Layer One DPG Standard Compliance | Layer Two Tests for Climate Relevance | Layer Three Infrastructural Features | Layer Four Outcomes |
|---|---|---|---|---|
| OpenLCA | Potential DPG; Software Category | **Relevance Alignment:** Industrial & supply chain mitigation (by-design).<br><br>**Technical Enablement:** Life-cycle calculators.<br><br>**Scalability:** Multi-sector adoption. | Modularity (LCA modules with plug-in architecture), interoperability (standardized LCA formats, support for multiple impact assessment methods e.g., CML, ReCiPe), technical maturity; user-centric modelling, sustainability via user community, trust via transparent LCA methods. | **Mitigation:** Tonnes $CO_2$e saved, # of businesses adopting low-carbon pathways. |
| OpenStreetMap | Verified DPG; Open Data Category | **Outcome-Based Relevance:** Climate risk mapping.<br><br>**Technical Enablement:** Editable open data.<br><br>**Scalability:** Global applicability. | Modularity (open-data modules), interoperability (open standards, APIs), maturity; user-centric contributions, sustainability via active community, trust via open governance, open-source methodology and documentation. | **Adaptation & Monitoring:** # of climate risk maps, disaster recovery ops supported, evacuation routes mapped. |
| Ushahidi | Verified DPG; Software Category | **Outcome-Based Relevance:** Disaster resilience & adaptation.<br><br>**Technical Enablement:** Crowdsourced mapping.<br><br>**Scalability:** Multi-country deployment. | Modularity (multi-channel reporting and multilingual deployment), interoperability (with other crisis platforms, GeoJSON, open APIs), technical maturity (clear governance and documentation with community contribution and training); sustainability via community support, trust via verified community data, decentralized ownership. | **Adaptation & Resilience:** % of hazard-affected population reached, response time reduced, community reports integrated. |

# Key Insights from Mapping Exercise

Mapping promising digital solutions against the complete framework, including the different outcome dimensions of climate action (mitigation, adaptation, monitoring & reporting) brought to light several insights:

### Mitigation-Focused DPGs

These tend to be by-design solutions with strong technical enablement and scalability. They will therefore typically be easy to discover in a scoping process for Climate DPGs, e.g., **Energy Access Explorer**, **Climate TRACE**, **OpenLCA**.

### Adaptation and Resilience-Focused DPGs

These solutions often emerge through outcome-based relevance, demonstrating flexibility and localisation potential. Due to their more multi-purpose/generic design, these solutions will not necessarily state that their main objective is climate action, and may therefore be missed in scoping processes that are too purpose-specific in scope, e.g., **Ushahidi**, **OpenStreetMap**, **DiCRA**.

### Monitoring-Focused DPGs

These consistently lead in interoperability and data trustworthiness, underpinning evidence-based climate governance, e.g., **GFW**, **GeoPrism**.

### Cross-Cutting Lesson

Open standards and interoperability remain critical for scaling climate DPGs across all domains, linking local action to global systems.

As a consequence, when developing a mapping framework, the scoping process for DPGs must be deliberately broad to capture multi-purpose solutions, such as those that might not be primarily branded as climate tools (e.g., **Ushahidi**). This broader approach should actively seek out and test solutions based on feedback from product owners and implementers detailing how DPGs are being successfully implemented for climate-relevant use cases. Furthermore, interoperability must be stressed as a critical enabler, allowing individual DPGs to function as modular building blocks for shared global digital infrastructure for climate action. By designing for openness, interoperability, climate action relevance, and enabling the tracking of climate outcomes, these solutions can form reusable, scalable, and cost-effective building blocks. They can help governments, communities, and innovators meet end-to-end needs throughout the climate action lifecycle across mitigation, adaptation, and monitoring, thereby accelerating the transition toward a low-carbon and climate-resilient future.

# Case Study: Applying the Framework to MapBiomas

# Case Study: Applying the Framework to MapBiomas

MapBiomas demonstrates how the framework can be applied to existing DPGs. The following assessment tests MapBiomas against the four layers of the framework.

## Assessment

Layer One

### Baseline Eligibility Against DPG Standard

MapBiomas Brazil was found to meet all nine eligibility indicators of the DPG Standard and was added to the DPG Registry in September 2025.

For Indicator 1 - Relevance to SDGs, MapBiomas reported relevance to SDG13 (Climate Action): Direct contribution through deforestation monitoring, identification of carbon sinks, and ecosystem change tracking. SDG15 (Life on Land): Land-use and biodiversity mapping across ecosystems in Brazil and globally and SDG6 (Water): Monitoring of water bodies, soil, and watershed health. For further detail, see the explanation that follows.

SDG 2 SDG 6 SDG 11 SDG 13 SDG 15

### SDG Relevance
Self-reported by MapBiomas

**SDG 2 | Zero Hunger:** By tracking the expansion of agriculture and pasture, MapBiomas supports planning for sustainable and efficient land use, helping balance food production needs with environmental conservation (Target 2.4).

**SDG 6 | Clean Water and Sanitation:** The platform includes monitoring of water bodies, supporting efforts to protect and restore water-related ecosystems such as rivers and wetlands, which is central to Target 6.6.

**SDG 11 | Sustainable Cities and Communities:** MapBiomas offers insights into land-use dynamics that can inform sustainable urban planning and help prevent urban sprawl over critical ecosystems.

**SDG 13 | Climate Action:** By providing detailed, annual land-cover and land-use maps, MapBiomas enables tracking deforestation and other emissions-related changes that empowers governments and organizations to plan climate mitigation and adaptation strategies based on reliable data.

**SDG 15 | Life on Land:** MapBiomas open data on deforestation, natural vegetation change, and land degradation is critical for monitoring biodiversity loss and guiding conservation and restoration efforts, supporting the sustainable management of terrestrial ecosystems.

Layer Two

## Initial Climate Alignment

MapBiomas directly supports SDG 13 (Climate Action) by being purpose-built to monitor and map crucial environmental dynamics, including land use, deforestation, fires, and water and soil health, across Brazil and other regions. This comprehensive, open-access data contributes significantly to climate mitigation by enabling the precise identification of carbon sinks and the rigorous monitoring of ecosystem degradation and deforestation. Simultaneously, it strengthens climate adaptation by supplying decision-makers—including governments, corporations, and civil society—with climate-sensitive ecosystem data necessary for assessing environmental code compliance, supporting sustainable land management, and developing effective adaptation and mitigation strategies. By generating transparent, verifiable data that underpins ecosystem preservation, MapBiomas aligns strongly with the criteria for DPG climate relevance given it's alignment with Indicator 1 of SDG 13.

Layer Three

## Infrastructural Approach

### Technical Criteria

**Modular Architecture & Open Standards**

- Partially modular: supports open APIs and data access, but modular deployment is not its primary design.
- Open data formats and schemas ensure reusability and interoperability across geographies.
- Improvement area: enhance modularity for tailored deployments (state or country-level customisation).

**Product Maturity**

- Consortium governance ensures continuity beyond political cycles.
- Transparent methodologies, strong user community (governments, companies, farmers).
- Ongoing funding and institutional support from academic and NGO partners, long term sustainability through public-private partnerships.

**Advanced Data Management & Interoperability**
(see also Indicator 8)

- Integrates multi-source geospatial data (satellite, land cover, soil, water, mining, fires).
- Improvement area: expand interoperability with OpenEO or other open geospatial infrastructures.

**Environmental Footprint Reduction**

- Environmental footprint of processing infrastructure not yet measured.
- Improvement area: integrate open-source tools like Code Carbon to quantify and optimise computational emissions.

**Monitoring & Evaluation (M&E)**

- Already enables monitoring of deforestation, water, biodiversity, and fires.
- Impact is measurable through adoption in government enforcement, corporate ESG, and finance.
- Improvement area: develop a structured M&E framework for climate-specific outcomes (e.g. GHG reductions, carbon sink preservation).

**Additional Beneficial Information**
(See Annexure 3)

Layer Four

## Outcomes:
## Measuring Climate Impact

MapBiomas demonstrates measurable climate impact across all three outcome dimensions - Mitigation, Adaptation & Resilience, and Monitoring & Data as follows:

### Mitigation: Quantifiable Emission Reductions / Avoided Deforestation

MapBiomas enables indirect yet measurable mitigation outcomes through open, high-resolution monitoring of deforestation, vegetation, and land-use change datasets covering 14 countries in Latin America and beyond.[3] Empirical research using its datasets estimates that ~ 300 Mt of CO2 emissions resulted from land-use change in Brazil's Caatinga biome - a region that functions as a critical yet vulnerable carbon sink.[4] Complementing this, MapBiomas RAD 2023[5] reported 1.83 Mha of deforestation in Brazil, a 11.6% decrease from 2022, equivalent to roughly ~80 Mt CO2e avoided. These data - spanning national to biome-specific scales - demonstrate how MapBiomas enables quantifiable monitoring of avoided deforestation and emissions.

### Adaptation & Resilience: Improved Ecosystem and Resource Management

Using MapBiomas' annual deforestation and burned-area maps, researchers applied a deep learning model to classify 10.9 Mha (12.7%) burned in the Caatinga (1985–2023), with an average of ~0.5 Mha/year and a peak of 0.89 Mha in 2021.[6] This spatially and temporally detailed analysis identifies priority areas for fire prevention and ecosystem management, enabling improved resource allocation, early warning, and targeted intervention. In parallel, satellite-based monitoring detected a loss of 3.3 Mha of surface water in the Amazon Biome during the 2023 drought, with 35% of losses within protected areas.[7] These datasets strengthen climate adaptation planning by integrating fire, land, and water dynamics. Through MapBiomas Alerta, annual alerts support timely responses that reduce vegetation loss, protect habitats, safeguard critical water sources, and enhance ecosystem and community resilience.

### Monitoring & Data: Data Availability, Accessibility, and Policy Uptake

MapBiomas publishes over 30 open, interoperable datasets annually, and provides widely used **APIs** and the **Data Toolkit**. This supports the integration with national and global reporting systems such as Brazil's NDCs[8], IPCC datasets, and SDG 13 and 15 reporting frameworks. Its data underpin key national assessments, including the Annual Report on Deforestation in Brazil (RAD) and Brazil's official GHG estimation system (SEEG). The initiative's 27 indicator M&E framework (p. 40-47)[9], such as "Accuracy of MapBiomas data", "Deforestation area increase/ decrease on previous year (% by biome, areas >5ha)", "Annual rate of increase of concentration of greenhouse gasses (GHGs) in the atmosphere", further operationalises measurable climate outcomes, ensuring continuous monitoring of technological and social impacts.

---

[3] External Evaluation Report (2019–2022). **brasil.mapbiomas.org/wp-content/uploads/sites/4/2024/01/External-Evaluation-Report-MapBImas-2019-2022.pdf.**

[4] Franca Rocha, W.J.S.; Vasconcelos, R.N.; Costa, D.P.; Duverger, S.G.; Lobão, J.S.B.; Souza, D.T.M.; Herrmann, S.M.; Santos, N.A.; Franca Rocha, R.O.; Ferreira-Ferreira, J.; et al. Towards Uncovering Three Decades of LULC in the Brazilian Drylands: Caatinga Biome Dynamics (1985–2019). Land 2024, 13, 1250. **doi.org/10.3390/land13081250**.

[5] **Annual Report on Deforestation in Brazil, prepared by MapBiomas (RAD 2023)**.

[6] Franca Rocha, W.J.S.; Vasconcelos, R.N.; Duverger, S.G.; Costa, D.P.; Santos, N.A.; Franca Rocha, R.O.; de Santana, M.M.M.; Alencar, A.A.C.; Arruda, V.L.S.; Silva, W.V.d.; et al. Mapping Burned Area in the Caatinga Biome: Employing Deep Learning Techniques. Fire 2024, 7, 437. **doi.org/10.3390/fire7120437**.

[7] Carlos M Souza Jr et al 2024 Environ. Res.: Climate 3 041002. DOI 10.1088/2752-5295/ad7c71.

[8] **BRAZIL'S NDC National determination to contribute and transform**.

[9] External Evaluation Report 2019–2022), p.40 pp.

# Key Strengths and Gaps

## Adaptation & Resilience

- Clear relevance alignment with SDG13 and SDG15.
- Provides open, interoperable, high-resolution geospatial data that supports climate monitoring, ecosystem management, and resilience planning.
- An open licensing and governance model ensures sustainability and legitimacy.
- Proven real-world applications across government, corporate, and civil society sectors.
- Global scalability across biodiversity-rich equatorial regions.

## Why MapBiomas Matters

MapBiomas provides open, high-resolution data on land use, deforestation, biodiversity, and ecosystem changes across Brazil and globally. By integrating satellite imagery with rigorous methodologies, it enables governments, civil society, and businesses to monitor environmental change, track carbon sinks, and inform climate mitigation and adaptation strategies. Its open-access datasets support evidence-based policymaking, sustainable land management, and ecosystem preservation. With transparent governance, strong community engagement, and interoperability with other climate tools, MapBiomas exemplifies, transforming environmental monitoring into actionable insights that drive resilience, conservation, and the transition to a low-carbon future.

## Gaps / Areas for Improvement

### Platform Reliance and Vendor Lock-in

While MapBiomas data is openly accessible for download, the substantial data volume leads many associated software tools and platforms to heavily rely on Google Earth Engine. This creates a potential risk of vendor lock-in, which could be mitigated by offering similar tools on alternative platforms like OpenEO.

### Limited Modularity and Interoperability

Compared to other Climate DPGs, MapBiomas exhibits limited modularity. Its tools and workflows are closely integrated with the MapBiomas infrastructure, making it challenging to repurpose components or integrate them into other national or sectoral platforms. Enhancing modular APIs and reusable components would improve interoperability, reusability, and localisation, allowing external users to integrate MapBiomas data into third-party applications, dashboards, or monitoring systems.

### Documentation Standardisation

MapBiomas provides comprehensive project-level documentation and metadata. However, standardising and improving the accessibility of this documentation is an area for improvement. Adopting standardised formats such as model cards for algorithms, data sheets for datasets, and decision logs for methodological updates would enhance reproducibility and facilitate integration with other climate monitoring systems.

### Indirect Measurement of Mitigation Outcomes

MapBiomas offers crucial land-use and deforestation data but does not directly calculate greenhouse gas emissions.

# Final Recommendation

MapBiomas is a promising candidate for becoming part of the upcoming Climate DPG Collection. It meets the DPG Standard and addresses all technical criteria, but with room to strengthen its position through:

- Greater modularity and adaptability across contexts.
- Open infrastructure interoperability (e.g., migration to OpenEO).
- Integration of climate impact M&E frameworks, including quantified mitigation and resilience measurements.

**Disclaimer**

This case study is based on an assessment of available information from the DPG nomination and publicly available information on monitoring and reporting. While Layer 1 (DPG Standard Compliance) has been verified, information presented in Layers 2 to 4 (Climate Alignment, Infrastructural Approach, and Outcomes) may contain unverified or incomplete details.

# The Collective Value of Climate DPGs

# The Collective Value of Climate DPGs

The upcoming Collection of Climate DPG can become a **digital backbone for global climate action**, offering **highly cost-efficient alternatives** to proprietary solutions. The defining strength of these digital solutions lies in the duality of enabling climate outcomes and being designed ideally with an infrastructural approach in mind.

By ideally forming scalable and interoperable solutions across mitigation, adaptation, and monitoring, the climate DPG Collection can transform digital tools into actionable infrastructure, realising these **efficiency gains** by reducing the expense of developing tailored climate tools and enabling organisations to rapidly adopt and implement best practices.

When interconnected or designed to interoperate, climate DPGs can create value greater than the sum of their parts; by reducing duplication and enabling rapid replication, these cost advantages potentially multiply. By linking datasets, exchanging information, and integrating reusable functionalities into broader digital ecosystems, individual tools can evolve into building blocks of open climate infrastructure. This approach has been significantly inspired by the international discourse on digital public infrastructure, which has brought global awareness around the need for countries to build cross-sectorally relevant, interoperable, societal scale systems.

The upcoming DPGs for Climate Collection will be a great complement to the existing DPG4DPI Collection, by bringing together solutions that have some of the same infrastructure characteristics (interoperability, reusability), but that also have direct, documented relevance to climate outcomes. This interoperable approach across the climate spectrum enables, for instance, open emissions datasets feeding monitoring platforms, which in turn connect to early-warning systems or policy decision tools. Such integration allows governments, communities, researchers, and innovators to work from a shared digital foundation while adapting tools to local contexts.

This interoperability is already in practice among some of the promising digital solutions that this report has looked at, such as GeoPrism, which integrates cross-sector spatial datasets into an open knowledge graph, enabling verified, traceable climate information for decision-making, disaster response, and policy planning.

> **GeoPrism demonstrates how interoperable digital public goods can support disaster response by enabling on-demand, ad hoc querying of data without prior integration efforts. Through collaborations with the Open Geospatial Consortium (OGC) and the US Army Corps of Engineers, the platform applies open data standards that preserve provenance and metadata, ensuring that published information remains trusted and traceable. This approach allows large language models (LLMs) to respond to natural language queries with verified, source-linked information drawn from authoritative datasets.**
>
> **— Nathan McEachen,**
> **Product Owner GeoPrism, CEO, TerraFrame**

The quote illustrates how open standards, modularity, and collaboration can turn interoperability into tangible value - enhancing coordination, data trust, and equitable access to reliable information.

# Summary and Call to Action

# Summary and Call to Action

## Defining What Matters: Distinguishing Climate DPGs by Linking Design to Measurable Impact

The defining strengths of climate DPGs lies in the duality of enabling climate outcomes and ideally being designed with an infrastructural approach in mind.

The proposed Climate DPG Framework, therefore, applies several layers to assess the relevance of candidate digital solutions.

**Climate DPG Framework**

| | |
|---|---|
| Layer One | The DPG Standard |
| Layer Two | Climate Alignment |
| Layer Three | Infrastructural Approach |
| Layer Four | Measuring Climate Outcomes |

Concretely, it helps to assess climate relevance by distinguishing between by-design relevance and outcome-based relevance (Layer two), ensuring DPGs are recognised for both their intentional design and/or their proven, real-world climate benefits. This dual focus expands the ecosystem of potential climate-relevant digital public goods.

With layer four, we aspire to probe these assertions through impact assessments. However, we caution that many solutions lack reliable data and metrics; impact is often reported anecdotally rather than by numbers. We hope that by emphasising sound impact assessment with this framework, we can contribute to the development of quantitative standards and assessment methods that capture climate outcomes more accurately. To this end, the framework proposes to link the digital and physical dimensions of climate action by combining technological criteria (e.g., data processed, systems integrated, user adoption levels) with tangible outcome criteria (e.g., emissions avoided/reduced, resilience gains, lives protected, livelihoods strengthened, hectares restored). This integration is meant to ensure DPGs are not only technically sound but also translate into demonstrable progress on mitigation and adaptation, enhancing transparency and accountability within Measurement, Reporting, and Verification (MRV) systems.

## Enabling Conditions for Sustainable Scale

Lastly, climate DPGs, and DPGs in general, depend on enabling conditions to thrive. They ensure durability, impact, and long-term adoption. While technical design, modular features and documented, real-world outcomes are critical, structural support is equally important:

### Financing

Long-term investment models that go beyond pilot funding, ensuring sustained infrastructure and continuous development.

### Governance

Community-driven maintenance, transparent governance, and adaptive operations to guarantee ongoing relevance and measurable climate impact.

Without these enabling conditions, even well-designed DPGs risk fragmentation, underutilisation, or loss of relevance over time.

# Call to Action: Developing and Scaling Climate DPGs

This report presents an initial version of a jointly developed framework for identifying climate DPGs, which will be maintained and evolved by the DPGA Secretariat following its presentation during COP30 in Belém, Brazil, in November 2025. We acknowledge that specifically for the category of AI DPGs, the framework needs to be further developed and tested with relevant solutions, which we aim to do with partners including UNFCCC and CTCN.

This framework will immediately be used as a basis to identify and assess existing promising DPGs and other potentially relevant open-source solutions, with the aim of creating a featured collection within the DPG Registry - a vital, dedicated resource making open climate solutions accessible and findable for governments and communities globally. The initial mapping of some existing and potential DPGs in this report has been used to stress-test and evolve the framework itself, and will also be used to prioritise assessments in order to start building the collection.

## Calls to Action for the International Community

The ultimate success of this work lies in collective action. We call on the international community to take the following actions:

- Identify and nominate additional DPGs and open-source projects for assessment.
- Consider open-sourcing relevant proprietary technologies; to use this framework as a guide when developing new climate tech.
- Use the Climate DPG Framework when building and designing new open-source climate tech.
- Mobilise financing to advance these important solutions.

As a community we can work together to ensure these tools accelerate a transition to a low-carbon and climate-resilient future for all.

# Annexures

# Annexure 1
## Definitions

| Term | Definition / Key Points |
|---|---|
| **Interoperability** | Ability of systems, datasets, and services to connect and exchange information seamlessly across products, geographies, and institutions.<br><br>– Within-product: Modules work together.<br>– Between-products: DPGs share or feed data into each other.<br>– Across geographies: Adoption with local standards and languages.<br>– Through exchanges: Participation in shared data or service marketplaces.<br><br>Relies on open standards, APIs, ontologies, and governance. |
| **Modularity** | Designing solutions as independent, interoperable components that can be adapted or reused without re-engineering.<br><br>– Plug-and-play: Add or remove modules easily.<br>– Integration: Modules function within other platforms.<br>– Localisation: Substitute data, languages, or logic for local needs.<br><br>Supports scalability, reduces duplication, and enables ecosystem collaboration. |
| **Measurement, Reporting, and Verification (MRV) Systems** | Frameworks for tracking, validating, and aligning climate-related data and outcomes with national and global goals. MRV integration enables climate DPG metrics and outputs to feed into official reporting systems such as NDCs, IPCC datasets, and sectoral MRV systems, strengthening transparency, accountability, and comparability. |

# Annexure 2
## Comprehensive list of SDG targets relevant for Layer two — Assessment of climate relevance by design

| Target | Definition |
|---|---|
| **Target 6.4** | Substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity. |
| **Target 7.2** | Substantially increase the share of renewable energy in the global energy mix. |
| **Target 11.5** | Significantly reduce the number of deaths and people affected and substantially decrease economic losses caused by disasters, including water-related disasters. |
| **Target 11.b** | Increase the number of cities implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters. |
| **Target 12.2** | Achieve the sustainable management and efficient use of natural resources. |
| **Target 13.1** | Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries. |
| **Target 13.2** | Integrate climate change measures into national policies, strategies and planning. |
| **Target 13.3** | Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning. |
| **Target 14.3** | Minimise and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels. |
| **Target 15.2** | Promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests, and substantially increase afforestation and reforestation globally. |
| **Target 15.3** | Combat desertification, restore degraded land and soil, and strive to achieve a land degradation-neutral world. |

# Annexure 3
# Additional Beneficial Information

These criteria are not prerequisites but significantly strengthen DPGs, making them more trustworthy, adoptable, and impactful.

## Environmental Footprint Reduction

Please note that the responsibility for ensuring an acceptable climate footprint is a shared responsibility between solutions designers and implementers.

### Rationale

Digital solutions themselves can contribute to carbon emissions. Though this responsibility is shared across developers and implementers of digital solutions. Climate DPGs should take steps to design their solution in a way that minimises the environmental footprint, ensuring that their operation does not disproportionately contribute to emissions or other environmental impacts while supporting mitigation, adaptation, or resilience objectives.

### Features

Optimised code, efficient algorithms, use of renewable-powered cloud hosting, footprint measurement (e.g., Code Carbon).

### Example

Open-source AI models optimised for energy efficiency contribute to lower emissions during large-scale deployment.

### Implication

Positions Climate DPGs as responsible digital actors, aligning their operations with their mission.

This internal measurement focus sets the stage for layer four on **Measuring Climate Impact**, which expands the scope from the design and development of the product to assessing tangible climate outcomes across mitigation, adaptation, and monitoring domains.

**Foundation is working to identify and systematically map projects with a focus on solutions that measure or mitigate the environmental impact of technology. Examples include Code Carbon and Zeus, both Mozilla Technology Fund awardees. We also see value in cross-referencing the Green Software Foundation's repository of measurement tools for developers, though it currently lacks evaluation of their effectiveness or usage.**

**— Lisa Gutermuth,**
**Senior Program Officer, Foundation**

## Measuring the Life Cycle of Digital Solutions and AI Systems

Digital and AI systems, while key enablers of climate action, also generate their own environmental footprints across the full life cycle - from development and model training to cloud hosting, data transfer, and end-of-life management. Understanding these impacts is essential to ensure that climate DPGs deliver net-positive outcomes.

Emerging open-source tools such as CodeCarbon help quantify the $CO_2$ emissions associated with software operation and AI model training, allowing developers to make informed choices about hardware, algorithms, and hosting. When integrated into development workflows, such measurement enables continuous optimisation for energy efficiency and transparency in reporting.

By embedding life cycle monitoring and carbon accounting into digital systems, DPGS that meet the climate framework can demonstrate that sustainability is not only an outcome of their use, but a principle guiding their entire design and operation – ensuring that digital solutions for the planet also practice what they promote.

## Monitoring & Evaluation (M&E)

Please note that M&E responsibilities lie with those that implement solutions, not necessarily the product developers and maintainers.

### Rationale

Impact should be measurable, not assumed. Without metrics, it is difficult to justify investments or assess effectiveness. However, the open-source nature of DPGs makes tracking implementations uniquely challenging. Gathering reliable metrics about a deployment requires commitment, coordination and alignment between many different actors that go far beyond the product owners. However it remains an important goal and for climate DPGs, this extends beyond tracking emissions to include climate-positive and co-beneficial outcomes.

### Features

Built-in monitoring of GHG reductions and broader climate-positive metrics such as resilience improvements, biodiversity protection, resource efficiency, and social inclusion. Climate indicators should be directly linked to digital features and usage data.

### Example

Climate TRACE tracks GHG emissions in near real-time, making monitoring an inherent feature of the platform.

### Implication

Enables evidence-based decision-making, strengthens accountability and learning, and helps funders and policymakers assess both direct and co-beneficial climate outcomes.

> **Impact cannot be assumed - it must be actively measured. By embedding monitoring features like tracking GHG reductions or resilience outcomes, digital public goods can stay accountable for delivering real-world climate benefits. While it remains difficult to directly attribute outcomes such as emission reductions, what matters is that platforms are well-built, widely used, and contribute to desired results, with development grounded in core needs and early collaboration.**
>
> **– Kevin Brege,**
> **Head of Climate and Sustainability, Google.org**

## Equity Considerations

### Rationale

All DPGs, but especially those that meet the requirements of the Climate Framework, should benefit all populations, especially vulnerable communities, to prevent digital or social exclusion

### Features

Inclusive access (multi-lingual, low-bandwidth support), participatory design with local communities, multi-stakeholder or commons-based governance models, safeguards for privacy and rights, and capacity-building to use climate data effectively.

### Example

**Ushahidi** enables community-led crisis mapping via SMS in low-resource areas. **MapBiomas** provides open geospatial data with guidance for governments, NGOs, and local communities.

### Implication

Embedding equity strengthens adoption, trust, and real-world impact, ensuring climate benefits reach marginalised and high-risk populations.

Ushahidi has proven to be a powerful DPG in empowering communities affected by climate change and other crises, especially those with limited resources or technical knowledge. In Tana River, northern Kenya, it enabled the community to map challenges, gather voices through low-tech channels like SMS and USSD, and present their needs to decision-makers - resulting in targeted interventions, including psychosocial support.

— Daniel Odongo
Director of Product, Ushahidi

# Annexure 4
## Integrating Measurement, Reporting, and Verification (MRV)

To strengthen transparency, accountability, and alignment with national and global climate goals, DPG climate metrics should be mapped to existing Measurement, Reporting, and Verification (MRV) systems. Integration ensures that outputs from digital public goods (datasets, dashboards, models) can feed directly into official reporting channels such as:

- Nationally Determined Contributions (NDCs) under the Paris Agreement.
- IPCC datasets for global monitoring of emissions and adaptation measures.
- Sectoral MRV systems, e.g., energy, agriculture, forestry, and water management.

## Climate Impact Dimensions and Criteria

The table below outlines how DPGs that meet the requirements of the Climate Framework contribute to measurable climate outcomes across key domains – mitigation, adaptation and resilience, monitoring and data, and cross-cutting enablers. It links technological and outcome criteria to quantifiable metrics that can be integrated into national and global Measuring, Reporting and Verification systems.

### Mapping HR Climate DPG Criteria and Metrics to MRV Dimensions

| Domain | Technological Criteria | Outcome Criteria | Metrics |
|---|---|---|---|
| **Mitigation** | Data processed on emissions, energy systems, land-use, or carbon accounting; integration with energy planning tools; deployment of renewable energy modules. | Reduced GHG emissions, increased renewable energy uptake, improved industrial efficiency. | Tonnes $CO_2$e avoided, MW of renewable capacity installed, % reduction in energy consumption, hectares of forest or cropland under sustainable management. |
| **Adaptation & Resilience** | Data on climate hazards, crop yields, water availability; integration with early warning or advisory systems; modeling of climate impacts. | Improved community and ecosystem resilience, faster disaster response, better resource allocation. | Number of people receiving early-warning alerts, % reduction in crop losses, hectares irrigated efficiently, time reduction in disaster response. |
| **Monitoring & Data** | Availability of climate datasets, APIs, dashboards, interoperability with other platforms. | Enhanced evidence-based decision-making, policy adoption, transparency. | Number of open datasets published, API calls or downloads, integration with national reporting systems, % of users leveraging data for planning. |
| **Cross-Cutting / Enabling** | Modularity, open standards, interoperability, community adoption. | Scalability, equity, sustainability of impact. | Number of countries or sectors adopting the DPG, number of localizations or adaptations, user satisfaction, energy footprint of digital operations. |

# Catalysing Climate Solutions: A Framework for Identifying DPGs for Climate Action

Digital Public Goods Alliance

www.digitalpublicgoods.net

# Catalysing Climate Solutions: A Framework for Identifying DPGs for Climate Action

Digital Public Goods Alliance