PATH

digital square

THE GLOBAL GOODS GUIDEBOOK

CLIMATE SERVICES FOR HEALTH ANNEX

Harnessing digital solutions for climate-resilient communities

Contents

Suggested Citation
Global Goods Guidebook: Climate Services for Health Annex. Seattle: PATH; 2025.

Acknowlegments

Digital Square is a PATH-led initiative funded by a consortium of donors. This guidebook is made possible with funding by Wellcome and the Rockefeller Foundation in support of the World Health Organization and World Meteorological Organization Climate and Health Joint Programme (Joint Programme office).

The findings and conclusions contained within are those of the authors at PATH and do not necessarily reflect positions or policies of the Rockefeller Foundation, Wellcome, and the Joint Programme office. Learn more at globalgoodsguidebook.org.

Endorsements

The Principles of Donor Alignment for Digital Health describe the importance of aligning around scalable, sustainable, accessible, interoperable, and evidence-based digital public goods (DPGs) for health that meet country priorities. By better coordinating the development of DPGs for health, such as those presented in this guidebook, stakeholders can play a crucial role in moving the global health sector from a past era of funding characterized by pilots and other proof-of-concept demonstrations to a future guided by investments in country-led and country-managed digital health strategies and systems that can be independently operated, expanded, and sustained by host governments and local partners over time.

The following organizations previously endorsed the latest version of the Global Goods Guidebook and have reconfirmed their endorsement for this Annex and overall support of using digital public infrastructure (DPI) for climate-informed health.

This guidebook is endorsed by:

JOINT OFFICE FOR CLIMATE AND HEALTH

Executive summary

As climate change accelerates, its impacts on human health are becoming more severe, manifesting through shifts in disease patterns and increased frequency of extreme weather events, straining already overburdened health systems. These intersecting challenges call for coordinated, data-driven responses. When designed with climate sensitivity in mind, digital health tools can play a critical role in early warning, risk forecasting, and adaptive public health planning and service delivery. DPI, interoperable systems that support inclusive service delivery and effective governance, is essential for integrating climate and health data. By combining satellite imagery, weather forecasts, and health system insights, DPI enables policymakers and health leaders to anticipate climate-related health risks, respond to evolving health needs, and strengthen the resilience of health systems, particularly in vulnerable communities.

Recognizing the urgency of this need, PATH, in partnership with Wellcome, the Rockefeller Foundation, WHO, and the WHO-WMO Climate and Health Joint Programme, launched the DPI for Climate and Health (DPI4CH) project in June 2024. The DPI4CH initiative aims to set the foundation to identify, synthesize, and promote valuable DPGs and DPI assets that will accelerate the access and use of integrated climate and health data information systems.

As part of this initiative, the inaugural Global Goods Guidebook Climate Services for Health Annex: Harnessing digital solutions for climate-resilient communities (Annex) offers an initial curated collection that can be built upon to share free, open-source digital tools and services designed to support health systems in integrating climate information into health planning and response. It builds on the original Global Goods Guidebook, expanding its scope with tools tailored to climate-health data integration. A key contribution of the Annex is the recognition and inclusion of three newly approved Global Goods for Climate and Health, aligned with an updated climate-health Global Goods maturity model (MM):

- **DHIS2**: The widely adopted health information platform, now upgraded with new capabilities to integrate climate data for more informed health decision-making.
- **EWARS-csd**: A platform that enhances early warning systems for climate-sensitive disease outbreaks.
- **GeoPrism Registry**: A geospatial data registry that links climate and health data to support better service delivery and resource planning.

The Annex provides an overview of the open call process, peer review, and criteria for global goods designation, along with descriptions of the newly approved tools and emerging innovations. It is a practical resource for governments, implementers, funders, and technologists working at the intersection of climate and health. We encourage stakeholders to use this Annex to identify and apply scalable, interoperable digital solutions that strengthen health systems.

Foreward from the WHO-WMO Climate and Health Joint Programme

The health impacts of climate change are no longer a distant concern. They are here, now, affecting people and health systems around the world in diverse and unequal ways. From shifting patterns of disease to more frequent heat waves and extreme weather, understanding, monitoring, and preventing the nexus of health risks amplified by changing weather and climate have never been more urgent.

To support countries in addressing these growing risks, the Joint Programme office is a unique partnership bringing together science, policy, information, and action to support governments and partners to better anticipate and respond to health risks of weather and climate.

This Global Goods Guidebook Climate Services for Health Annex is part of that effort. While DPI has not historically been designed with climate resilience in mind, it plays a vital role in building it. Service delivery components such as telemedicine, supply chain management, and patient record systems actively support health systems to handle climate challenges better. Furthermore, climate- and health-focused digital global goods can strengthen DPI by providing open, interoperable tools and data systems that integrate climate information into health decision-making. Climate-enabled health DPI can accelerate the access and use of standardized climate information more easily and accelerate efforts to predict, prepare, and respond to climate-related health risks in coordinated and scalable ways by considering the influence of weather and climate on health risk, the timing of vector control, opening of cooling centers, and issuing public advisories that are more precise and protective.

Effective climate-health integration requires strong collaboration across sectors, better data access, user-centered systems, and expanded training opportunities. WMO's global network, built through decades of cooperation among its member states, enables the collection, processing, and sharing of vital weather, climate, and environmental observations, information, and services. But data alone are not enough. They must be translated into actionable information for health professionals, whether they're managing a disease surveillance system, designing an early warning tool, or writing a national adaptation plan.

WMO's 2023 resolution on climate, environment, and health (WMO's 19th Congress Resolution 17) underscores these needs and calls for a more coordinated and practical approach to using science and technology to support human well-being.

This Annex reflects what is possible when sectors come together with a shared purpose. We hope it serves as a valuable resource for those working at the intersection of climate and health, whether you are just starting out or building on existing efforts. Additional tools, case studies, and guidance can be found at ClimaHealth.info, a joint WHO-WMO initiative supporting learning and collaboration in this growing field.

We are grateful to everyone who contributed their time, knowledge, and experience to this Annex. We look forward to continued collaboration.

Dr. Joy Shumake-Guillemot, Lead
WHO–WMO Climate and Health Joint Programme

September 2025

WHO: Climate- and weather-responsive digital health systems

Climate change is recognized by WHO as a significant global public health threat. It acts as a threat multiplier, exacerbating existing systemic vulnerabilities across populations and health systems. The increasing frequency of extreme weather events and gradual climatic shifts escalate risks to human well-being, livelihoods, and health, while also placing health systems under considerable strain.

These environmental changes can impact biodiversity, food security, nutrition, air quality, and access to safe water, contributing to an increase in food-, water-, and vector-borne diseases. In 2024 the Seventy-Seventh World Health Assembly (WHA) highlighted this critical issue through resolution WHA77.14, which calls for global action to foster health and develop climate-resilient, sustainable health systems. Building on this momentum, in May 2025, at the Seventy-Eighth WHA, member states adopted the first-ever Global Action Plan on climate change and health. The Global Action Plan 2025–2028 [EB156(40)] acknowledged the urgent need to address the health impacts of climate change, positioning health systems as part of the climate solution. Each WHA action builds upon previous resolutions going back two decades, which acknowledges the interconnectedness of health, environment, and climate change.

WHO's Global Strategy on Digital Health, with its mandate recently extended through 2027, provides a framework for harnessing technology to improve health outcomes. This strategy guides countries in digitally transforming their health systems by focusing on interoperability standards and national digital health architecture. It supports patient-facing systems such as telemedicine and point-of-care systems such as electronic health records, increasingly enhanced by artificial intelligence for decision support. It also underpins the maintenance of a global DPI, such as verifiable health records through initiatives like the Global Digital Health Certification Network. A key challenge moving forward is ensuring these digital health systems can effectively achieve interoperability with the extensive standardized climate and weather data curated by organizations like WMO.

As part of a broader set of recommendations and priority actions, the WHA77.14 resolution specifically urges member states to enhance their data systems. A key recommendation is to:

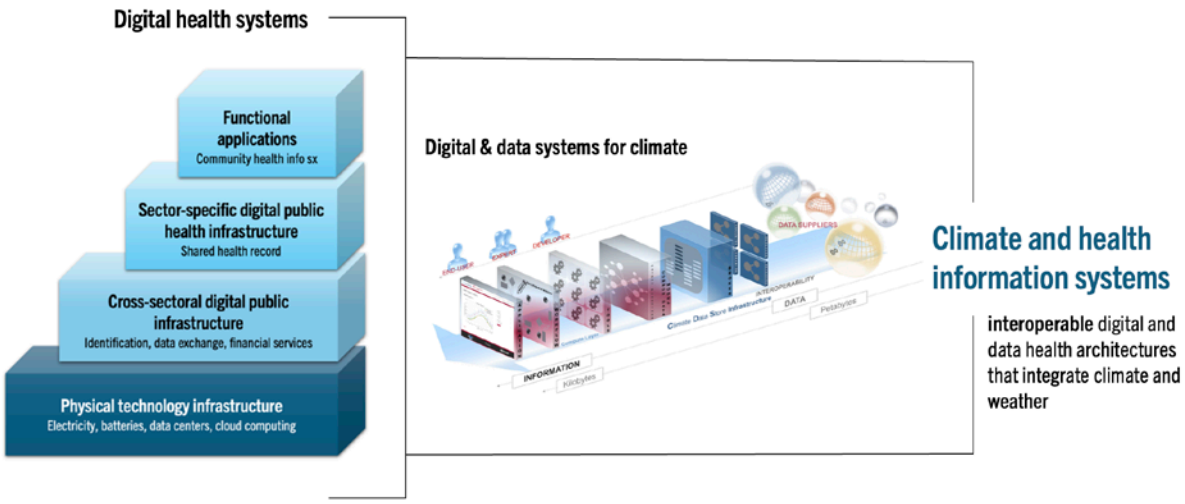
> *"Integrate climate data into existing monitoring, early warning, surveillance, and data collection systems, including data disaggregated by sex, age, disability, and any other relevant factor, where appropriate."*
>
> This integration is crucial for enabling *"evidence-based decision-making and targeted interventions that respond to the impacts of climate change…on health and health systems."*

Technical integration of climate and health information systems provides operational means to ensure critical data streams foster necessary combined evidence to inform more equitable policy choices and ensure that interventions are targeted effectively. The Global Action Plan 2025–2028 [EB156(40)] similarly notes the necessity to:

> *"Support integrated climate and health data and surveillance systems and identify gaps for integrating climate and weather information into country-level health information systems, including by working through the Joint Programme office to build collaborative partnerships among national meteorological and hydrological services and national ministries of health."*

Achieving true interoperability between diverse datasets—including satellite information, in situ climate data, and health information—is vital for understanding and addressing how seasonal variations and extreme weather events can worsen health risks and strain health system capacities.

Integrated climate and health information systems



To support these efforts, WHO is engaged in the following key activities aimed at fostering interoperable climate-health solutions:

- Working through initiatives such as the Joint Programme office to advance the use of interoperable digital tools, data, and DPI. The overarching impact of these activities is to enable climate-informed health action by fostering interoperable, sustainable national information systems and supporting data-driven decision-making at all levels.
- Systematically addressing priority climate-health data challenges by documenting standardized "use cases" for operationalizing climate-informed health services. This includes defining essential data, workflows, and system specifications guided by approaches like the WHO Specific, Measurable, Achievable, Relevant, and Time-bound (SMART) Guidelines.
- Supporting country-led solutions by providing technical assistance, convening partners, and enabling capacity building for an array of climate and health interventions.
- Supporting the development and implementation of early warning and surveillance systems, which serve an operational function and as early adopters of interoperability requirements.
- Convening diverse partners around global strategies and action plans for climate and health information systems.

The Digital Public Infrastructure for Climate and Health Project

The DPI4CH initiative, led by Digital Square at PATH in partnership with Wellcome, the Rockefeller Foundation, and the Joint Programme office, focuses on strengthening global health resilience to climate change by integrating climate and health data through interoperable DPI and DPGs. By adapting and expanding the Global Goods Guidebook to include climate-informed health tools, bridging knowledge sharing, and advocating for coordinated investment at global forums, the project empowers governments, implementers, and funders to deploy scalable, open-source technologies that enable proactive, data-driven responses to climate-related health threats, especially for populations facing socioeconomic disparities.

Through the DPI4CH project, Digital Square at PATH has laid the foundation for global support and investment in DPI for health (DPI-H) by elevating the intersection of climate change and health in key global fora such as the Brazil G20 Health Working Group, the UN General Assembly (UNGA), and the Global Digital Health Forum. PATH underscores the importance of DPI-H in mitigating climate change risks and adapting to its impacts, especially in countries at highest risk of loss and damage. Building on this momentum, PATH urges donors and country leaders to prioritize funding for digital climate-health solutions and advocate for DPI-focused investments that strengthen health systems that respond and adapt to the changing climate.

Where meteorological and climate data may be standardized and available, healthcare professionals and health policymakers report inconsistent access, challenges with integrated health data quality, and lack of interoperability. By making user-centered global goods that are adaptable for local context and priorities more readily accessible and creating user-centered, interoperable digital climate-health data dashboards, decision-makers can have tools available for improved prediction and response to outbreaks, emergencies, and other health system priorities that are impacted by extreme weather.

The development of cross-cutting digital public infrastructure tools can facilitate shared data for decision-making on multiple levels:

INTERNATIONALLY

The availability of cross-cutting climate-health tools and related policies, standards, and guidance for use can inform coordinated investment and implementation of existing and emerging strategies—like WHO's Climate Change and Health Action Plan and WMO's framework for climate services—for governments and national partners to draw on.

NATIONALLY

Interoperable tools and data dashboards can facilitate sharing health information services across ministry and related government and nongovernmental agencies, such as those providing meteorological services, public health, and e-government, to guide new policies and plan and deliver targeted resources.

LOCALLY

Stakeholders engaged in sharing data via interoperable data dashboards create a feedback loop reflecting the frontline impact of climate-informed health and information services on communities and individual lives.

Making the case for climate-informed global goods

This Climate Services for Health Annex to the Global Goods Guidebook reflects the growing recognition—endorsed by WMO and a coalition of global partners—that digital innovation must be part of a larger digital public health infrastructure. It identifies and elevates open-source, interoperable DPGs that help translate climate data into actionable insights for health actors. These tools represent a critical bridge between meteorological science and public health systems, enabling decision-makers to anticipate outbreaks, protect vulnerable populations, and build climate-resilient health services.

At its core, this work aims to support countries in operationalizing the WHO-WMO shared vision: integrating climate intelligence into digital health systems to improve lives. By showcasing global goods that meet rigorous criteria for maturity, scalability, and public benefit, this Annex serves as both a resource and a call to action—for governments, implementers, donors, and technical partners—to accelerate the adoption of climate-informed digital tools and invest in a sustainable, equitable DPI-H.

How to use this Annex

The Global Goods Guidebook Climate Services for Health Annex is a supplement to the original Global Goods Guidebook—a compendium of Global Goods for Health (a subset of Digital Public Goods) that features mature, open-source software and services that are adaptable to different countries and contexts. It is a resource for policymakers, procurement officials, and health leaders to quickly identify global goods and emerging innovations in the field of climate services for health that can be adopted, adapted, and scaled to meet local needs to reduce climate change's health and economic impacts at national and regional levels.

Designed to be complementary to the online Global Goods Guidebook, the Annex connects users with tools searchable by type, classification, supported standards, and relevant use cases. Interactive maps also show geographic locations where specific global goods have been implemented. Each global good is summarized in detail, including information on its functionality, implementation, user communities, maturity level, and compliance with health and climate data standards. Links to user communities, technical documentation, and other supporting resources are also provided. Additional features of the online guidebook include climate and health use cases linked to relevant global goods, along with explanations of classification criteria, interoperability standards, and licensing models.

The Global Goods Guidebook is continually updated through the open call process managed by PATH, ensuring it reflects the most current set of approved tools and remains a "living" resource. This static Annex serves as a quick reference to newly approved climate-health interoperability tools and provides contextualization while pointing users to the online repository.

Process: How a digital health tool becomes a global good

The process to become a global good involves several steps: updating the MM to be inclusive of climate and health categories; creating a cross-cutting peer review group (PRG) of subject matter experts to review, vet, and validate that tools meet the criteria for inclusion; and launching an open call process to source climate-informed health data and information tools.

Criteria to become a global good

The minimum requirements for software to become a global good for climate and health include:

- Be available and published under an open license such as as Open Source Initiative (OSI)–approved licenses.
- Demonstrate relevance to advancing the Sustainable Development Goals (SDGs).
- Align to SDG #3 Good Health and Well-Being: Ensure healthy lives and promote well-being for all, at all ages.
- Align to SDG #13 Climate Action: Take urgent action to combat climate change and its impacts.
- Meet the requirements of the Digital Public Good Standard and be registered (or provide proof of having applied for registration) as a DPG.

Adapting a climate-health maturity model

MMs for global goods have been curated by Digital Square at PATH since 2017 on behalf of the global digital health community. These models are periodically updated to reflect the evolving digital health landscape and the growing complexity of global needs.

The latest iteration, known as the Maturity Model for Climate and Health (MMCH), introduces new indicators specifically designed to assess open-source digital tools that integrate climate and health data. This model plays a central role in the PRG process explained later, guiding the evaluation and approval of global goods for inclusion in the Annex. It also serves as a practical reference for anyone interested in understanding internationally recognized criteria for assessing digital tools in this emerging space.

Development of the MMCH was informed by broad community input. Feedback was gathered through targeted workshops held at the Digital Public Goods Alliance Annual Members Meeting in Singapore in November 2024, workshops at the Open Digital Health Summit in Nairobi in December 2024, and the DHIS2 Annual Meeting in Oslo in June 2025. Virtual sharing and feedback sessions were also hosted by regional digital health networks—with specific outreach to those working on regional climate issues—including the Central American Network for Health Informatics, the Pan-African Health Information Network and International Medical Informatics Association, and the Asian eHealth Information Network—via ongoing engagement with the WHO-hosted Digital Health & Interoperability Working Group on Climate and Health.

The model and indicator review were also informed by one-on-one and small-group conversations with leading climate experts from WMO, the Global Heat Health Information Network, Pasteur Institute Climate Change Research Fellows, Institute of Development Studies climate-related research fellows, and the project's PRG of subject matter experts across climate and health.

The model includes six core indicators:

1. Global utility.
2. Community support.
3. Software maturity.
4. Equity and inclusive design.
5. Support for climate-resilient health systems.
6. Contribution to low-carbon digital health systems.

These indicators are further broken down into 35 sub-indicators, covering areas such as multilingual capabilities, documentation, data privacy and security, interoperability, standards alignment, and more. The resulting model provides a consistent assessment framework for comparing tools using globally recognized criteria:

- Supports evidence-based decisions for funders, implementers, and governments.
- Encourages continuous improvement by highlighting areas for growth.
- Promotes global alignment and fosters collaboration across sectors and regions.
- Applies a climate lens to ensure tools contribute to climate-resilient and low-carbon health systems.

In summary, the MM helps to raise visibility for emerging DPGs and ensures that they are not only technically sound but also equitable, scalable, interoperable, climate relevant, and ultimately impactful for the communities they serve.

Open call

In March 2024, PATH launched an open call for digital health tools (software applications, content, and services) that integrate climate, weather, and health data to address climate adaptation, mitigation, and planning to protect and improve human health, enhancing our ability to predict and respond to climate-related health risks. The open call aimed to identify and curate a collection of global goods that strengthen interoperable climate and health information sharing more systematically across sectors to support health system resilience in the face of a changing climate. Developers and implementing organizations were invited to submit applications, including detailed information on their digital tool's functionality, maturity, governance, implementation footprint, and alignment with global standards. The application includes a self-assessment of the current state of the tool using the MMCH. The call was widely publicized to climate and digital health experts and communities of practice (CoPs) and open through May 30, 2024. Tools submitted that met the global goods criteria and that mapped to the proposed climate-health maturity framework are included in this Annex.

Convening a cross-cutting peer review group

The PRG is a curated group of subject matter experts who ensure rigorous global standards lead to the approval of tools designated as global goods. Expert evaluation of submissions ensures that assessments are transparent, inclusive, and grounded in technical, programmatic, and contextual expertise. The PRG is responsible for:

1. Identifying and defining categories and sub-categories for the MM.
2. Initial screening of open call submissions to review for completeness and eligibility of tools that meet the basic criteria, including being open source, designed for public benefit, and aligned with the definition of a DPG.
3. Subject matter expert evaluation of eligible submissions with recommendations of tools to be designated as global goods for final review by the Global Goods Review Board, a group established for oversight of the Global Goods Guidebook content that consists of technical experts.

The Global Goods Review Board considers the recommendations of the PRG and makes the final determination on whether a tool meets the required thresholds for designation as a global good specifically for climate and health. Tools may be fully approved, approved for a specific category (e.g., health only, climate and health), or recommended for further development before resubmission. Feedback from the review process is made available to applicants, including strengths identified and areas where further development is encouraged. Publishing approved global goods and recognition as DPGs that meet rigorous global standards.

The DPI for Climate and Health PRG consists of independent experts with a balance across climate and health, geographies, gender, technical, policy, and subject matter experience.

Frederick Ato Armah, Caitlin Augustin, Sameen Babur, Christovam Barcellos, Xavier Berthet, Timothy Bouley, Felipe Colon-Gonzalez, Gordon Niboyenyel Dakuu, Tufa Dinku, Adam Drolet, Dercio Duvane, Vikas Dwivedi, Heidi Good, Hichem Ben Hassine, Kim Hill, Matt Hulse, Ingerid Huus-Hansen, Catherine Kabahuma, Shona Kamps, Matthew Keks, Max Krafft, Greg Kuzmak, Alinda Lauer, Rachel Lowe, Cristina Lussiana, Akhil Malhotra, Tiwonge Manda, Nathan McEachen, Garrett Mehl, Abby Minor, Jessica Moore, Martin Muchangi, Tapiwa Mungani, Sonja Myhre, Omiel Patrick Okecho, Paulino Omoj Omay, Erick Omollo, Judy Omumbo, Maeghan Orton, Yiqi Pan, Pham Duy Quang, Ben Ryder, Gabby Samuel, Geir Kjetil Sandve, Joy Shumake-Guillemot, Taufiq Sitompul, Oyindamola Sogunro, Brian Ssennoga, Patrick Tagny, Saikat Mandal Tanu, Linda Taylor, Jins Thomas, Mauricio Santos Vega, Chris Zielinsky.

Global goods for climate and health

OVERVIEW

DHIS2 is an open-source, web-based platform for collecting, visualizing, analyzing, sharing, and managing both aggregate and individual-level health data. It supports online and offline data collection via the web and mobile devices. Widely used as a national-scale health management information system (HMIS) and an integrated disease surveillance and response system (IDSR), DHIS2 is also increasingly used for patient-level records in a variety of health programs and in related domains such as health logistics and supply chain management.

Using DHIS2 for climate and health allows countries to leverage years of existing population health data while integrating climate, weather, and environmental data directly into their existing DHIS2 systems. This facilitates the analysis of climate-related health impacts and the forecasting of climate-sensitive disease risks. These tools include:

- **DHIS2 Climate App:** Allows users to import climate and environmental data and harmonize it by geography (org units) and time.
- **Chap Modeling Platform:** An open-source platform that uses machine learning for climate and health modeling.
- **DHIS2 Modeling App:** Provides a user-friendly interface within DHIS2 to select data to use to generate predictions, train predictive models, visualize predictions, and evaluate model accuracy through the Chap platform.

DHIS2 software development and the development of the Chap Modeling Platform are led by the HISP Centre at the University of Oslo (HISP UiO). HISP UiO also coordinates a network of 23 local health information service provider (HISP) groups based in-country in Africa, Asia, the Middle East, and Latin America that provide long-term direct support and capacity building to ministries of health (MOHs) and local implementers of DHIS2.

Digital Public Goods Alliance registration: https://www.digitalpublicgoods.net/r/dhis2

Contact: post@dhis2.org

WHO system classifications: D6 HMIS

DPI system classifications: HMIS

WMO system classifications: A2 Observations

Website: https://dhis2.org

Demo: https://im.dhis2.org/public/instances

Primary users: Health workers at facility and community levels, supervisors, program managers and district health officers, national-level stakeholders, administrators, MOHs, and climate and health experts and researchers.

GLOBAL UTILITY

Source code: https://github.com/dhis2, https://github.com/dhis2-chap/chap-core

License tool is published under (OSI): 3-clause BSD License (DHIS2), GNU Affero General Public License v3.0 (Chap)

Geographic Reach and impact: Afghanistan, Algeria, Angola, Antigua and Barbuda, Bangladesh, Benin, Bhutan, Botswana, Burkina Faso, Burundi, Cabo Verde, Cambodia, Cameroon, Central African Republic, Chad, Chile, Colombia, Comoros, Congo, Cote d'Ivoire, Democratic Republic of the Congo, Djibouti, Dominica, Ecuador, Egypt, Eritrea, Eswatini, Ethiopia, Gabon, Gambia, Ghana, Grenada, Guatemala, Guinea, Guinea-Bissau, Haiti, Honduras, India, Indonesia, Iraq, Jamaica, Jordan, Kenya, Laos, Lebanon, Lesotho, Liberia, Libya, Madagascar, Malawi, Maldives, Mali, Mauritania, Mauritius, Morocco, Mozambique, Myanmar, Namibia, Nepal, Niger, Nigeria, Pakistan, Palau, Panama, Papua New Guinea, Rwanda, Saint Lucia, Saint Vincent and the Grenadines, Sao Tome and Principe, Senegal, Sierra Leone, Solomon Islands, Somalia, South Africa, South Sudan, Sri Lanka, Sudan, Suriname, Syrian Arab Republic, Timor-Leste, Togo, Tonga, Uganda, United Republic of Tanzania, Vanuatu, Venezuela, Vietnam, Yemen, Zambia, Zimbabwe.

Implemented in 90 low- and middle-income countries, with 75 deploying DHIS2 as an HMIS on a national scale. National implementations of DHIS2 typically include routine health data from all major public health programs collected at the facility level (or at the district level where infrastructure is limited) and aggregated upward through an organizational hierarchy. In addition, MOHs in more than 50 of these countries use DHIS2 as an IDSR platform, and more than 30 use it for managing health logistics and supply chain data.

DHIS2 is used by international health programs and organizations (such as WHO; the Global Fund to Fight AIDS, Tuberculosis and Malaria; Gavi, the Vaccine Alliance) for the management of health programs related to specific diseases, such as human immunodeficiency virus, tuberculosis, malaria, and others. Many nongovernmental organizations (NGOs) also use DHIS2 for data management at the global and country level. When these implementations are taken into account, DHIS2 is currently being used in at least 130 countries. Ten of these countries are currently piloting the integration of climate data into their existing DHIS2 systems and the use of new DHIS2 tools for climate and health.

COMMUNITY SUPPORT

Public-facing tool roadmap and documentation: https://dhis2.org/roadmap/, https://github.com/dhis2-chap/chap-core/wiki/CHAP-Roadmap

Technical and developer documentation: https://developers.dhis2.org/, https://docs.dhis2.org/en/use/use.html, https://docs.dhis2.org/en/manage/manage.html, https://dhis2-chap.github.io/chap-core/

User guide documentation:

- **Documentation repository:** https://docs.dhis2.org/en/home.html
- **For end users:** https://docs.dhis2.org/en/use/use.html
- **For implementers:** https://docs.dhis2.org/en/implement/implement.html

Languages available: English, French, Spanish, Portuguese, Hindi, Vietnamese, Chinese and Norwegian

Additional languages are available on request, and DHIS2 community members are encouraged to contribute to DHIS2 translations.

Community engagement: The DHIS2 CoP is a global network of over 10,000 active members from more than 90 countries. Member CoPs include technical implementers, system administrators, developers, program experts from ministries of health and education (and other governmental agencies using DHIS2), the HISP network, international and regional public health organizations (WHO, UNICEF, Centers for Disease Control and Prevention, United States President's Emergency Plan for AIDS Relief), NGOs, donor organizations, and the private sector implementing or supporting DHIS2 projects.

Dedicated community engagement platforms or mailing lists: The DHIS2 CoP is a public, web-based discussion forum used for communication both between the core DHIS2 team and the global community and between community members directly in other languages.

SOFTWARE MATURITY

Health standards: ICD-9, ICD-10, ICD-11, LOINC, SNOMED, ADX, HL7 FHIR

Interoperability standards: ADX, HL7 FHIR

Climate standards: None

EQUITY AND INCLUSIVE DESIGN

User representation in design: Development of new DHIS2 features is based on input from the HISP network and complemented by the global user community. Priority is given to generic improvements that can have an impact across implementations, rather than those that are specific to one place. Input on the design of the DHIS2 core platform has been gathered over decades through HISP groups working directly with MOHs and other partners in low- and middle-income countries in multiple regions, continents, language communities, and levels of economic development.

Offline and Low-Bandwidth Functionality: Yes

CLIMATE RESILIENT HEALTH SYSTEMS

Climate and health data integration and interoperability: DHIS2 for climate and health enhances existing DHIS2 systems by integrating climate, weather, environmental, and earth observation data; the development of climate and health analytical and modeling tools; and the design of data visualizations and dashboards to support effective and timely analysis and decision-making in response to climate-sensitive health risks. The integration of climate data is facilitated by the DHIS2 Climate App, which allows users to import a variety of climate and environmental datasets from validated sources and automatically harmonize and integrate them with health data.

LOW CARBON HEALTH SYSTEMS

End-user device impact and data storage efficiency: DHIS2 mobile implementation can (and often does) utilize a "bring your own device" model, in which end users use DHIS2 on their own existing devices, thus minimizing electronic waste. DHIS2 can run effectively with reduced computing power and store data efficiently, which further reduce carbon impact.

EWARS-csd

OVERVIEW

EWARS-csd is a validated data-driven modeling system with a user-friendly interface to empower frontline health care workers to use data for appropriate and timely local response to climate-sensitive diseases. It has the potential to improve collaboration at a regional level (i.e., regional surveillance, data sourcing, joint response) for surveillance and response, applying a multisectoral approach.

Developed by the Special Programme for Research and Training in Tropical Diseases (TDR) and WHO, EWARS-csd builds on a machine learning integrated nested Laplace approximation (INLA) prediction algorithm that is data and area specific, uses historical disease records, and analyzes their association with alarm indicators retrospectively (function of dashboard 1 at the country or central level). It further employs prospective (weekly) alarm information (e.g., mean temperature, humidity, rainfall, ovitrap index) to predict a forthcoming outbreak (function of dashboard 2 at the district level).

The tool is entirely owned by users and uploaded on local servers, enabling countries to manage their own data and ensuring security and privacy. The tool is further designed to allow secure access and communication within and between districts (i.e., MOHs have the administrative power to assign users and passwords).

Contact: healthclimate@who.int

WHO system classifications: B3 Health Program Monitoring Systems, A1 Communication Systems

DPI system classifications: A1 Community Health Information System

WMO system classifications: D1 Decision Support Systems, D2 Climate Risk Platforms

Website: https://tdr.who.int/activities/ewars-csd

Demo: https://www.who.int/emergencies/surveillance/early-warning-alert-and-response-system-ewars

Primary users: MOHs and district health managers coordinate between all relevant stakeholders, such as local epidemiologists, meteorologists, entomologists, national and local management agencies that assess risk and develop response strategies, and the public communication channels used to disseminate warning information.

GLOBAL UTILITY

Source code: https://github.com/Laith-hk/AUTO-EWARS-csd/blob/main/EWARScsd_R_script_to_download_M24.zip

License tool published under (OSI): GNU General Public License version 3

Geographic Reach and impact: Bangladesh, Burkina Faso, Colombia, Dominican Republic, Ethiopia, India, Laos, Madagascar, Malawi, Mauritius, Mexico, Mozambique, Myanmar, Nepal, Oman, Saudi Arabia, Senegal, Thailand, Timor-Leste

The tool has been deployed in 19 countries across Africa, Asia, the Middle East, and Latin America. In these countries, EWARS-csd has contributed to (1) strengthened cross-sectoral collaboration, including between the health and meteorological sector (e.g., signing of a memorandum of understanding); (2) strengthened collaboration and coordination across government levels (local, subnational, central); (3) heightened awareness of MoH staff and partners (academia, WHO country office) of the linkages between climate and health; and (4) strengthened in-country capacity for risk mapping, disease modeling, and output interpretation. For countries that have moved from the deployment to the operational phase, EWARS-csd has contributed to proven and enhanced public health responses to climate-sensitive diseases. Several evaluations and country experiences have been published in peer-reviewed journals. The deployment and scale-up are actively supported by WHO and TDR.

COMMUNITY SUPPORT

Languages available: English, Spanish, Thai.

Community engagement: WHO and TDR periodically organize trainings, webinars, and workshops to bring the CoP (i.e., country teams) together to share experiences and best practices. Bilateral training takes place to support country teams in deployment and scale-up. WHO also enables the link-up of country teams to the broader climate and health community, for example, through the Alliance of Transformative Action of Climate Change and Health (ATACH) and global meetings that involve a multitude of stakeholders, including developers, researchers, practitioners, and others.

Dedicated community engagement platforms or mailing lists: A monthly follow-up and training meeting with all countries using or implementing EWARS-csd is organized and coordinated by WHO to support the technical and operation applications of EWARS-csd in the country.

SOFTWARE MATURITY

Health standards: ICD-9, ICD-10, ICD-11

Interoperability standards: HL7 FHIR

Climate standards: NetCDF

EQUITY AND INCLUSIVE DESIGN

User representation in design: The tool incorporates regular input from users at both central and local levels (skilled and unskilled alike) with feedback gathered through regional and country meetings leading to timely updates and improvements.

Offline and Low-Bandwidth Functionality: The calibration process to generate the data- and area-specific algorithm is conducted annually. These algorithms and associated parameters are stored permanently in a local server and updated every time a new run is performed. The prospective prediction is weekly and functions as long as the country server of the national program is functioning.

CLIMATE RESILIENT HEALTH SYSTEMS

Climate and health data integration and interoperability: The tool primarily relies on climate and health data for directing the public health and national surveillance program disease control activities.

GeoPrism Registry

OVERVIEW

GeoPrism Registry (GPR) is the first open-source Common Geo-Registry (CGR) to provide a single source of truth for managing geographic data over time across multiple organizations and information systems. It hosts, manages, regularly updates, and shares lists, associated hierarchies, and geospatial data over time for geographic objects core to the spatial data infrastructure, sustainable development, and public health (e.g., administrative divisions, settlements, health facilities, schools, and other relevant physical and nonphysical geographic features). GPR utilizes Open Geospatial Consortium standards to bring geospatial awareness from multiple information systems normalized by common geographies to large language models.

Digital Public Goods Alliance: https://www.digitalpublicgoods.net/r/geoprism-registry

Contact: info@terraframe.com

WHO system classifications: D5 Geographic Information Systems (GIS), C5 Health Worker Registry

DPI system classifications: B5 Interoperability Layer

WMO system classifications: C3 GIS, B1 Climate Data Integration and Interoperability

Website: https://geoprismregistry.com/

Demo: https://demo-georegistry.geoprism.net/

Primary users: Government ministries

GLOBAL UTILITY

Source code: Code repository – https://github.com/terraframe/geoprism-registry

Licensed tool published under (OSI): LGPL GNU Lesser General Public License,

Geographic reach and impact: United States, Mozambique, Laos

GeoPrism is the technical foundation for the Disease Data Management System (DDMS) and provides hierarchy and ontology management for normalizing disparate datasets by common geographies and ontological terms in addition to integration with DHIS2 and spatial dashboarding capabilities. The DDMS has been implemented in several countries in Africa and Asia, including Zambia, Bioko (Equatorial Guinea), Ethiopia, the Philippines, and three provinces in India.

COMMUNITY SUPPORT

Public-facing tool roadmap and documentation: https://github.com/terraframe/geoprism-registry/issues

Technical and developer documentation: https://github.com/terraframe/geoprism-registry/wiki, https://hub.docker.com/r/terraframe/geoprism-registry

User guide documentation: https://docs.geoprismregistry.com, https://geoprismregistry.com/docs/features/

Languages available: English, Laotian, and Portuguese

However, it can support adding new languages without the need to write additional code. Once a language has been added to the system, a localization spreadsheet containing all of the terms that need to be translated can be exported. Once translated, the spreadsheet can be reimported into the application.

Community engagement: GeoPrism Registry is built and stewarded by a community of professional organizations and in-country teams. The main contributing organizations include TerraFrame, the Clinton Health Access Initiative, and the Health GeoLab Collaborative. TerraFrame is the developer of the software; the Clinton Health Access Initiative oversees implementations and promotes advocacy, and the Health GeoLab Collaborative works with national statistical ministries in Southeast Asia and contributes to the WHO Global Health Facilities Database (GHFD).

Dedicated community engagement platforms or mailing lists: https://forum.geoprismregistry.com

SOFTWARE MATURITY

Interoperability standards: HL7 FHIR

Climate standards: WMS, WFS

EQUITY AND INCLUSIVE DESIGN

User representation in design: Contributing organizations provide critical resources and expert guidance. In-country teams include the Agancia Nacional de Desenvolvimento Geo-Espacial of Mozambique, the Ministry of Health for Laos, the US Department of Interior, and the US Department of Agriculture. As software users, these teams provide much- needed feedback to help direct development to meet real-world needs.

CLIMATE RESILIENT HEALTH SYSTEMS

Climate and health data integration and interoperability: By managing the single source of truth for geo-objects (e.g., locations, features, org units), hierarchies, and networks of geo-objects according to spatial and nonspatial semantic properties, GPR facilitates the integration of data across DPGs and spatial data infrastructures. Additionally, it can sustainably bring geo-awareness from such sources into large language models.

Nascent climate-health tools /emerging innovations

Beyond these new approvals, the review process surfaced several promising DPGs that are actively advancing climate and health data integration. While not yet meeting the global-scale criteria as defined by the MM for formal approval, they reflect the growing momentum and innovation in this nascent yet critically important field and include but are not limited to:

- **ClimWeb**: Empowers national meteorological and hydrological services and environmental institutions to deliver critical climate information effectively through a comprehensive, open-source platform. Featuring intuitive content management, real-time satellite visualization, Common Alerting Protocol (CAP) alert composer, and integrated marketing tools, ClimWeb ensures weather and climate services reach decision-makers and communities when they need them most. Trusted by more than 27 institutions across Africa, this innovative solution transforms how climate services are managed and communicated, enabling organizations to maximize their impact with modern, accessible technology
- **CAP: Standards-based implementation tools**: Includes Google Public Alerts freeware, mapping platforms that are CAP-enabled such as the Environmental Systems Research Institute's platform, geographic information systems (GIS)–based platforms with related CAP functionality, and emergency management freeware such as WMO's Emergency Education and Training Programme.
- **IDS-DRR open-source flood risk analysis platform for disaster preparedness (CivicDataLab and open contracting partnership)**: Aggregates diverse datasets related to disaster risk reduction, including flood hazard and rainfall data, to inform a climate-resilient disaster response. Currently piloted in parts of India.
- **OpenHIM with Climate Mediator (Jembi Health Systems)**: Extends an established interoperability platform to support climate data integration, with initial deployment planned in Mozambique.
- **Speedy Mesh (SpeedyKom)**: Supports climate, human, and animal health data integration with national deployments across Africa (Cameroon) and regional applicability through platforms such as the African Union's Digital One Health Platform and Intergovernmental Authority on Development initiatives.

These emerging innovations reflect some of the growing momentum to equip health systems with the digital public infrastructure needed to withstand climate shocks, improve preparedness, and safeguard vulnerable populations.

Emerging tools from the Global Health Resilience Group at the Barcelona Supercomputing Center

The Global Health Resilience (GHR) group, within the Earth Sciences Department at the Barcelona Supercomputing Center (BSC) develops cutting-edge modeling and digital innovations at the intersection of climate and health to enhance resilience to climate-sensitive health challenges globally and locally. The GHR group is developing a suite of open-source R packages called GHRtools designed to streamline climate-informed disease risk modeling and forecasting for a range of users, including public health, environment, disaster risk management, and humanitarian agencies. Developed as part of the HARMONIZE and IDExtremes projects, these tools support analyses across a wide range of health outcomes and climate-related exposures, while accounting for underlying demographic and socioeconomic inequalities and other potential risk factors. All packages are expected to be released on CRAN by March 2026, with beta versions available toward the end of 2025:

- **data4health**: Processes health data (e.g., numbers of symptomatic individuals or confirmed disease cases) typically sourced from surveillance systems and aggregates them in space, time, or by demographic groups.
- **clim4health**: Processes climate data (e.g., temperature, precipitation, or drought indicators) from weather stations, reanalysis, and forecast datasets, with postprocessing steps such as bias correction, downscaling, and spatiotemporal aggregation.
- **GHRexplore**: Provides a wide variety of visualizations for exploratory analysis of temporal and spatiotemporal health data, including time series, heatmaps, seasonality plots, thematic maps, and more.
- **GHRmodel**: Supports modeling health outcomes using Bayesian hierarchical spatiotemporal models with complex covariate effects (e.g., linear, nonlinear, interactions, distributed lag nonlinear models) in the R-INLA framework.
- **GHRpredict**: Computes out-of-sample probabilistic predictions of disease case counts and outbreak risk using INLA spatiotemporal models and evaluates predictive performance via a range of cross-validation schemes.

Additional climate-health considerations for global goods scale and sustainability

Data sharing agreements

Both WHO and WMO have established data privacy, sharing, and use agreements that should be considered when sharing health data to ensure ethical, efficient, timely, and equitable data practices. These agreements promote transparency in data sharing that builds upon existing work, facilitates innovation, and contributes to better health outcomes for individuals and communities.

The WHO data policy emphasizes the importance of data sharing to facilitate rapid analysis and informed decision-making, particularly during emergencies, while also outlining principles for data sharing across different categories such as surveillance, epidemiology, emergency response, genetic sequences, observational studies, and clinical trials.

WHO's unified data policy governs international data exchange for weather, hydrology, and climate data for monitoring, protection, and prediction among its 193 member states and territories, with an emphasis on the free and unrestricted exchange of core data essential for safety, security, economic welfare, and environmental protection.

WMO Cg-19 Resolution 17 emphasizes the integration of climate, environment, health science, and services to address inadequate intersectoral cooperation; improve co-design and deployment of demand-driven and fit-for-purpose technology; strengthen interdisciplinary skills and capability; decrease limitations in data quality, access, and exchange and system interoperability; and harness new technology for sustainable systems-based decision support.

The most relevant data are both collected and shared at the local and regional levels. Appropriate data sharing agreements with local- and regional-level data custodians are a key driver of effective partnerships and in developing and operationalizing tools. WHO and WMO have brokered data sharing agreements in many countries, as have digital ecosystem actors such as the HISP UiO Centre and country HISP groups, to put in place climate-health–specific data sharing agreements. These efforts facilitate information exchange and interoperability and foster good data governance between country-based meteorological and national climate agencies. More on these efforts here and here.

UNESCO and CODATA toolkit

Launched on June 4, 2025, this toolkit, developed by a United Nations Educational, Scientific, and Cultural Organization–Committee on Data (UNESCO-CODATA) working group, provides resources to help stakeholders develop data policies aligned with open science principles for use during times of crisis.

As outlined in the 2021 UNESCO Recommendation on Open Science, the toolkit does this by providing actionable guidance for data sharing and management in crisis situations. A key advantage is that it links to FAIR, TRUST, and CARE and the UNESCO open science principles and values. CODATA includes a factsheet, a guidance document, and a checklist to support the development of context-sensitive data policies.

- **Factsheet:** Provides an overview of the role of data policies in crisis situations and how open science can improve data management.
- **Guidance:** Offers a structured framework for developing data policies aligned with open science principles.
- **Checklist:** Helps stakeholders design data policies that reflect open science values.

Climate and health resources from the WHO-WMO Joint Programme office

- **ClimaHealth:** https://climahealth.info/
- **ClimaHealth Resource Library:** https://climahealth.info/learn/resource-library
- **WHO's Climate Change and Health:** https://www.who.int/teams/environment-climate-change-and-health/climate-change-and-health
- **WHO-WMO Joint Programme:** https://climahealth.info/who-wmo-joint-programme/
- **WMO Information System 2.0 Wis2.0:** https://community.wmo.int/en/activity-areas/wis/wis2-implementation

Addendum

Glossary of terms

CAP	Common Alerting Protocol
CODATA	Committee on Data
COP	community of practice
DDSM	Disease Data Management System
DPG	digital public good
DPI	digital public infrastructure
DPI-H	digital public infrastructure for health
DPI4CH	Digital Public Infrastructure for Climate and Health
FOSS	free and open-source software
GHR	Global Health Resilience
GPR	GeoPrism Registry
HISP	health information service provider
HMIS	health management information system
IDSR	integrated disease surveillance and response system
INLA	integrated nested Laplace approximation
MM	maturity model
MMCH	Maturity Model for Climate and Health
NGO	nongovernmental organization
OSI	Open Standards Institute
PRG	peer review group
SDG	Sustainable Development Goal
TDR	Special Programme for Research and Training in Tropical Diseases
UiO	University of Oslo
UNESCO	United Nations Educational, Scientific and Cultural Organization
WHA	World Health Assembly
WHO	World Health Organization
WMO	World Meteorological Organization

Addendum

Consider global goods and digital public goods

Global goods are open-source, digital health applications designed to mitigate some of the generic cons of open-source software.

They are:

 Free and open-source software (FOSS) adaptable to different countries and contexts.

 Supported by a strong community.

 Funded by multiple sources.

 Deployed at significant scale.

 Designed to be interoperable across commonly used systems.

For more examples, see the Global Goods Guidebook.

Understanding FOSS:

- "**Free**" means that anyone is freely licensed to use, copy, study, and change the software in any way.
- "**Open source**" means the source code for the software is openly shared so people can improve or adapt the software's design.
- FOSS decreases risk of vendor lock-in and can help facilitate government ownership.
- **Free in this context does not mean without cost**; implementing and maintaining digital tools will cost money.
- Factor these costs in when **budgeting and calculating total cost of ownership**.

Sources: https://wiki.digitalsquare.io/index.php/What_are_Global_Goods, adapted from Digital Health: Planning National Systems course material

PATH