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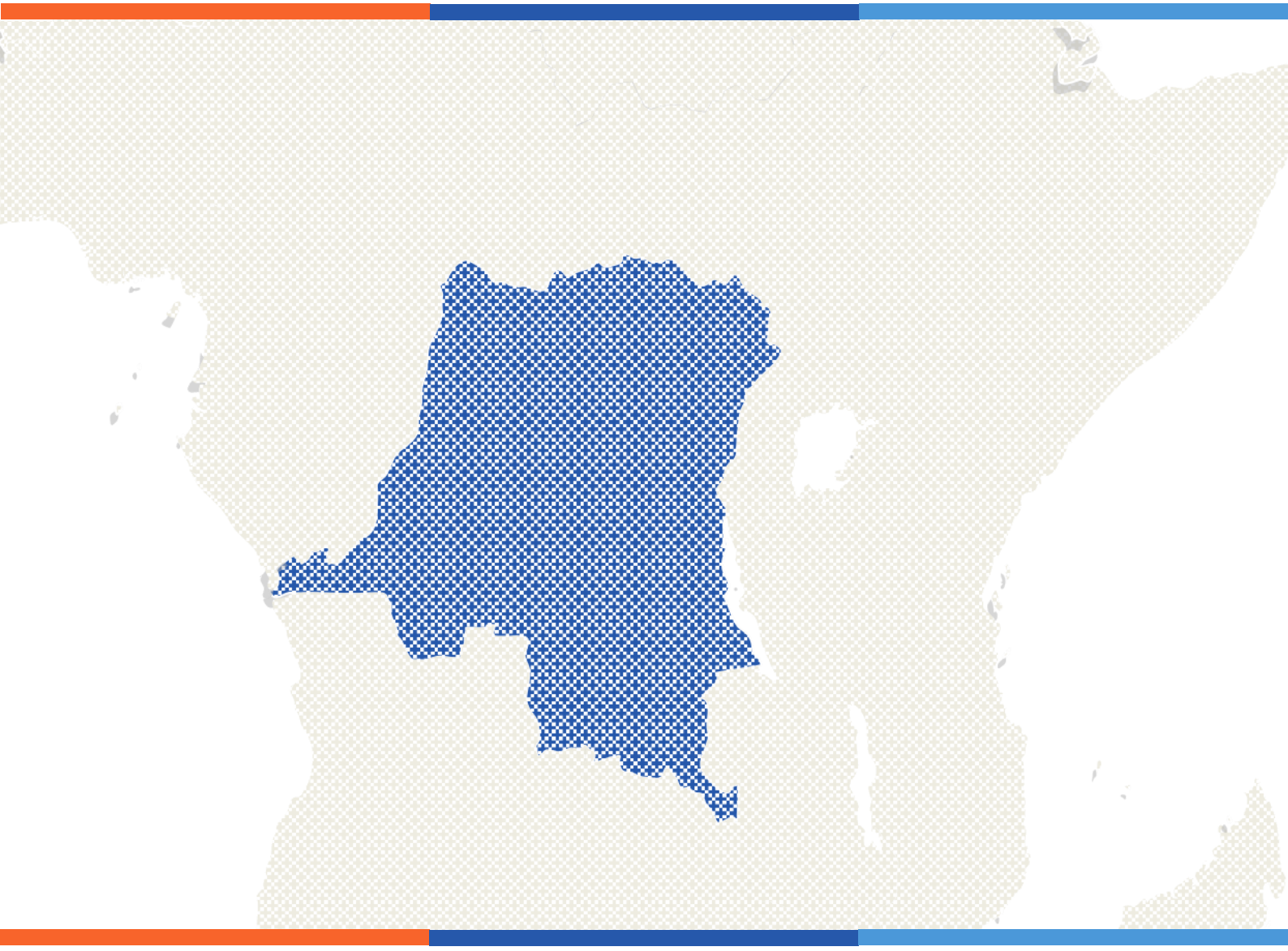

DEMOCRATIC REPUBLIC OF CONGO'S HEALTH GEOSPATIAL VALUE PIPELINE LANDSCAPE REPORT

Exploring DRC's geospatial ecosystem - 2023

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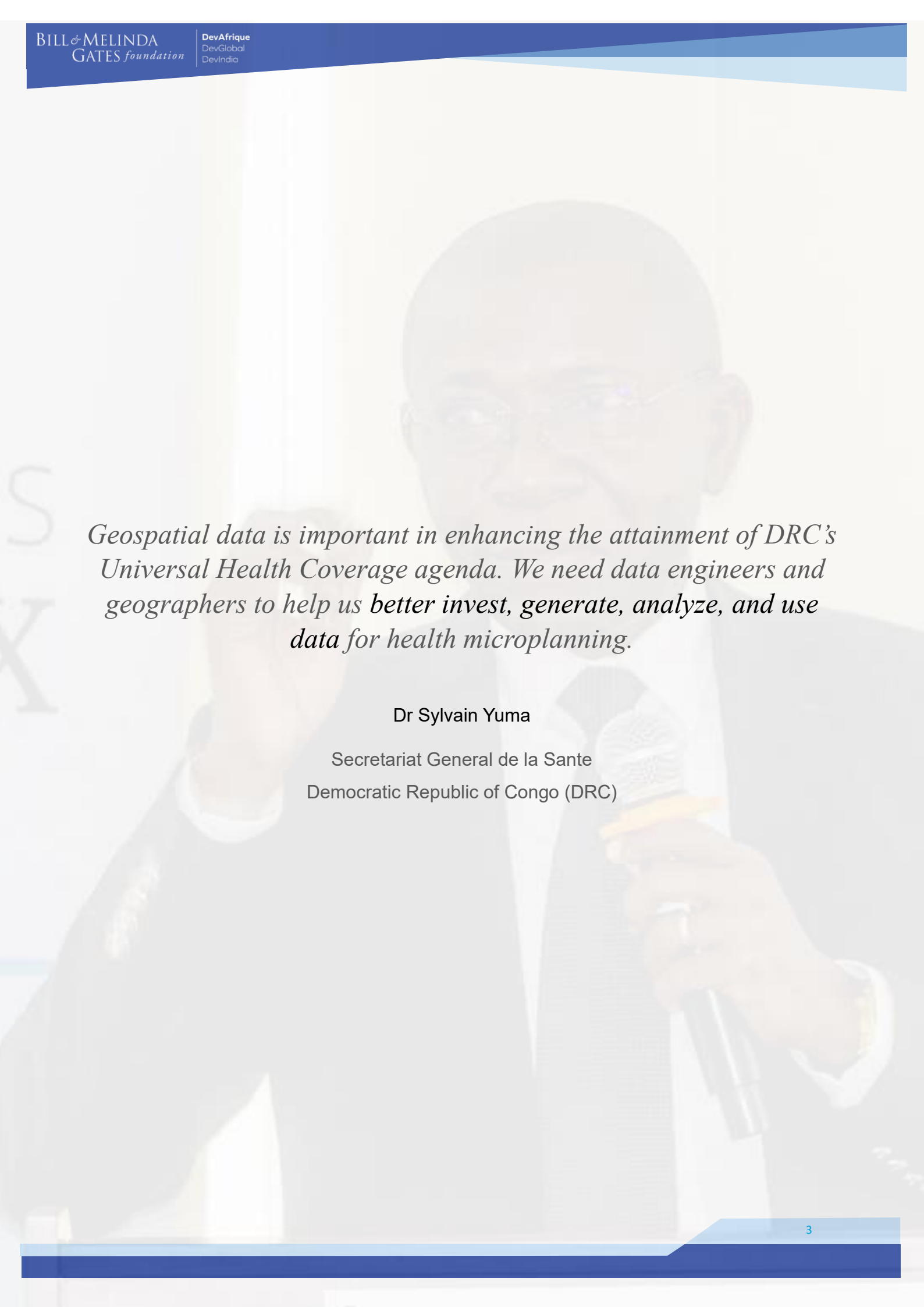

Geospatial data is important in enhancing the attainment of DRC's Universal Health Coverage agenda. We need data engineers and geographers to help us ***better invest, generate, analyze, and use data*** *for health microplanning.*

Dr Sylvain Yuma

Secretariat General de la Sante

Democratic Republic of Congo (DRC)

1.0 Acronyms

ANICNS	Agence National de l'ingénierie Clinique et du Numérique de la santé
BCR	Bureau Centrale de Recensement
BCZ	Bureau Central de la Zone de Santé
BMGF	Bill and Melinda Gates Foundation
CAID	Cellule d'Analyses des Indicateurs de Développement
CCCM	Camp Management Camp Coordination
CDC	Center for Disease Control and Prevention
CENI	Commission électorale nationale et indépendante
CHAI	Clinton Health Access Initiative
DHIS2	District Health Information Software (version 2)
DRC	Democratic Republic of Congo
DSNIS	Direction du Système Nationale de l'Informatique de la Santé
EPI	Expanded Programme on Immunization
GAVI	Global Alliance for Vaccines and Immunization
GIBS	Groupe Inter Bailleurs Santé
GRID3	Geo-referenced Infrastructure and Demographic Data for Development
GRASP	Geospatial Research, Analysis, and Services Program
IFRC	International Federation of the Red Cross
IGC	Institut Géographique du Congo
INS	Institut National de Statistique
INSP	Institut National de Santé Publique
IMWG	Information Management Working Group
IOM-MHD	International Organization for Migration – Migration Health Department
KSPH	Kinshasa School of Public Health
MSF	Médecins Sans Frontières
NASA	National Aeronautics and Space Administration
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
ODK	Open Data Kit
OSFAC	Observatoire Satellital des Forêts d'Afrique Centrale
PATH	Global Health Organization (Formerly Program for Appropriate Technology in Health)

PNECHOL	National Program for the Elimination of Cholera and the Control of Other Diarrheal Diseases
PNLP	National Program for the Fight against Malaria
PEV	Programme Elargi de Vaccination
QGIS	Quantum Geographic Information System
RDC	République Démocratique du Congo
RGC	Référentiel Géographique Commun
SANRU	Primary Health Care in Rural Environments
UCLA	University of California at Los Angeles
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
UNFPA	United Nations Population Fund
USAID	United States Agency for International Development
WHO	World Health Organization

2.0 Background and Overview

With the growing need for data driven decision making, geospatial data provides valuable insights into the relationship between people, places, and the environment. Geospatial data entails any data with a location or contains coordinate information (e.g., latitude and longitude). By combining location-based information with other health sector data sets, health programs can identify patterns, trends, and relationships for interventions. Geospatial data can further enable health project teams to accurately locate places, determine routes, calculate distances, and travel times for campaigns, identify high-risk areas, optimize emergency response routes, and provide real-time situational awareness during disasters or crises.

2.1 Overview

The findings from multiple stakeholder engagements focusing on DRC's geospatial ecosystem are presented in this report. The value pipeline assessment approach is summarized in the first section; findings on DRC's health sector geospatial data generation, analysis, operationalization, and cross-cutting themes – i.e., policy and governance, stakeholder coordination, and capacity building in the second section; and prioritized challenges and opportunities as identified by stakeholders within the ecosystem are contained in the third section.

2.2 Background

The DRC's health geospatial data ecosystem was assessed to – explore the current geospatial landscape, unravel the gaps within the ecosystems, identify opportunity areas within the ecosystem, and leverage an in-country stakeholder validation forum to determine actions needed to contribute to ongoing developments within DRC's health geospatial ecosystem.

The value pipeline framework was used to assess the ecosystem using three comprehensive pillars – data generation, data analysis, and data operationalization. It was further utilized to analyze the ecosystem within the sub-pillars, including cross-cutting sub-pillars like capacity building, governance, and stakeholder coordination. The framework also includes evaluation themes that were applied to each pillar and sub-pillar of the value pipeline framework to gain an in-depth understanding of the context.

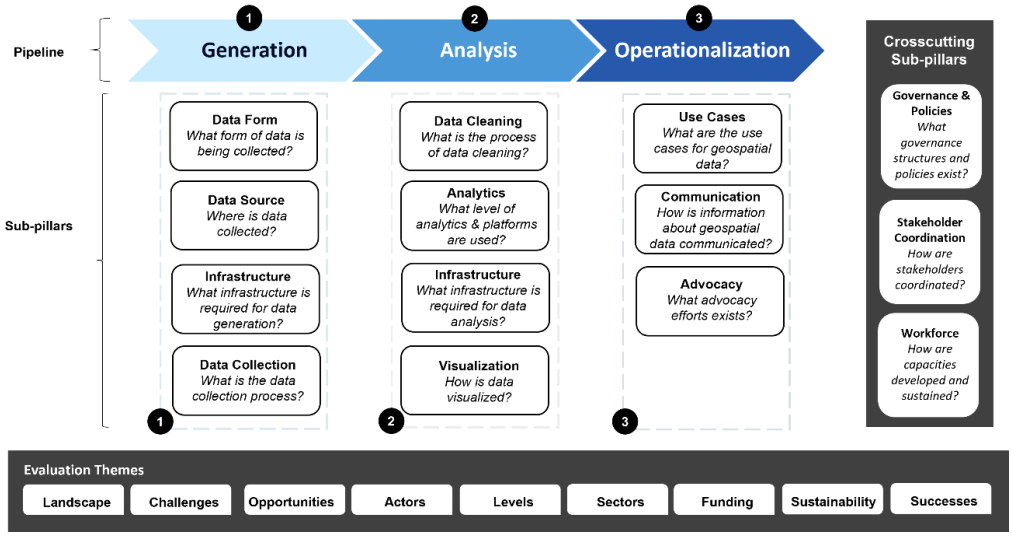

Figure 1 Geospatial value pipeline framework

3.0 Findings: Geospatial Landscape in DRC

DRC has been utilizing geospatial data for interventions since 1984, especially in population-based applications. However, the country's geospatial ecosystem has evolved rapidly over the last ten years – from minimal utilization of geospatial data to its increasing use in health interventions, including vaccine microplanning. The ecosystem is in the active development stage, with support and key investments from partner organizations in the health sector.

3.1 General Overview of Landscape

3.1.1 Geospatial Data Generation

Various forms of geospatial data are generated in the country, including settlement data (settlement extents-contours of villages and point polygons), health facility data (hospitals, health centers, health posts, and community care sites), health boundaries (health zones – 519 sub-divided into average 20 health areas) and population (high-resolution raster layers – grided layer at 100 × 100 m grid population estimate). In addition to these forms of data, transportation networks, and river bodies are collected during health mapping. Government and non-government actors largely execute data generation efforts in the country. Within the government, the Division of the National Health Information System (DSNIS), the National Agency for Clinical Engineering and Digital Health (ANICNS), L'Institut National de Statistique (INS), L'Institut Géographique du Congo (IGC), and the Kinshasa School of Public Health (KSPH) predominantly generate geospatial data. Within the non-government community, actors like the Geo-Referenced Infrastructure and Demographic Data for Development (GRID3), World Health Organization (WHO), Bluesquare, Primary Health Care in Rural Environments (SANRU), IMA World Health, ACASUS, International Federation of the Red Cross (IFRC), National Program for the Fight against Malaria (PNLP) and Humanitarian Open Street Maps (HOSM) have played active roles in data generation. The NGO sector's data generation efforts are organized through their various projects and partnerships with government agencies. The University of California (UCLA) also collected geodata on health in Mai-Ndombe, Kwilu, Kwango, and Kinshasa. Despite multiple data collection efforts, data harmonization remains a concern, with some of these organizations lacking a repository to share collected geospatial data with the geospatial community.

The generation of geospatial data is triggered by program and government demands. Both programs and the government have specific questions that they want the data to answer. Under programs, data are generated to plan for their interventions, quality monitoring, and service delivery. For example, the desire to understand the malaria program's coverage of insecticide treated bed net distribution campaign triggered the geo-referencing of all their distribution data in partnership with SANRU and IMA, and they relied on GRID3 to monitor and visualize coverage quality for further decision making. Similarly, the EPI (PEV) Polio campaign program extensively relies on geospatial data and vastly contributes to data generation efforts in the provinces of Haut-Lomami and Haut-Katanga. The data are mainly used to expand

and better streamline the polio vaccination strategy in these provinces.

There are multiple geospatial data sources within the ecosystem, with the four most common being the GRID3 data hub, Common Geographical Repository (RGC), DHIS2, and Bureau Centrale de Recensement (BCR) by the National Statistical Agency (INS). The data within these repositories are not fully interoperable. Bluesquare and GRID3 are working to ensure that data within the ecosystem is interoperable. The partnership is focused on ensuring that all health data are updated, captured from different sources, validated, integrated, uniformly formatted, and may be linked to the DHIS2 system. GRID3 and Bluesquare, through the GRID3 technical committee (explained in the stakeholder coordination section), ensure that all the new data from the different working groups are standardized and interoperable by doing regular updates and validation with all stakeholders.

set up in 2006 to update the RGC's datasets regularly. GRID3 works with various working groups in the ecosystem to improve health mapping.

Stakeholders within the ecosystem also have their primary geospatial data archived within their institutions and mostly not shared widely with other actors. These in-house data need to be validated by the IGC if they are to be presented as valid for operationalization and sharing within the ecosystem and internationally. Unlike in other countries, the IGC (instead of the national statistics agency) is mandated to validate all national geospatial data. For this purpose, they also serve on the GRID3 technical committee (discussed in later sections). The other sources of data include repositories and websites like the EPI, NASA website, RGC (Référentiel Geographique Commun), Quickbird, OSFAC, Humanitarian Data Exchange, and Cellule d'Analyses des Indicateurs de Développement (CAID).

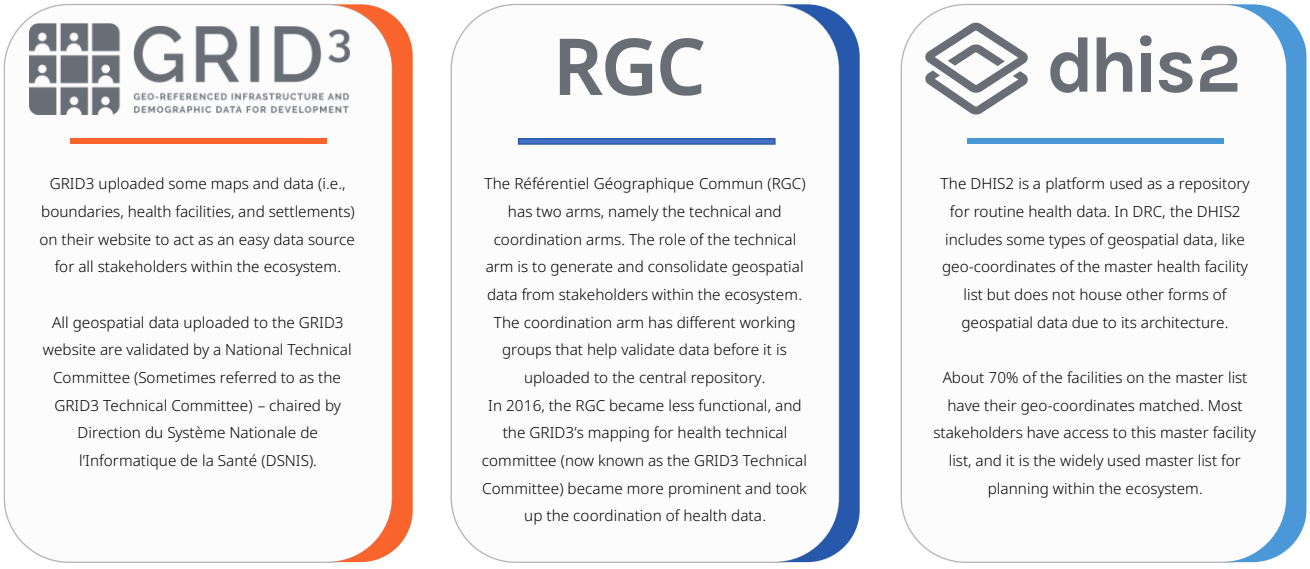

Figure 2 Common geospatial data sources within the ecosystem

However, working groups existed before the GRID3 technical committee, with the initial ones

Existence of geospatial data is not uniform across provinces in DRC due to digital

disparities across these provinces (regions) and health zones – i.e., provinces with high donor investments in geospatial data (Haut-Lomami, Tanganyika, Haut-Katanga, Maniema, and Kasaï-Oriental) have digital maps available compared to those with low or no donor involvement (provinces such as Sankuru, Lualaba, South Kivu, Maindombe, Mongala, Tshuapa, North Ubangi, and South Ubangi), as they had to focus their efforts more on emergency interventions or outbreak operations. This challenge is further compounded by the size of DRC – with 26 provinces and 519 health zones – making universal last-mile implementation extremely challenging. Some provinces are the size of other African Countries or bigger. For example, the schedules and the processes for vaccination programs are set at the national level and should cover all provinces. But in practice, the processes adopted for one province would not be the same as others. This difference is mainly due to variations in the realities and challenges encountered from province to province.

> *"… Once you get to a country of this size, the local-level implementation becomes very complicated. The differences in the use of technology alone are vast. Some populations are still learning how to use Cell phones for vaccine collections…"* – UCLA

The DRC consists of three distinct contexts of health zones: urban, rural, and mixed urban-rural (peri-urban). Information technology literacy, energy access, and network coverage vary vastly among these contexts (and often within the same context) and affect geospatial data generation, adoption, or access. To ensure that some provinces are not left out due to the digital disparities, stakeholders use digital and printed maps to ensure that all contexts are covered. Also, owing to limitations around the availability of digital tools, most of the stakeholders – including government agencies - store their geospatial data on computers and USB sticks. For example, DSNIS stores its geospatial data on computers as they lack a data hub, server, or central repository. There are currently some isolated discussions on developing a central repository, but still inconclusive[1]. The DHIS2 is the closest platform that compares to a centralized repository in DRC. Even though the DHIS2 is widely used, it cannot host data beyond health facility lists (e.g., settlement data) mostly because of its architectural limitations.

Geospatial data-generating capacity at the provincial level is limited, which could partly be attributed to the digital disparities mentioned in the previous paragraph. At the same time, limited financial capability at this level inhibits large-scale procurement and adoption of better-quality tools by various units of the Ministry of Health at national and provincial levels. As a result, the Ministry has adopted a revolving solution to the skill gap cases by deploying national level Ministry of Health staff – in most cases - to support provincial staff whenever skill gaps exist. Generally, this national level support is provided during data validation, as noted in the analysis section of this brief. When skills are unavailable among government actors nationally, the development partners bridge this gap by investing in external consultants to

[1] ANICNS is currently developing a centralized data repository to host all health data.

support data generation efforts. Like several African countries, DRC has no dedicated space agency for satellite data generation; instead, they partner with the private sector and development partners like the World Health Organization and other United Nations agencies.

Geospatial data generation is mainly funded by development partners and non-governmental organizations, mostly from the Bill and Melinda Gates Foundation (BMGF), Global Fund, GAVI, USAID, World Bank, Africa Development Bank, WHO, and other UN agencies.

3.1.2 Geospatial Data Analysis

Geospatial data within the DRC is not fully interoperable due to the limited standardization of generated data and the limitation of the existing repositories. Partners like GRID3 and Bluesquare are working to standardize the core data layers for better interoperability, serving as the basis for a system capable of improving cross-organizational collaboration and interconnectedness of geospatial data available in the country. Interoperable data allows for the integration of diverse datasets from multiple sources. This enables comprehensive analysis, pattern recognition, and the generation of holistic insights. By combining different data types, such as geospatial data and demographic data, health projects can gain a deeper understanding of complex phenomena, make data driven decisions, and discover new insights.

The Ministry of Health (MoH) in DRC uses a bottom-up approach for geospatial data validation within the health sector by hosting monthly data validation meetings starting within the health zones. However, this validation process happens frequently during public health emergencies and occasionally during non-outbreak periods due to the limited resources of the Ministry of Health. The effectiveness of the bottom-up approach in data validation is acknowledged by development partners like UCLA, as noted below:

> *"…Local healthcare workers know where health facilities are, but national organizations coming into DRC do not, and are not getting accurate maps due to a top-down approach. The bottom-up approach is the most effective…."* UCLA

So far, the government validation process has not used satellite imagery (INS recently started using satellite imagery for validation), elevations, or good-quality raw data for the redefinition of boundaries. GRID3, a non-profit partner to the government, has one of the most robust validation processes within the ecosystem. The IGC uses some satellite simulations supplied by the University of Tervuren, but due to the lack of qualified staff and the necessary equipment, these simulations are not extensively used. See Figure 3 for an example validation process.

The validated data using the bottom-up approach and often checked by the GRID3 national technical committee (discussed in the cross-cutting section), are often adopted for geospatial analyses.

Geospatial analyses conducted within the health sector are still at the intermediate stage using ArcGIS, PowerBI, and other visualization dashboards. ANICNS proposed the creation of a dashboard that will leverage a centralized data repository, but this centralized repository does not yet exist. The current dashboards are

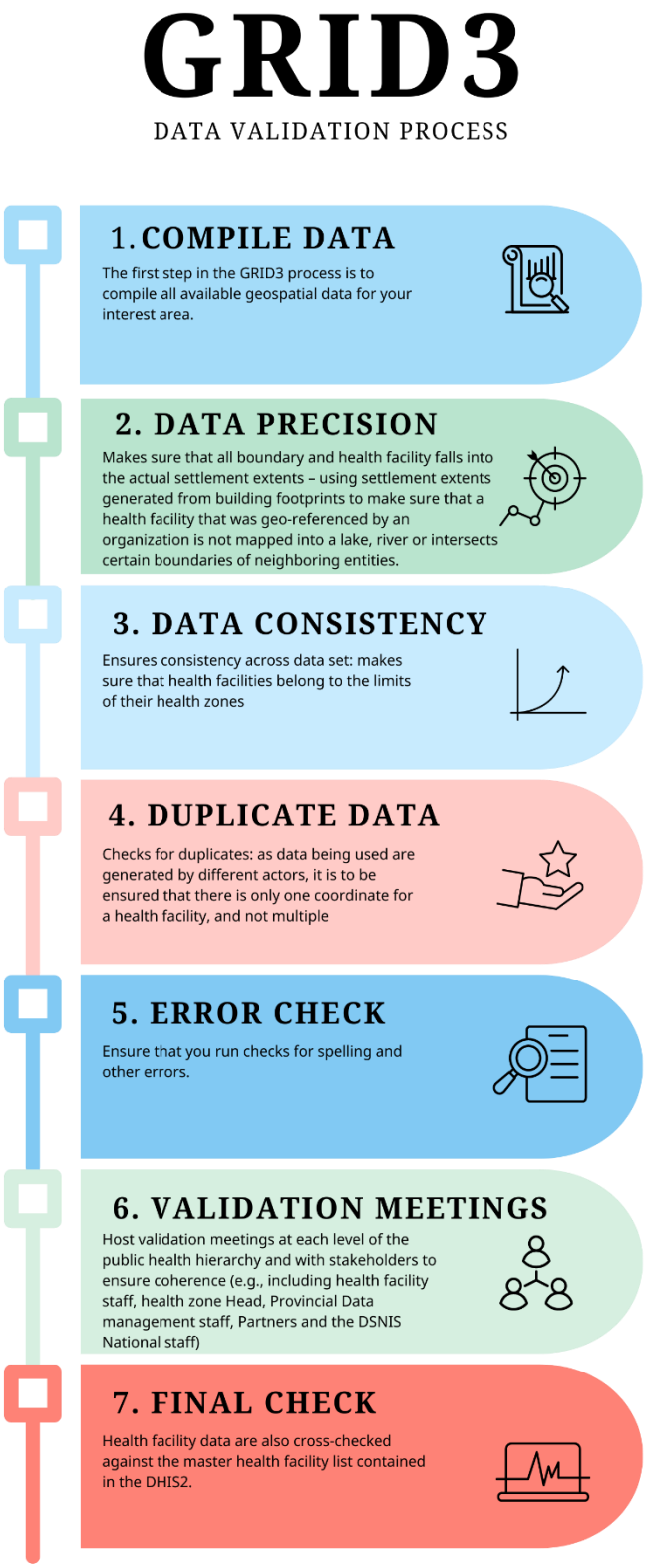

Figure 3 Example of validation in DRC's health geospatial Ecosystem

program specific and siloed – preventing stakeholders from using a single platform to visualize all available geospatial data. Some actors within the health ecosystem are exploring cross-cutting analyses to generate more insight from geospatial data. For example, ACASUS uses vaccination data for analysis to inform microplanning but is further exploring the potential of using this data to explore child migration trends for vaccination planning.

> *"…We can analyze vaccine data to generate trends in migration. For example, when our teams visit a particular community and find X number of children, then go back after six months and find a lot more or fewer (close to zero) children than usual, we can do an analysis that shows us that this is a moving population. We can do this with data that is already captured over time. Because we generate very granular data, the analysis potential is limitless, but we currently mostly only use it for management-focused decision type of analysis…."* – ACASUS

The potential of advanced geospatial data analysis using artificial intelligence and machine learning is nearly untapped within DRC's geospatial data ecosystem. This is mainly due to limited skills within the ecosystem – especially among government actors. Given the growing demand for geospatial data, there are opportunities for advanced geospatial analysis.

Stakeholder collaboration in the geospatial analysis pillar is increasing significantly with the cooperation and coordination of development partners like the Gates Foundation, Global Fund, GAVI, WHO, OCHA, GRID3, Bluesquare, ACASUS, OSFAC, and Red Cross Federation. For example, the Global Fund collaborated with the University of Geneva and SANRU to analyze

population data for community healthcare sites in Maniema, and with GRID3 and GAVI for the Malaria program. Also, the Gates Foundation collaborated with CHAI to analyze whether community care sites were adequate for the population distribution with support from GRID3 for the Cholera program.

DRC's geospatial ecosystem is witnessing an increasing adoption of geospatial data visualization platforms to enable decision making around programs. For example, the malaria program uses a dashboard to visualize the distribution of bed nets. Similarly, GRID3 developed a dashboard for the malaria program to verify and display settlements that are covered by the program. GRID3 also supports the Global Fund with a visualization that displays deviation or fraud from the bed nets distribution protocol.

Similarly, ACASUS developed a vaccination tracking system that monitors the zero-dose children vaccination process in the provinces of Haut-Lomami and Tanganyika. This immunization program uses dashboards to monitor whether the immunizer or immunization campaign teams cover their assigned areas. However, most of these dashboards are designed for the provincial and program levels rather than the country level. At the national scale, Bluesquare developed a dashboard for the Ministry of Health on a platform called IASO to give an overview of the proportion of health facilities across health zones with available coordinates.

3.1.3 Geospatial Data Operationalization

Geospatial data operationalization covers translating geospatial data into use cases, communication, and advocacy around the data and uses cases.

Geospatial data use cases in DRC are mostly within the health and agriculture sectors. The health sector is the most advanced in operationalizing geospatial data due to emergency response efforts on health epidemics, polio, and routine immunization programs. Population mobility mapping by IOM-MHD, which helps to evaluate the population flow in relation to the evolution of the Ebola outbreak, is an example of a use case from the health sector. Other uses for geospatial Data in DRC are urban planning, transportation planning, and population estimates. Most geospatial use cases align with the priorities of the donor organizations and health crisis responses.

DRC has advanced significantly in the uptake of geospatial data for health planning and interventions. Currently, the government – with the support of development partners – is increasing its adoption of geospatial data for use case generation. For example, Global Fund has partnered with UNDP in Maniema province to pilot the use of population data to profile accessibility of care for better service delivery. The national Malaria and Cholera programs also use geospatial data to decide where to set up community care sites. Figure 4 shows an example use case for geospatial data.

Communication on the benefits and use cases of geospatial data among actors within the ecosystem is limited, with no repository of use cases and outdated information on stakeholder websites. However, there are some project and intervention-related communication efforts among specific stakeholder groups, for example, the Ministry of Health, OCHA (through

the Humanitarian Data Exchange), GRID3, ACASUS, WHO, and other non-profits. In the health sector, most geospatial communication efforts are around the promotion of the use of health status maps and products informed by data on outbreak cases dashboards, among others.

USE CASE SPOTLIGHT

MALARIA BED NET CAMPAIGN MICROPLANNING AND COVERAGE MONITORING

GRID3 uses geospatial data to generate maps that enable the Malaria program to know the accurate distance between health facilities and villages for outreach activity planning. These generated maps, help the province and health zones to determine the logistics and staff needed for the bed net distribution campaign. GRID3 has also built a geo-referenced dashboard to enable the malaria program to track the coverage of its interventions.

Figure 4 example of geospatial use case for malaria

Advocacy around the use and financing of geospatial technology is evolving – the most recent being from ANICNS. On 7 April 2023, the new digital transformation of the health system operational plan was presented to the Minister of Digital, Désiré-Cashmir Kolongele, by the director of ANICNS, Jean Thierry Kalombo. The plan proposes consolidating all digital data from various fields into a DRC data center. Post the presentation of the plan, the government is engaging partners to raise funds and plan for its execution. In addition, ANICNS is developing a framework to ensure the digital transformation of the entire health system to support the implementation of the country's universal health coverage plan.

According to this new strategy, ANICNS will take on a broader responsibility of stakeholder coordination within the data ecosystem, including geospatial data, as it leads the digital transformation for the health sector vis-a-vis the health data storage, management, and protection.

3.1.4 Cross-cutting Pillars: Geospatial Data Policies and Governance, Stakeholder Coordination, and Capacity Building

DRC's Ministry of Health (MoH) has set up the National Agency for Clinical Engineering and Digital Health (ANICNS) – an agency to manage all digital and information technology governance for health and clinical engineering. ANICNS is a public scientific and technical agency – under the auspices of the Ministry of Health – whose mission is to support the digital transformation of the healthcare system, ensure the digital governance of universal healthcare coverage and clinical engineering in the Democratic Republic of Congo. ANICNS is unique to the Ministry of Health and is envisioned to reduce the compartmentalization of digital systems for their multiple programs (e.g., malaria, polio, and HIV) by consolidating dispersed health data into a data center, which has been a challenge within the Ministry of Health.

> *"... multiple programs that exist within the Ministry of Health or in other ministries have compartmentalized information systems, making it impossible to have a Dashboard of all diseases. For example, in our country, we do not have any. We have a Malaria Dashboard, you have*

initiatives on polio, you have some initiatives on HIV and other diseases. It is a silo…." - ANICNS

ANICNS continues to evolve after three years of operation with ongoing recruitment and redefinition of their objectives and scope of interaction with other Ministry of Health departments like DSNIS. The evolution of ANICNS and its intersection within the Ministry of Health data units remain ambiguous – initial interviews with stakeholders showed that roles and responsibilities are still unclear – e.g., who is doing what, how, and with which budget. The lack of clarity around the roles of ANICNS within the geospatial data setup of the Ministry continues to create complexity in stakeholders' interaction with the Ministry of Health. Most of the geospatial stakeholders within the health sector still view DSNIS within the Ministry of Health as the primary actor responsible for geospatial data.

There is not one window arrangement for existing governance policies for geospatial data, as each sector has its policies. For example, the UN Agencies on emergency response and OCHA coordinate and direct emergency data and alerts through the IM Working Group.

Despite the evolution of ANICNS within the health sector, no official policy or governance system is set up for the broader geospatial ecosystem in DRC. As a result, there are overlapping and unclear mandates among some government agencies like ANICNS and DSNIS. Further, the Ministry of Digital Affairs, ANICNS, OCHA, PATH, GRID3, ACASUS, and Ministry of Health (DSSP/DSNIS) would all be crucial to developing and supporting a governing body in DRC.

Institutions such as ANICNS, the Ministry of Digital Affairs, and SNIS/DSNIS, among others, are funded by the DRC government through the approval of the Ministry of Health and with the support of other organizations such as PATH, WHO, UNICEF, GAVI or projects such as GRID3 and ACASUS. To ensure sustainable funding for digital health beyond donor funding, the Ministry of Health has set up the National Institute of Public Health (INSP). The INSP generates its funding from taxes and the health promotion fund royalties.

"… *today we know that digitalization is strongly supported by our partners, which is a good thing, but when a program or a project stops, what happens? There is no continuity in collecting information, no continuity in processing, and no continuity in having funds. So, the idea is to have INSP provide the means that will make it possible to sustain the different projects*…." – ANICNS

Coordination among geospatial stakeholders in DRC is diverse and structured along sectoral or programmatic needs. These may include:

- Humanitarian/Non-profit programmes – are coordinated or grouped under clusters or working groups such as IM Working Group, Logistics Cluster, Health Cluster, Protection Cluster, CCCM Cluster, etc.
- Health programs – are grouped and often coordinated around the Ministry of Health under the leadership of the General Secretariat of Health, the SNIS/DSNIS.
- Population programs – are grouped under the Ministry of Planning, with support from UNFPA, INS, BCR, IGC, CENI.

- Other private stakeholders are included in the structures mentioned above based on their areas of focus and programming.

DSNIS and ANICNS are leading the coordination of health geospatial data governance in DRC. Nevertheless, structures such as the GRID3 technical committee, IM Working Group, and Logistic Cluster support ANICNS and DSNIS with the coordination of geospatial stakeholders within the ecosystem.

GRID3's technical committee[2] – led by DSNIS – coordinates different actors within the health geospatial sector. It was initially started as the Mapping for Health committee during the mapping for health project implementation between 2020 and 2021. Since then, it has started the coordination of stakeholders on the generation of data for core geospatial data layers (i.e., settlement, health facility, population, and transport networks). The GRID3 working groups focus on the use of geospatial data to support – EPI interventions in the field; health

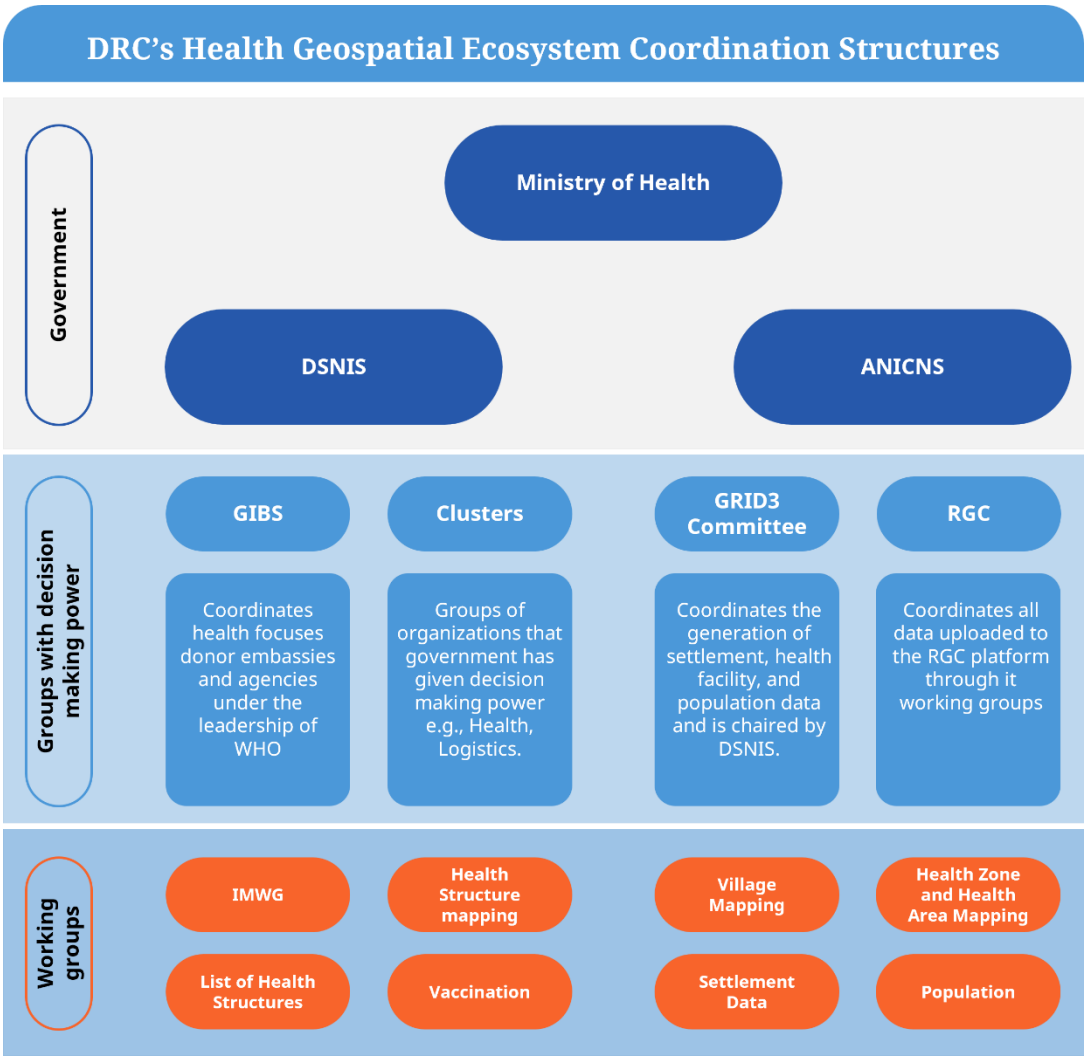

Figure 5 Summary of coordination structures within DRC's health geospatial ecosystem

[2] The technical committee is called the GRID3 technical committee because it was initially set up by GRID3 as part of the mapping for health project.

mapping and data governance by addressing the process of obtaining, publishing, owning; and in maintenance of all data collected and created in implementation of GRID3 project. The committee has about 26 organizations, including Bluesquare, CHAI, and Red Cross, working together to centralize the geospatial data while linking it with all other data, including polio, immunization, etc.

In addition to stakeholder coordination structures along program needs, geospatial stakeholder coordination in DRC was modified to ensure relevance and sustainability. For example, DSNIS has quarterly meetings with development partners for better coordination regarding geospatial data. ANICNS, unlike DSNIS, does not have a defined coordination meeting cadence as the institution is still getting grounded.

The Inter Donors Health Group known as GIBS (Groupe Inter Bailleurs pour la santé), aside GRID3, DSNIS, and ANICNS, – is a group of partners that meets regularly under the World Health Organization's (WHO) coordination and is limited to bilateral and multilateral cooperation, United Nations, and global vertical donors such as GAVI and the Gates Foundation. The GIBS is not embedded within the Ministry of Health, but rather coordinates donor embassies and agencies focuses on health. The GIBS includes representatives from various donor agencies, including the World Bank, the European Union, the World Health Organization (WHO), the United Nations Children's Fund (UNICEF), United Nations Population Fund (UNFPA), Joint United Nations Programme on HIV/AIDS (UNAIDS), Global Fund, GAVI, and South Korea and the Bill and Melinda Gates Foundation as observer members. As of 2020, the GIBS Coordination is managed by Dr Amédée Prosper DJIGUIMDE from WHO.

Capacity building efforts within the ecosystem are mostly driven by in-person or online courses taken on independent open websites and capacity building sessions organized by donors and other stakeholders involved in specific campaigns. For example, ACASUS trained nurse supervisors on geospatial technology in health zones. Using train-the-trainer model, the trained nurse supervisors re-train lower health officers within a month of the training and further support these lower staff in use of – mobile phones, vaccine tracker, and microplanning. Most training efforts within the ecosystem target government staff at the national and district level. The training efforts mostly cover geospatial basics like the use of QGIS and data collection. Further, training efforts are linked to partner projects which have other goals beyond training and defined closure timelines, therefore, training efforts end up not sustained and treated as proxy interventions.

3.2 What is Working in the DRC Geospatial Ecosystem

As part of the assessment Dev-Afrique engaged geospatial stakeholders in the DRC to explore systems and processes that are effective in the geospatial ecosystem. These effective systems and processes span the three core pillars of the value pipeline – generation, analysis, and operationalization – and the cross-cutting stakeholder coordination, capacity building, and governance sub-pillars. Stakeholders in DRC identified the processes that should be sustained. These are discussed in this section.

3.2.1 What is Working in Geospatial Data Generation

Increasing Donor Support

Actors within the geospatial ecosystem are receiving increased donor support to generate, digitize, and operationalize geospatial data across several provinces in the country. Recent donor support has targeted data generation at the health zone and health area levels. In addition, donor funding extends to procuring geospatial tools and processes, including data generation, training, and strategic planning.

Availability of the master facility list in DHIS2

The DHIS2 is one of the most expansive data repositories in DRC. It also contains the master health facility list that is accessible to all stakeholders within the ecosystem. Despite up to 30 percent of health facilities not being geo-referenced, local stakeholders mentioned that the DHIS2 remains the reference repository for most health-focused stakeholders and advocated for its sustenance.

Launch of GRID3 published data

Over the years, GRID3 has extensively mapped several provinces in DRC. These data – including boundaries, health facilities, and settlements – were published on the GRID3 website to increase accessibility by all stakeholders and support programmatic planning.

Launch of the technical committee

The technical committee - chaired by DSNIS - is crucial in coordinating geospatial stakeholders within DRC's health sector. The advent of this technical committee improved access to geospatial data among actors aware of the committee's existence, but it is still a challenge for those who are unaware. The committee has a listserv of its members who regularly receive validated and updated data from partner organizations. Nonetheless, stakeholders cited the coordination role of this technical committee as effective, including utilizing a mailing list for geospatial data updates.

Utilization of GRID3 micro-census data for microplanning

Given the lack of a recent national census and the absence of reliable government population data within the ecosystem, actors such as ACASUS have relied on the population estimates from GRID3 micro-census activities.

Current geospatial data is enabling vaccination microplanning for vaccination campaigns

The generation of geospatial data by several actors within the ecosystem improved vaccination microplans and health maps of

health zones. However, despite the continued impact of geospatial data on vaccination campaigns, more resources and efforts are needed to expedite the expansion of data generation efforts.

3.2.2 What is Working in Geospatial Data Analysis

Availability of GRID3 standardized data validation process

GRID3's comprehensive data cleaning and validation process is well standardized and has proven to be crucial in analyzing geospatial data within DRC's ecosystem. GRID3 currently fills the geospatial data validation and standardization gap within the government.

Existing bottom-up approach for data validation

The government uses a bottom-up approach in some districts for data validation. This validation approach – supported by donors – involves on-the-ground validation and monthly reporting meetings with sub-national staff. Though expensive, this bottom-up data validation process has been effective thus far in the few provinces where it is implemented. This works well in provinces with donor support compared to those without – due to its resource-intense nature.

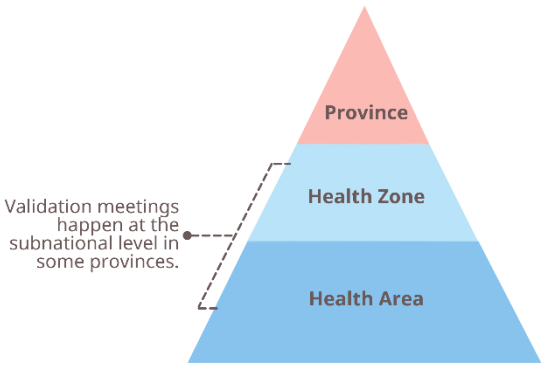

Figure 6 Bottom-up validation in some provinces

Utilization of geospatial data analysis for programmatic interventions and planning by stakeholders

More stakeholders can clean and analyze data using tools like Excel and Power Query, while Illustrator, InDesign, Kobo Collect, Google Forms and Power Bi are used for the collection, analysis, and visualization of geospatial data. For example, the National Institute of Demographic Studies (NIDS) used geospatial data to identify existing health centers and populations with access to health services. They used the information to prioritize essential areas for constructing new community care sites and geo-referential microplanning for family planning (FP).

Data Visualization Outputs Are Enabling Last-Mile Delivery

Stakeholders cited that visualization outputs like dashboards and digital or paper maps contribute significantly to effective last-mile delivery.

3.2.3 What is Working in Geospatial Data Operationalization

Increasing use of geospatial data for microplanning/routine immunization

The government's health ministry and other actors acknowledged the increasing importance of geospatial technology in the country's health planning, including immunization microplanning. RGC, GRID3, and DHIS2 data are being used by UNICEF, ACASI, WHO, and PEV (EPI programme) to translate geospatial data into

microplans that the immunization teams use for operational planning and expansion of coverage.

Increased use of dashboards and tracking systems

Digital dashboards are increasingly being adopted across the program areas in DRC. These dashboards have proven to be crucial for program monitoring and evaluation. For example, the malaria program uses a dashboard to track bed net roll-out coverage in DRC. Similarly, the vaccination tracking system developed by ACASUS is also being piloted in Haut-Lomami and Tanganyika provinces to track vaccination coverage, and help vaccinators register up-to-date data.

Communication

Stakeholders have organized some project-specific workshops with their partners. These project workshops have facilitated collaboration among certain actors but not ecosystem-wide. However, stakeholders note that a lot of the meetings happen only in Kinshasa. They further noted that the meetings are not frequent due to the associated cost of facilitation.

3.2.4 What is Working in Governance, Stakeholder Coordination and Capacity Building

Creation of ANICNS

The Ministry of Health created ANICNS in 2018 to support Health Digitization in DRC. This is a significant change in the government structure, and the roles within the agency are still unclear, which unfortunately creates more complexity at the administrative level. Although ANICNS has been functional for the last three years, yet it is understaffed and underfunded.

Increasing stakeholder coordination on geospatial technology

Coordination efforts are being made within the health sector over the past years. This increasing coordination is supporting partnerships and gradually reducing duplication within the ecosystem. The GIBS, RGC working groups, and GRID3 2020 technical committee are the major successful geospatial coordination structures available for data validation and sharing.

One of the ecosystem's successful stakeholder coordination and advocacy efforts is the IM Working Group, which operates at the humanitarian level and tries to advocate and coordinate all IM and GIS efforts. The IMWG, chaired by OCHA, constitutes international organizations working on information management. The IMWG seeks to define information management standards, standardize tools, and provide information on use cases and gaps within the ecosystem.

Integration of EPI monitoring data into DHIS2

The integration of the EPI monitoring data into the DHIS2 each week and its extraction to prepare the weekly monitoring cell meetings were effective. Bluesquare's development of an interface– piloted in February 2023 - that allows for quarterly updates and seamless download of the data from DHIS2 has complemented this effort.

Launch of the Digital Square project- funded by USAID

Stakeholders highlighted the launch of USAID's Digital Square Project in March 2023 as crucial to DRC's geospatial ecosystem. Digital Square project provides technical support to bridge the health equity gap in DRC. Specifically, the project aims to 1) strengthen institutional capacities of ANICNS, 2) Support the MoH through the next stage of development of the investment roadmap.

Existing Training Programs

The following are examples of training programs in DRC's health geospatial ecosystem:

Data managers are trained on how to better handle geospatial data for online polio campaign data using the DHIS2.

Training of field actors on the use of ODK tool in the identification of households for distribution campaigns of mosquito nets.

On-site training of central-level data managers in seven provinces through the GRID3 Mapping for Health project.

Adoption of GIS tools by some health zones

Despite limited geospatial capacity and adoption in some provinces, some health zones and DPS agents adopted GIS tools. Most of the health zones adopting GIS tools fall within donor-funded provinces.

USE CASE SPOTLIGHT

VACCINATOR TRACKER FOR VACCINATION CAMPAIGNS

ACASUS developed a technological vaccinator tracker for two provinces – Haut-Lomami and Tanganyika. The application allows the vaccinator to report more regular and detailed data. The application registers geolocations even when a location has limited internet connectivity. It allows the vaccination team to understand the covered locations. ACASUS uses GRID3 data to map out where health facilities are and to understand population distribution for planning whether to have a fixed or satellite session. A 2021 evaluation showed that about 85% of the health facilities in the two provinces are using recommendations generated from the vaccinator tracker as they are, and 15% adapt them based on their realities.

3.3 What is not working in DRC Geospatial Ecosystem

The DRC geospatial value pipeline assessment also explored major challenges within the generation, analysis, and operationalization pillars through desk research, in-person interviews, and a broader conversation at the 2023 DRC geospatial stakeholders' forum (see annexure 3 for forum attendees). The stakeholders prioritized the challenges based on how impactful and feasible addressing them would be. Table 1 summarizes the challenges that were prioritized by stakeholders in DRC's health geospatial ecosystem.

3.3.1 Geospatial Data Generation

Inaccuracy of existing data

With no metadata available on most existing data, the accuracy of geospatial data in DRC is one of the major challenges within the geospatial ecosystem. The available geodata and geolayers for most health areas do not overlap due to these inaccuracies. In addition, there is a variation between the recorded boundaries in the health areas and health zones and the actual boundaries cited during field visits or program implementation. This is also true for boundaries at different administrative levels. For example, interviewed stakeholders cited the RGC repository as having imprecise geospatial data for a large part of DRC. Further, the inaccuracy in some of the existing data that is layered with geospatial data could be attributed to the inaccuracy of the data provided by the local survey respondents during health campaigns.

The inaccuracy of existing data is also caused by the poor management of boundary changes, positions, and inconsistency in the names of health areas. Stakeholders mentioned that a health area can be called Ngoyi today and abruptly change to Yumba the following day, even though it was initially mapped under the previous name. Further, the same trend is observed when regional divisions are being implemented. These changes increase the cost of data generation as the generated names have to change, and sometimes, the areas in one region may end up in another.

Incomplete geospatial data

Beyond the inaccuracy of geospatial data in DRC, most geospatial data are incomplete. Currently, only 15 out of 26 provinces in DRC have their settlements, health facilities, roads, and health area and zone boundaries mapped – largely by GRID3 and Bluesquare. Despite these efforts, provinces like North Kivu, South Kivu, and Ituri have incomplete geospatial data, while Sud Ubangi and Nord Ubangi have no mapped data. The lack of mapping efforts in some of these health zones and provinces can be attributed to insecurity and lack of priority by development partners. Interviewed stakeholders highlighted insecurity within the country as one of the major reasons for gaps in data collection. For example, stakeholders mentioned that some villages in the Lake Tanganyika area could not be mapped due to fears of being attacked by rebel groups.

No centralized data repository

There are many health area data circulating within the ecosystem due to the lack of a central data repository. Many versions of the data are circulated informally within the ecosystem due to

the difficulty in accessing data from DSNIS due to long and bureaucratic processes. The lack of a centralized repository causes difficulties in data access among stakeholders within the ecosystem. Most actors store their geospatial data on in-house computers, USB sticks, and external hard drives. Despite the lack of a centralized repository, the DHIS2 portal is the most expansive platform in DRC – housing some of the health geospatial data. Eben though the DHIS2 houses some geospatial data, it does not include all types of geospatial data due to its architecture.

Disparities in the level of digital access across provinces

The capacity to utilize geospatial tools and systems varies significantly across health zones and provinces in DRC. This disparity is largely influenced by the level of donor investments in specific health zones or provinces. Provinces with high donor investments – such as Haut-Lomami, Tanganyika, Haut-Katanga, Maniema, North Kivu, and Kasaï-Oriental – have better access to and utilization of digital maps compared to Provinces with low or no donor involvement – such as Sankuru, Lualaba, South Kivu, Maindombe, Mongala, Tshuapa, North Ubangi, and South Ubangi. Some of these provinces with low to no support have no geospatial data.

In some provinces – North Kivu, South Kivu, and Ituri – with access to digital tools, the digital health development plans are not utilized or implemented. This is mainly due to limited financial, human, skills, and organizational capacity. In other instances, the province reverts to hand-drawn maps due to limited access to printers capable of printing new or updated maps.

Limited technology, internet, and tools for data generation

Last-mile implementers at the provinces and health zone/area levels have limited access to computers, GPS tools, smartphones, and other technologies due to power outages and limited internet connectivity. The limited technology and internet make it difficult to generate geospatial data, especially at the last-mile, where these are huge challenges.

In some provinces like Kasaï, Lomami, North Ubangi, South Ubangi, and Sankuru, the computer equipment are outdated and unable to run newer applications like QGIS or ArcGIS.

Gaps in the sustainability of data generation interventions

Sustainability continues to be a major challenge with geospatial interventions. Despite the donor investment over the years, several geospatial interventions could not be sustained without the continued support of implementing partners or financing from donors. For example, the Global Fund purchased about 5,000 tablets for health centers across the provinces about two years ago. However, owing to poor monitoring and ownership of this intervention by the government partner, these tablets were either misplaced or damaged – leading to a need to procure new sets of digital tools for field deployment.

Lack of recent and reliable population data

Population data is complementary to all forms of geospatial data, and lack of a reliable census limits the potential of data analysis for microplanning. Currently, only estimates and

micro-census data of some provinces are used to inform microplanning and analysis for other interventions.

Despite continued geospatial data generation efforts by development partners in DRC, the country has not conducted a national general population census in about 40 years. The population data currently utilized within the ecosystem is derived from a standardized extrapolation that has been done over the years – not based on any actual recent data. Given this challenge, the health sector has often deferred to population estimates through sources like GRID3. The GRID3 project conducts micro-censuses that aim to curb this gap but still lacks nation-wide coverage. Recently, the DRC government set up a technical body called the Central Census Bureau within the Institut National de Statistique (INS) to plan and execute the second general population and housing census in DRC. However, the date of the Census is yet to be announced.

Lack of collaboration among geospatial data generation actors.

Despite the limited scope of geospatial data generation in DRC, collaboration remains limited, with programs and organizations working in isolation. Some of these organizations do not share data with the government's coordinating department, DSNIS, and the broader Minister of Health. In the case of the malaria program in DRC, it took the GRID3 technical committee – chaired by DSNIS – more than a year to access DRC's malaria data from implementing partners. There are three implementing partners focusing on malaria – INS, SANRU, and Chemonics – all with different donors (Global Fund, RPMI), meaning that you must talk to all the partners to gain access to the data. This request channel complicates the access to data and data sharing. Separately, the DRC's electoral commission (Commission Electorale Nationale Indépendante - CENI) has a lot of data that could be used for different spatial analyses and microplanning; however, access to these data is denied to other stakeholders, including actors in the health sector.

3.3.2 Geospatial Data Analysis

No standardized data validation process or programs

The validation processes used by the government are not as robust as those of partners and NGOs like the United Nations Family and GRID3. This is mainly because the government has no standardized validation process and does not have the financial and technical resources to undertake thorough validation. The validation conducted by the government does not utilize satellite imagery, best-quality raw data or elevations, or secondary data that would help refine boundaries.

Inoperability of data

Geospatial data available within the repositories of geospatial actors in DRC are not standardized and not interoperable – lacking usefulness for everyone in its current state and linkages to other systems. As a result, these data require more resources for data cleaning before it is usable for analysis and programmatic interventions. Some of the issues around interoperability include challenges around the coding of variables. The management of this type of data requires a secondary cleaning of the

data, and its adaptation based on the knowledge of domain, needs, and use of these data.

Insufficient provincial-level staff for the validation of field data

Government workers in the provinces and health zones often have pre-defined responsibilities, which usually do not include geospatial data validation. Data validation is a secondary function most workers view as complementary, non-binding, and often as a means to extra income. As a result, interviewed actors within the geospatial ecosystem proposed the dedication and assignment of key staff within the government to data validation.

Limited utilization of the DHIS2

Despite the DHIS2's position as the widely used data source in DRC, its utilization for spatial analysis remains limited and needs to be improved. The limited utilization is mainly due to skills limitations – as very few government staff are trained on DHIS2 across the ecosystem – and a lack of awareness of the data available within the DHIS2.

3.3.3 Geospatial Data Operationalization

Limited training of government staff within Health Areas

The interviewed stakeholders highlighted that even though most training happens at the health zone level with the BCZ, the inability to train last-mile implementers directly caused geospatial data quality gaps and a lack of data usability at the point of generation. DRC's health system has four main levels – the National, Provincial, Health Zone, and Health area levels. Each of these levels has its own structure, the Provincial Health Division at the provincial level, BCZ at the Health Zone level, and Health center at the health area level. Most training initiatives target the BCZ level due to the high cost of training health area staff.

Lack of investment in data network for communication

The poor state of the communication and internet infrastructure in DRC limits the effective implementation of programs at the last-mile – especially with the usage of digital tools. Several years ago, systems like the Very- Small-Aperture terminal (VSAT)[3] were deployed to mitigate communication challenges. However, VSAT equipment is either no longer functional or requires significant repair. Despite the current state of the VSAT, investment in infrastructure repair is required. A functional VSAT will aid the accessibility of stakeholders in the health zones and provinces to the DHIS2 system or other online data repositories.

The advancement of communication technology also necessitated the need for an upgrade of DRC's communication system to aid last-mile delivery. 4G and 5G internet technology will aid intervention optimization and increase the connectedness of the BCZs in hard-to-reach areas with the central office.

Restricted access to past use cases

Interviews with stakeholders showed that awareness of geospatial use cases remains low despite the increasing number of use case

[3] VSAT is a satellite communication system that handles data, voice, and video signals providing access to locations with very weak internet and mobile coverage.

applications within the geospatial ecosystem in DRC. This low level of awareness can be attributed to the insufficient demonstration of successful geospatial use cases. Documentation and sharing of use cases represent a significant challenge within DRC's geospatial ecosystem. Although the geospatial ecosystem in DRC is relatively small, cross-learning and reapplication of best practices are limited – especially among actors working at the last-mile. In some instances, actors lack functional websites to show case their use cases or repositories to independently store this information – a scenario also similar to the challenge of project documentation and information management among government partners. In other cases, functional websites of partners operating in DRC's ecosystem are not regularly updated, thus limiting awareness of the geospatial efforts in DRC.

Limited government and last-mile buy-in

DRC – like many countries in Sub-Saharan Africa – is a democratic State. The recent 2019 DRC government transition has triggered several reforms across key sectors like health. With changes in key government priorities and strategies, the commitment to advancing programmatic outcomes through geospatial technology varies, given the need to build new relationships with decision makers in government. This becomes important given the low level of awareness regarding the benefits of geospatial technology, especially in provinces with no access to core data layers. Similarly, transition in government also brings about staff redistribution, which further affects the retention of previously trained workers in their roles at the last-mile. The remaining or new staff may need re-engaging and re-training, to orient them on the potential of geospatial data.

Poor communication and reporting

Intra-government communication can sometimes be complicated amidst existing bureaucratic challenges. Monitoring, reporting, and learning on geospatial intervention in the health sector is mostly vertical – from health zones to the national government through official reporting or working groups. Horizontal communication – across health programs – is less common. The limited communication among programs limits cross-learning and the integration and scaling of geospatial interventions into multiple programs.

Poor communication leads to many duplicated efforts, skewed learning, and failure to reapply and scale successful use cases. As a result, investment in structured vertical communication and increased horizontal communication can amplify the impact of interventions and reduce costs due to shared learning and potential synergies.

Inadequate funding for geospatial activities

Unlike some other African countries, DRC does not have an assigned geospatial technology government agency nor dedicated funding. Rather, geospatial interventions are embedded into programmatic areas within the sectors and funded by development partners, mainly within the health sector. The gap in funding by the government of DRC is significant given the size of the country and the existence of many unmapped, inaccessible, and insecure geographic areas to conduct geospatial field activities. Despite increasing donor interventions, especially within the health sector, government funding remains crucial for the

sustainability of current programs and to finance critical geospatial inputs, including hardware (such as GPS units, tablets or smartphones with GPS capabilities, and drones), software (such as GIS software for data analysis and mapping, and specialized software for processing images taken by drones), data (such as base maps and satellite imagery), and skilled and trained personnel.

3.3.4 Geospatial Data Governance and Policies

No regulatory framework for geospatial data

The absence of a dedicated institution responsible for geospatial data causes a lack of a coordinating structure for geospatial data regulation – collection and standardization - in DRC. Geospatial technology is largely driven by development partners – mostly within the health sector – with no regulatory structure for geospatial data in DRC. This gap results in unstandardized data generation processes, fragmentation of the geospatial ecosystem, and lack of coordination repository for data storage among actors. The recent restructuring of the ANICNS and the proposed national data storage system offer the closest step towards coordination around geospatial activities in DRC and the implementation of a guideline or policy on geospatial data.

3.3.5 Stakeholder Coordination

Poor collaboration among government directorates, including within the Ministry of Health

Bureaucratic challenges in government continue to impede collaboration and shared learning on geospatial application among the several directorates and institutes of the Ministry of Health. Currently, there are two bodies with increased utilization of geospatial technology in their activities within the Ministry of Health; DSNIS and ANICNS. DSNIS is a directorate under the Ministry of Health and is responsible for health mapping, while ANICNS is a standalone agency reporting to the Ministry of Health and deals more with broader health systems. Despite reporting to the same principal, the Minister of Health, there is a poor collaboration between ANICNS and DSNIS – further leading to duplication of work and effort and implementation of closely similar initiatives.

Similar to the lack of collaboration between directorates, there is also limited collaboration between different government health programs. For example, the family planning program and the National Institute of Statistics have not fully utilized the potential of each party's data generation structures to drive optimized health outcomes.

Lack of collaboration among government establishments and programs strains government resource mobilization initiatives, reduces resource efficiency, and directly affects resource allocation and efficiency for geospatial data generation.

No dedicated teams committed to coordination efforts

The RGC[4], working groups, and GRID3 technical committee[5] are voluntary-based coordination groups. Therefore, the people participating in these groups all have full-time jobs elsewhere. When requested to validate data after working 70 hours a week, they do not have enough time, hence, delay data validation, and are likely to make errors in the data.

3.3.6 Capacity Building

Lack of sustainable, structured capacity building programs within the ecosystem

The advancements in computer technology require continuous training on particular technology and software to ensure skills are always up to date within the ecosystem. However, people are often trained one-off, without follow-up training, even when technology advances. The training covers basic-level QGIS. Even when the partner returns after a year to conduct training within the ecosystem, they train participants in the same components. The one-off training model does not promote sustainability and scaling up of capacity building programs within the program areas.

Limited and uneven geospatial skills at the province level

Technical geospatial capacity is concentrated at the national level and declines through the provinces and health zones. Within the provinces, geospatial capacity, including digital map usage, is more prevalent in the provinces with significant donor interventions, while provinces with limited or no donor engagements often lack access to maps and mostly have a wide skill gap. These provincial actors are not well equipped to assume remote supervision of the health zone teams owing to limited skills (insufficiency of trained people). In some provinces, the skill gap is often bridged through the deployment of students – due to their higher literacy level – for geospatial activities like data collection.

High turnover of staff with geospatial skills within the ecosystem

High staff turnover results in a skill gap as the trained staff would leave for other work opportunities. Geospatial institutions like ANICNS and DSNIS are understaffed and have limited capacity for broader scale mapping projects. This led to inconsistencies in the quality of outputs from geospatial generation, analysis, and operationalization across the ecosystem, especially from the last-mile implementers.

[4] The RGC coordinates different working groups that help validate data before it is uploaded to the RGC repository.

[5] GRID3's technical committee – led by DSNIS – coordinates stakeholders on the generation of data for core geospatial data layers (i.e., settlement, health facility, population, and transport networks).

3.3.7 Summary of prioritized challenges among stakeholders in DRC's Health Geospatial Ecosystem

The highly prioritized challenges by stakeholders within DRC's health geospatial ecosystem are summarized in Table 1

Table 1 Summary of prioritized challenges among stakeholder in DRC's health geospatial ecosystem

Geospatial Data Generation	
Inaccuracy of existing data	There is a variation between the recorded boundaries in the health areas and health zones and the actual boundaries cited during field visits or program implementation. This is also true for boundaries at different administrative levels. For example, interviewed stakeholders cited the RGC repository as having imprecise geospatial data for a large part of DRC.
Incomplete geospatial data	Beyond the inaccuracy of geospatial data in DRC, most geospatial data are incomplete. Currently, only 15 out of 26 provinces in DRC are mapped – largely by GRID3 and BlueSquare.
No centralized data repository	There are many health area data circulating within the ecosystem due to lack of a central data repository. Many versions of the data are circulated informally within the ecosystem because it is difficult to access data from DSNIS due to long and bureaucratic processes.
Limited technology, internet, and tools for data generation	Last-mile implementers at the provinces and health zone/area levels have limited access to computers, GPS tools, smartphones, and other technologies – including power outages and limited internet connectivity.
Lack of collaboration among geospatial data generation actors	Despite the limited scope of geospatial data generation in DRC, collaboration remains limited, with programs and organizations working in isolation. Some of these organizations do not share data with the government's coordinating department, DSNIS, and the broader Minister of Health.

Geospatial Data Analysis

No standardized data validation process or programs	The validation processes used by the government are not as robust as those of partners and NGOs like the United Nations Family and GRID3. This is mainly because the government does not have the financial and technical resources to undertake thorough validation.
Insufficient staff at the provincial level to validate data collected in the field	Government workers at the provinces and health zones often have pre-defined responsibilities, which usually do not include geospatial data validation. Data validation is a secondary function most workers view it as complementary, non-binding, and often as a means to an extra income.
Limited utilization of the DHIS2	Despite the DHIS2's position as the widely used data source in DRC, its utilization for spatial analysis remains limited and can be improved.

Geospatial Data Operationalization

Restricted access to past use cases	Documentation and sharing of use cases represent as a significant challenge within DRC's geospatial ecosystem. Although the geospatial ecosystem in DRC is relatively small, cross-learning and reapplication of best practices are limited – especially among actors working at the last mile.
Limited government and last-mile buy-in	With new office bearers at the national and sub-national levels due to government transitions and staff redistribution, there is need for new engagements on the potential of geospatial data. Some new office bearers have not interacted and do not understand the use and potential of geospatial data.
Poor communication and reporting	Intra-government communication can sometimes be complicated amidst existing bureaucratic challenges. Monitoring, reporting, and learning on geospatial intervention in the health sector is mostly vertical – from health zones to the national government through official reporting or working groups. Horizontal communication – across programs – is less common.
Inadequate government funding for geospatial activities	Unlike some other African countries, DRC does not have an assigned geospatial technology government agency nor dedicated funding. Rather, geospatial interventions have been embedded into programmatic areas within the sectors and funded by development partners, mainly within the health sector.

Governance and Policies

No regulatory framework for geospatial data	The absence of a dedicated geospatial policy framework has led to unclear and competing mandates among government agencies. Currently, geospatial technology is largely driven by development partners – mostly within the health sector - with no regulatory structure for geospatial data in DRC.

Capacity Building

Limited and uneven geospatial skills at the province level	Technical geospatial capacity is concentrated at the national level and declines through the provinces and health zones. Provinces with significant donor interventions have more capacity compared to those without.
High turnover of staff with geospatial skills within the ecosystem	High turnover of staff results in a skills gap as the trained staff would leave for other work opportunities. Geospatial institutions like ANICNS and DSNIS are understaffed and have limited capacity for broader scale mapping project.

3.4 Opportunities in DRC's Geospatial Ecosystem

This section summarizes the key opportunities for investment within DRC's geospatial ecosystem. Dev-Afrique held a geospatial stakeholder consultative forum with key health sector actors from the government, non-profit, and academia in DRC to drive discussion and alignment on priority challenges and their proposed solutions (Table 2). The geospatial stakeholders' forum is the culmination of the end-to-end assessment of the geospatial ecosystem (Annexure 3-- List of participants).

During this stakeholders' forum, participants aligned on the most feasible and the most impactful challenges for the geospatial community (donors and local actors) to prioritize for immediate interventions (Annexure 2 for snippets of the session). A summary of the most impactful and feasible challenges alongside the proposed opportunities as aligned by the participants at the stakeholders' forum shown in Table 2.

Table 2 Summary of prioritized challenges and their proposed solutions

Geospatial Data Generation		
Challenge	**Opportunity/Solution**	**Responsible Organization**
Limited technology, internet, and tools for data generation	1. Advocate for the extension of coverage among network operators VODACOM and AIRTEL. This will allow most Health Areas internet and cellular connectivity for communication and data uploads. 2. Encourage Health Zones (HZs) to access internet services through partners working within their locations. For example, in Ituri province, Medecins sans frontières (MSF) purchased VSAT and allowed other partners without internet in those areas to access theirs for free.	MoH, Government
Inaccuracy of existing data	1. Improve understanding of the use of Excel for basic data cleaning and analysis among staff at the last-mile. Excel is one of the easiest and most accessible tools at the last-mile. 2. Develop a standardized data validation process to ensure that circulated data is accurate. The Ministry of Health should verify geospatial data quality with on-site healthcare personnel, as it enhances the quality of the collected data.	PTF,MoH

Incomplete geospatial data	1. Leverage various campaigns that are heavily funded and have access to hard-to-reach areas. The hard-to-reach areas mostly have incomplete data, as most programs are unable to reach them. Increasing the number of healthcare campaigns at the last-mile will improve accessibility to some communities, as the campaigns help in accessing hard-to-reach communities. 2. Provide remuneration for community relays. Community relays are volunteers who educate community members on various health issues within the community. Given their significant role as first points of contact for health information and data within the community, they should receive remuneration. 3. Leverage and support the government's 145 territories development project that is already underway. The project seeks to build new infrastructure and roads and expand network and electricity coverage. 4. Expand decentralization of the data collection process to the sub-national level. Currently, the national level and province support data generation efforts within some health areas and health zones due to limited capacity.	MoH, ANICNS, PTF
Inadequate funding for geospatial activities	1. The Ministry of Health should advocate for a higher allocation for health sector in the national budget and improved collaboration for grants. 2. Increase domestic funding for health by exploring the Health Promotion Fund (FPS - Fonds de la promotion de la santé), which aims to increase funding for the Ministry of Health and improve the supply of health care in the DRC. 3. Advocate for more donor support.	MoH, Donors
Lack of collaboration among geospatial data generation actors	1. Integrate the digitalization of all mass health campaigns being piloted by MoH, ANICS, WHO, and CHAI.	MoH, ANICNS

	2. Integrate activities in health development plans to ensure inter health program and stakeholder collaboration. 3. Expand the membership of working groups and the GRID3 technical committee to allow more stakeholder participation. 4. Institutionalize and expand the GRID3 Technical Committee and the RGC Working Groups.	

Geospatial Data Analysis		
Limited utilization of the DHIS2	Strengthen the use of DHIS2 for available data utilization by integrating plugins for additional analysis and visualization capabilities – similar to the DHIS2 tracker deployment during the COVID 19 campaigns.	DSNIS, MoH, PTF
No centralized data repository	1. Fast-track development of the centralized repository at ANICNS. 2. Increase sensitization of all available data hubs within the ecosystem. These data hubs serve as a source of geospatial data. For example, the GRID3 DataHub could help people who do not have licenses, do not have internet, or do not have powerful software like ArcGIS to do quick geospatial analyses and basic visualizations using free layers.	GRID3, PTF, MoH
No standardized data validation process or programs	1. Institutionalize the GRID3 technical committee, the IM Working group, and the RGC Working group to strengthen the data quality validation within the ecosystem. The working groups should also provide and regularly update the mailing list of members. The institutionalization of these groups would also lead to more streamlined opportunities for geospatial data generation. 2. Make the data interoperable and accessible online (it is necessary to find the resources needed to have a good internet connection at the BCZ). This would allow the BCZs to publish the latest data easily and be usable at the point of generation.	MoH, PTF

Geospatial Data Operationalization		
Restricted access to past use cases	1. Public sharing of reports etc., via a neutral site like RGC. 2. Partners should regularly update their websites and showcase their provincial and health area use cases.	DSNIS / ANICNS / PTF
Poor communication and reporting	1. Host regular stakeholder workshops. 2. Use neutral public platforms like the RGC and the MSPHP website to communicate and publish experiences/lessons learned on accessible websites. 3. Promote extensive platforms for stakeholder consultations within the ecosystem. 4. Organize a national GIS symposium with the inclusion of all strategic recommendations and the national plan.	DANTIC / ANICNS
Limited government and last-mile buy-in	1. Strengthen MoH's leadership and ownership of geospatial data. 2. Develop use cases for advocacy campaigns towards MoH/MF. 3. Implement forums and platforms for lessons learned in the generation, analysis, and operationalization of geospatial data among health areas	

Geospatial Stakeholder Governance, Stakeholder Coordination, and Capacity Building		
No regulatory framework for geospatial data	1. Include the use of geospatial data in the normative and policy framework of health.	
Limited geospatial skills at the province level	1. Implement multisectoral training plans at the central and provincial levels (training on ODK derivative tools, and familiar forms). 2. Create a training thematic group and set up a multisectoral team of provincial trainers to support the HZ. 3. Integrate geospatial data awareness and training into existing household data training within the ecosystem.	DSNIS with the support of ANICNS and PTF.
High turnover of staff with geospatial skills within the ecosystem	1. Improve the salary and work conditions of already trained analysts to reduce the brain drain rate. 2. The Minister of Health should discuss the assignment of personnel in the provinces by the provincial governors with the council of ministers to ensure that more staffing is considered. 3. Decentralize training: Train more staff at the provincial level in the health zones by using local universities for more technical training. 4. Restructure the health sector by giving more staff recruitment autonomy to provincial health divisions. This would enable each provincial health division (DPS) to have a rapid and efficient staff recruitment system. 5. Have data managers train more support staff within Health Areas to increase human capital. Most Provincial health Divisions have only 1 data manager trained in data analysis, Microsoft Excel, and geospatial database per health zone.	Secretary General / Governors, ANICNS, DPS

Annexure 1: Leading actors in the operationalization of data (Use Cases)

Ministry of Health (MoH)	**Routine Immunization**: In 2018, the MoH wanted to boost immunization rates by 15 %, but despite the investments made, the rates were not improving. One of the innovation pillars acknowledged by the MoH was geospatial data and geo-reference microplanning – using geospatial data to drive microplanning to allow clear definitions of boundaries to ensure that there are no households or villages that end up between two health areas and are not visited for immunization because there was no outreach happening. The use of geospatial data helped the MoH drive improvement in immunization coverage. GAVI funded and in partnership with the DRC MoH a planned vaccine delivery drone launch in Equateur province, the latter has 18 health districts that are difficult to access, especially during the rainy season, and for some of them, the only way to reach them is by river. This situation made it difficult to access the vaccines, which was made possible using drones linked with geospatial data.
GRID3	**Immunization Microplanning:** GRID3 works with UNICEF, ACASI, WHO, and EPI to translate geospatial data into microplans that the immunization team uses for operational planning – campaign planning and defining the number and location of people to vaccinate. The use of geospatial data helped them boost the coverage of immunization. **Cholera program Community care site planning**: Optimization of community care services in Kasaï province: CHAI partnered with GRID3 to use geospatial data to plan community care site locations for the provision of care to remote populations in support of the PNECHOL-MD (cholera program). They used geospatial data to prioritize locations that have many people.
GAVI	**GAVI in partnership with GRID3 – routine immunization use case**: Geospatial data were used to determine where all the fixed vaccinations were happening and where more outreaches should happen within each health zones. Core data layers helped define how many fixed sessions were needed to cover a certain population and where the outreach locations should have been placed to maximize reach. The data are also used to assess how many people are covered within each health area/zone. This influenced increasing vaccination coverage in Tanganyika province.
PNECHOL	**Optimization of services in Kasaï province**: PNECHOL partnered with GRID3 to use geospatial data to plan community care site locations for the provision of care to remote populations. They use geospatial data to prioritize locations that have many people.
MSF	**Yellow fever vaccination campaign**: In 2016, MSF ran a vaccination campaign for 10 days in Kinshasa to vaccinate people against yellow fever. Using geospatial

	data, they were able to vaccinate 710,000 people within this short timeframe. MSF hired a GIS officer who ended up building 240 GIS products, including street maps, transportation accessibility maps, population data, and visualizations that were updated daily and showed the progress of this campaign throughout the city. These visualizations enabled the team to not only track progress but also identify gaps within vaccination centers. This allowed a quick response to address gaps.
CDC	**Mapping the Ebola Outbreak in 2020:** CDC/ATSDR's Geospatial Research, Analysis, and Services Program (GRASP) program supported the CDC in updating existing maps of both DRC's Western and Eastern provinces where the first Ebola outbreaks occurred in 2020. GRASP took the existing and outdated maps of the province to review them against current satellite images, hand-drawn maps, existing borders, and landmarks. They also added additional data, such as health facility locations, and showcased the initial infected areas and their distance from the Eastern outbreak. GRASP continues to support health crisis response efforts, including COVID 19 and global polio eradication efforts.
Institute of Tropical Medicine	In the early 2000s, ITM managed a health zone mapping program that mapped health zones in Bandundu City and other former provinces. Currently, those health zones are some of the most accurate Health Zones. It took a lot of integration, but ITM microplans are very accurate. Every village made it into the microplan because they would pay their interviewers $ 1/GPS point. Some of these health zones have thousands of points but came out extremely accurate.
ACASUS	**ACASUS has developed a technological vaccinator tracker for two provinces** – Haut-Lomami and Tanganyika. The application allows the vaccinator to report more regular and detailed data. The application registers geolocations even when a location has limited internet connectivity. It allows the vaccination team to understand the covered locations. ACASUS uses GRID3 data to map out where health facilities are and to understand population distribution for planning whether to have a fixed or satellite session. A 2021 evaluation showed that about 85% of the health facilities in the two provinces are using recommendations generated from the vaccinator tracker as they are, and 15% adapt them based on their realities.
Bluesquare	Bluesquare is developing and deploying multiple tools within its systems for data generation. For example, they have developed an application that enables the mapping of community health sites at the community level. They are partnering with Global Fund to generate community health site data in about 16 provinces for microplanning.

Annexure 2: Highlights from the DRC Stakeholder Forum

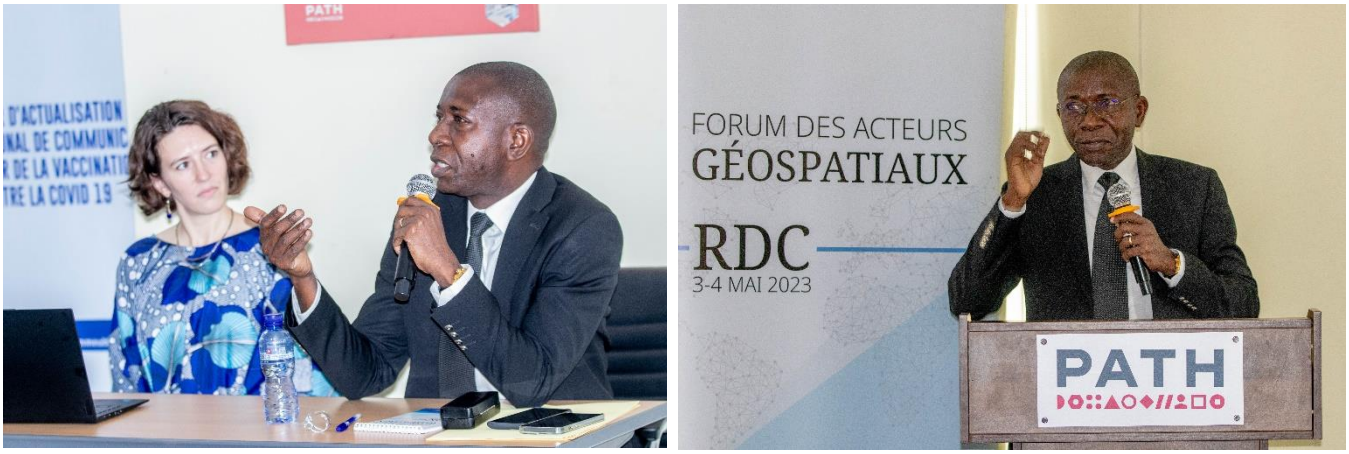

Figure 7 Presentation and official opening by the Secretary General

Figure 8 Stakeholder group working sessions during the stakeholder forum

Figure 9 Group photo of participants at the stakeholder forum

Annexure 3: List of participants at the DRC Geospatial Stakeholder Forum

Name	Organization
Jose Blaise Malengo	ANICNS
Claire Halleux	Bluesquare
Dr Collard Madika Kasongo Umpafu	BMGF
Elvis Thsibasu	ANICNS
Ridwan Sorunke	Dev-Afrique
Shuko Musemangezhi	Dev-Afrique
Michel Isamuna	Dev-Afrique
Micheline Bambi	Dev-Afrique
Lisa Schol	DevGlobal
NKAMBA	Ecole de Santé Publique de Kinshasa
Dr Albert Kabasele	ETS (Ecole de Telecommunication et Teledection Spatiale)
Kevin Tschirhart	GRID3
Emmanuel Rukengwa	GRID3
Christian Shadrack	IFRC/Croix Rouge
Cedric Mbaki	INS/BCR
ANAKANI	Institut National des Statistiques (INS/BCR)
Gabriel Ilunga	ANICNS
Henri Kazadi	Institut National des Statistiques (INS)
Mr Serge Bokuma	Institut National des Statistiques (INS)
Martine Nyota	Ministère de la Santé (DSSP/DSNIS)
Dr Nestor Dizal	Ministère de la Santé Publique / Cellule d'Appui et de Gestion Financière (CAGF)
Pascal Mukenyi	Programme Elargi de Vaccination (PEV)
Mano NTayingi	IMA World Health
Dr Christel Muteba	Programme National de Lutte contre le Paludisme (PNLP)
Dr Bienfait Kisamba	SANRU
Dr Assy Lala	SANRU
Secretary General Dr Sylvain Yuma	Secretariat General de la Sante
Dr Eustache Bibala	Division Provinciale de la Santé de Maniema
Dr Stéphane Kota	Programme National de Lutte contre le Paludisme (PNLP)
Mbungu Nsimba Eguard	Programme National de Lutte contre le Paludisme (PNLP)

Karl Angendu	Institut National de la Santé Publique (INSP)
Dr Mwamba Kazadi Dieudonné	Institut National de la Santé Publique (INSP)
Zeynabou Sy	University of Geneva
Henri Mbiya Ngandu Luboya	WHO
Alain Nsunda	Wildlife Conservation Society
Dr Dalau Mukadi	Université de Kinshasa