Assessing the Use of Mapping for Health (M4H) Data for Immunization Program Implementation and Associated Impact on Coverage and Equity in the Democratic Republic of Congo

COMPREHENSIVE RESEARCH REPORT

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Executive summary

Mapping for Health (M4H) in DRC aims to strengthen the equity and effectiveness of vaccination interventions in the Democratic Republic of the Congo (DRC), through the provision of accurate and improved micro-plans and harmonized and integrated spatial demographic and health data. It prioritizes the identification of missed settlements to address the situation of “zero-dose” children in DRC, which is a major concern. According to Gavi, zero-dose children account for almost half of all vaccine-preventable deaths. This gender-sensitive research study aimed to assess the uptake and use of geospatial data for micro-planning and implementation of routine immunization programs and the associated impact on immunization coverage and equity.

Due to delays in the introduction of the geospatial data in the prioritized research sites due to Covid-19 and the end of the M4H project implementation before the EPI Program was able to adopt and use the data, HealthEnabled received permission from Gavi to focus on a previous GRID3 site for the quasi-experimental and coverage and equity components. The original research design included a cost-effectiveness component, however, due to the lack of economic data from the previous GRID3 intervention (not funded by Gavi), it was not possible to complete the economic evaluation. For this mixed-methods research, we have documented the uptake, use, and perceived impact of geo-referenced micro-plans in Kasai and Haut-Lomami and used Kasai Central as a control. We have documented the uptake and experiences with the gender intervention in Kasai and conducted the quasi-experimental analyses of secondary survey data with Haut-Lomami as the intervention site and Kasai and Kasai Central as control sites. It is strongly recommended for a supplemental cost-effectiveness analysis to be conducted in Kasai in 2024/2025 to compare the outcomes in Haut-Lomami (intervention without gender and with a mobile supervision tool) and Kasai (intervention with gender and without a mobile supervision tool).

This study shows that geo-referenced micro-plans are well received, utilized, and led to changes in the approach to immunization service delivery with perceived improvements in identification and reaching zero-dose children. In addition, the gender intervention is perceived to have led to a significant change in the approaches taken to overcome sociocultural gender norms and engage civil society and communities to reach as many children as possible, leveraging the ability of women to engage more effectively with female caregivers and engaging with men as caregivers to support vaccination services. The intervention strength survey and robust qualitative study provide insights into user experiences and the mechanisms through which geo-referenced data may have contributed to observed improvements in immunization coverage and equity in Haut-Lomami in comparison to Kasai and Kasai Central.

Through the quantitative analyses, we observed that geo-referenced micro-plans may have contributed to a dramatic and sustained trend towards high immunization coverage, lower zero-dose, and reduced dropouts in Haut-Lomami in comparison with less dramatic positive trends in Kasai and Kasai Central. The equity study shows that wealth level is a factor influencing zero-dose cases. For households in the second and third quintiles, the project had a downward impact on the percentage of zero-dose cases in the intervention province, whereas the percentage increased in the two control provinces. The intervention analyses indicated no impact on the poorest strata of households, which showed the same upward trend in zero-dose rates in all three provinces.

Recommendations from this study are to include gender analyses, design, and evaluation in upcoming geospatial interventions for immunization and to conduct further cost-effectiveness research to examine the overall value for money of the effective use of geospatial data on immunization outcomes. The cost-effectiveness analysis is needed to inform recommendations for further investment in this strategy as a means of increasing immunization coverage and equity in particular the identification and reach of zero-dose children.

Background

Mapping for Health (M4H) in DRC aims to strengthen the equity and effectiveness of vaccination interventions in the Democratic Republic of the Congo (DRC), through the provision of accurate and improved micro-plans, and harmonized and integrated spatial demographic and health data. In combination, a set of gender and equity integration and capacity development activities aim to help relevant stakeholders address gender-related and social exclusion barriers to reach zero-dose and under-vaccinated children. The initiative is supported by Flowminder and the Centre for International Earth Science Information Network at Columbia University (CIESIN), and in collaboration with WorldPop at the University of Southampton (UoS) and partners. The project is part of the Geo-Referenced Infrastructure and Demographic Data for Development (GRID3) program and targets nine priority provinces of DRC, namely Kinshasa, Kwilu, Kasai, Kasai Oriental, Lomami, Haut-Lomani, Haut-Katanga, Sud Kivu and Ituri.

The Mashako Plan, a unique, high-level national health initiative, contributes to the advancement of health information systems in DRC by aiming to increase the effectiveness of vaccination interventions. A key strategy is the integration of geospatial demographic and health data into decision-making. M4H's innovative approach in supporting the achievement of the Mashako Plan and extension to the rest of the country could lead the way for other African countries. CIESIN and Flowminder, in collaboration with GRID3 partners, have proposed M4H in DRC to bridge demographic and health data gaps in a coordinated, holistic way.

The M4H innovation was identified through the INFUSE program at Gavi, The Vaccine Alliance, and is funded by the Canadian Government. Infuse is an innovation accelerator and supports programs that are proven and ready to scale. It is also being supported by the DRC Country Team and co-led in collaboration with the M&E Team. The GRID3 Consortium is already in DRC and has done some early work modeling populations and producing core geospatial data layers: settlements, health boundaries, and health facilities. One of the key objectives of this project is to effectively use spatial data to improve micro-planning within the EPI program. The program's gender equity approach focuses on the Expanded Programme on Immunisation (EPI) and civil society partners to have gender capacity to collect, analyze, and devise gender-responsive vaccination strategies to reach those left behind.

To support this effort, Gavi engaged HealthEnabled through the "Effective Design, Implementation, Integration, and Evaluation of Digital Health Systems to Enhance the Strategic Use of Data for Immunisation Programming" grant to assess the ability of the proposed approach to be evaluated and develop a research design to evaluate the acceptance and effective use of Mapping for Health data for microplanning and routine immunisation implementation and its impact and cost-effectiveness on immunisation outcomes.

This evaluation took place in 3 provinces, two of which had benefited from geospatial data from M4H and or the preceding GRID3 intervention, i.e. Kasaï Province (M4H) and Haut-Lomami Province (GRID3); and a control province, Kasaï Central Province, which had not benefited from the intervention.

Description of the Intervention

The M4H intervention is comprised of three main components, namely 1) creation of mapping for health data, 2) population estimation, and 3) geo-referenced micro-plan development. In addition, there was a fourth component of mobility data, but due to the project completion, we were unable to assess its adoption and use. For replicability and scalability, it will be important to do a systematic mapping of the various inputs and the sources of inputs. We were unable to do so as part of this research study. It is recommended that this assessment be included as part of a future cost-effectiveness study.

CREATION OF MAPPING FOR HEALTH DATA

Health zone participatory mapping is defined as:

The process of generating administrative base maps (containing settlements, health areas boundaries, health facilities) through a collaborative process between GIS mappers (using existing data and satellite imagery) and local health teams (local knowledge of their area)

- In each health zone, two mappers work closely with representatives of each health area to identify and validate settlements, boundaries and health facilities
- The mappers then train health workers to use smartphones in order to go back to their health area and take GPS coordinates to complete the administrative base maps
- The data is gathered, verified, and consolidated by the mappers
- The data is shared to the MCZ/ ECZ for review and validation
- On average ~10 -day process per health zone

POPULATION ESTIMATION

Population estimation was defined as an independent source of population numbers used to help improve resource allocation/ plan appropriate routine immunisation strategies as part of the micro and macro-planning process. The result is a 100m x 100m gridded population layer with uncertainty measures, with gender and age breakdown. Population estimates were then provided to users at different level (area, zone, province, etc.) for micro and macro-planning. The method used to produce the estimates is:

- A microcensus survey was conducted in randomly selected areas within the provinces.
- A spatial model was built using microcensus survey data, sub-national boundaries, settlement data and other geospatial covariates; as a result population estimates were developed for the entire provinces.

MICRO-PLAN DEVELOPMENT

During participatory mapping exercises, georeferenced health area and zone boundaries were developed to inform and align the management units commonly used in microplans. Likewise, the location and names of settlements belonging to each health area and health zone were collected and organized. Using

geospatial tools, the datasets above (i.e. health boundaries and population estimates) were used to produce estimates of the various age-group populations contained within each health area and health zone. These estimates were then plugged in into microplanning dashboards and maps that would display benchmark indicators such as number of routine sessions needed (in the case of the dashboards); and basemaps with names and localization of settlements and health facilities/ health posts (in the case of the maps).

MOBILITY ESTIMATES

Mobility estimates from mobile phone usage data was defined as a system for automated routine capture of mobility estimates from CDR data and were to be developed for all M4H provinces. However, due to the completion of the project before this data was able to be shared and used, we were unable to assess its adoption and use. These definitions are provided for future research validation and consideration.

Mobility indicators include:

- Number of subscribers estimated to reside in each health zone, each month, and % changes from the previous month and from the median of the past 12 months
- Origin-Destination Matrix of home relocations for all subscribers, for each pair of health zones, each month: the number of subscribers who changed residence from health zone A in the previous month to health zone B in the current month
- The number of subscribers classified as “highly mobile” (regularly changing their health zone of residence or stay (e.g. every few months)
- Trajectories of groups of subscribers classified as “highly mobile”: for each sufficiently large group (>15 subscribers), the list of their mainstays in a given location each month over the last x months (e.g. the last 6 months)
- If a particular event (e.g. flood, conflict): the number of subscribers classified as ‘displaced’ by the event (forced change in location of residence), daily and then monthly after the mobility of the population displaced by that event has fallen below a given level
- Estimates of the number of people from a number of subscribers, for the above data products (number of people residing in each HZ, number of people migrating from HZ A to B, number of highly mobile people, number of displaced people)

ACCEPTANCE AND USE OF MAPPING FOR HEALTH DATA FOR ROUTINE IMMUNISATION PLANNING

For this research, HealthEnabled worked with M4H to define the following prioritized considerations for the acceptance and use of M4H data.

The core geospatial layers can be used to provide key and timely insights for health zone and provincial decision-makers to:

- identify hard-to-reach settlements or settlements likely to fall in between two health catchment areas
- estimate the population of the health areas and health zones within healthcare facilities’ catchments.
- estimate the number of vaccines needed for a health area based on its population
- assess the population coverage of current fixed vaccination strategies
- optimize outreach vaccination strategies based on population distribution
- optimize the cold chain and new fridge allocation based on population distribution

An effective use of geospatial data for micro- and macroplanning processes by health staff is defined as:

> *All health areas in M4H provinces leverage the use of core geospatial data (i.e. population estimates, health boundaries, health facilities, and settlements) to develop micro-plans that can identify areas where children may live, determine the number of vaccines needed, and assign optimal immunisation strategies and cold supply chains (i.e. location of sites with functional cold storage) by proximity to health facilities and population distribution.*

All health zones in M4H provinces aggregate health area-level microplans (produced using geospatial resources) to develop health zone microplans, and to support and monitor health area immunisation planning and implementation activities. It also considers and/or uses mobility data to update plans and immunisation activities.

Key outputs include:

- Cumulative identification of at-risk population and settlements that do not fall within reach of monthly routine vaccination sessions;
- number of vaccines needed;
- and optimal immunisation strategy and cold supply chain by proximity to health facilities and population distribution.

M4H provinces use aggregate health zone-level microplans (produced using geospatial resources) to develop provincial macroplans, and to support and monitor provincial immunisation planning and implementation activities. It also considers and/or uses mobility data to update plans and immunisation activities.

National EPI programme uses provincial geospatial macroplans to support and monitor provincial immunisation planning and implementation activities. It also considers and/or uses mobility data to update plans and immunisation activities.

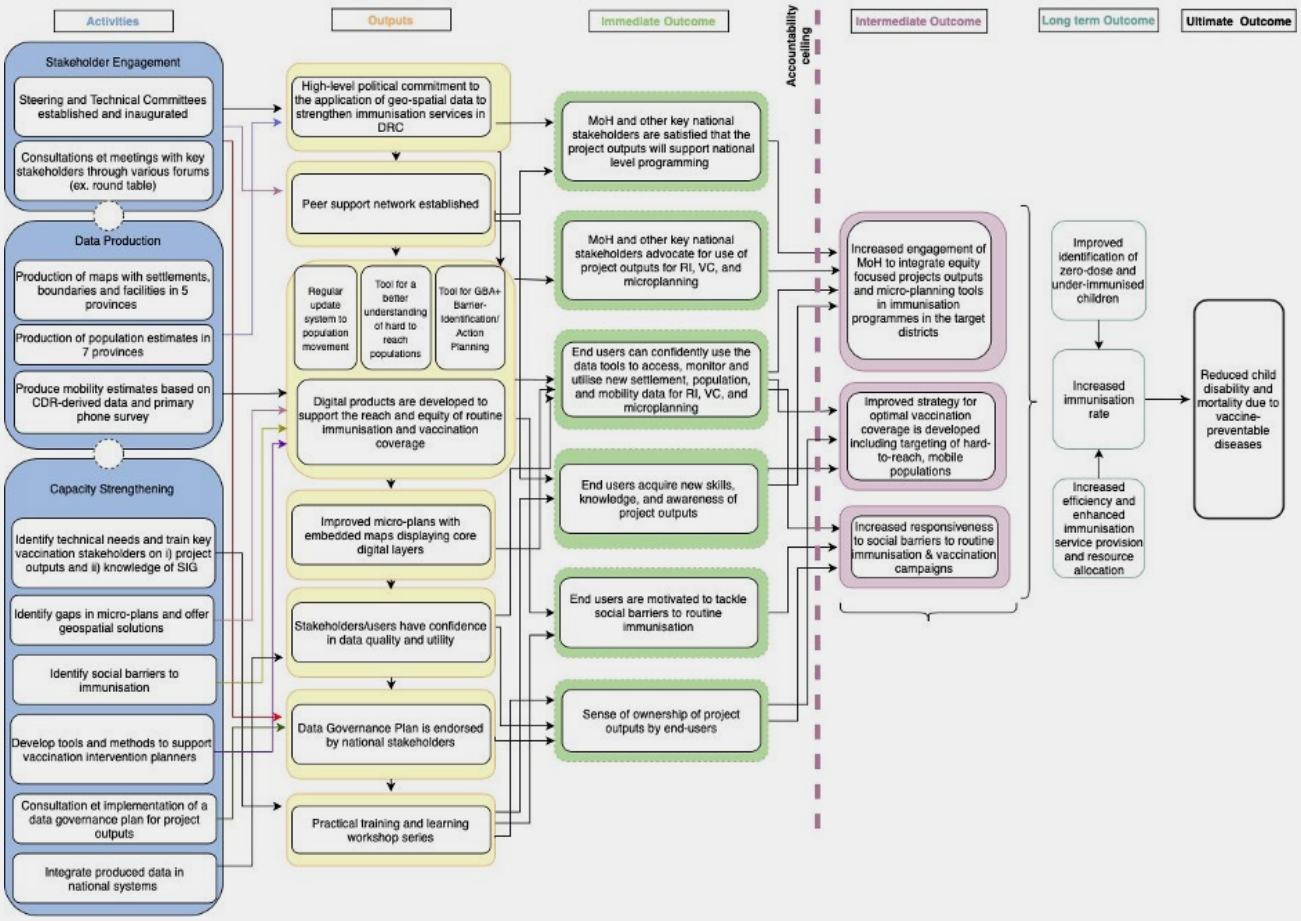
Acceptance and use of geo-enabled data and microplans generated for participating health areas, health zones, and provinces can be documented and observed through the following EPI/ immunisation activities. Specifically, we aimed to look at the effects of M4H by different levels of users on:

1. Adopting and (if possible) updating population estimates for routine immunisation planning, implementation, and monitoring
2. Setting immunisation targets
3. Identifying zero-dose children and their primary caregivers
4. Identifying under-immunised children and their primary caregivers
5. Adjusting vaccination strategy to optimize vaccine service delivery
6. Updating stock levels and distribution points
7. Identifying and adapting targets and strategies to population shifts through use of mobility estimates
8. Increasing gender considerations in immunisation service planning, implementation, and monitoring based on what the program carried out in the gender specific component of M4H and to assess how the geospatial mapping component was influenced by gender differences among data users and whether the geospatial mapping provides more accurate data from a gender and equity perspective.

Theory of Change

The figure below outlines the theory of change for M4H. This was used to inform the development of the qualitative instruments (observation and interview guides), the intervention strength survey instruments, and the secondary analyses of immunisation coverage survey data. The gender interventions were evaluated separately using a rapid ethnographic approach and relevant Health Zones and Health Areas were purposefully included as sited for the intervention strength survey.

FIGURE 1: THEORY OF CHANGE OF THE MAPPING FOR HEALTH



Evaluation overview

STUDY DESIGN

This is a mixed-methods study with a quasi-experimental design. Impact was assessed using a pre/post study design which draws upon the EPI Programme Immunisation Coverage Surveys conducted with support from KSPH in 2021, which was repeated in 2022. Efforts to assess impact were both informed and complemented by qualitative research (direct observations and in-depth interviews) and intervention strength surveys in prioritized Health Areas in intervention and control sites to assess adherence to micro plans with and without M4H data. A targeted rapid ethnographic study was conducted in Health Zones and Health Areas in Kasai which were exposed to gender-specific program activities. These sites were purposefully included in the intervention strength survey sample.

This study followed a qualitative approach focused on interviews with various participants, including the Provincial Head of Division, Antenna Chief Medical Officer, Data Managers at the EPI-Antenna level, Analysts in charge of the health information system to the DPS, Service Director of EPI Monitoring and Evaluation, CB Carto / DSNIS. Interview guides were designed to facilitate the interviews with key informants.

EQUITY STUDY

Three key equity-related variables were used in this study: household wealth, telephone use by the head of household, and urban or rural residence of the household. The relative household wealth variable is described in five modalities: poorest, second poorest, middle poorest, fourth poorest and richest. The variable “household cell phone access” is measured by two modalities: without cell phone and with cell phone. Finally, the “place of residence” variable has two modalities: urban and rural.

Initially, the idea was to carry out an economic evaluation study (impact assessment) based on a full-cost accounting approach, in its “activity-based cost” variant, at the end of which the incremental cost per life saved and the cost per disability-adjusted life-year avoided of implementing M4H in calendar years 2019-20 compared with the status quo of circa 2014 would have to be calculated, on the one hand, and the main cost drivers identified by means of sensitivity analysis, on the other. With this in mind, a data collection tool covering the various activities before, during and after the project was identified, but the data was not available. Given the unavailability of costing information on the activities, the study was reoriented towards a comparative approach of a descriptive study. This involved determining whether the implementation of M4H in Haut-Lomami and Kasai provinces is associated with significant differences in the percentage of zero doses among children aged 12-23 months post-intervention in the poorest and poorest economic strata between 2020 and 2021

SETTING

Evaluation activities were carried out in 3 Provinces- two intervention and one control. The province selection was done in collaboration with implementing partners and key stakeholders and prioritizes implementation in sites that have health zones that represent urban, peri-urban, remote, and conflict settings. Selected provinces are Kasai (M4H with gender), Haut Lomami (GRID3 without gender intervention), and Kasai Central (control site). Our sample size was 113 health facilities to be investigated in 98 Health Areas in 15 Health Zones in the three provinces.

STRATIFICATION

Each study province was subdivided into two strata: urban and rural. This categorization was made according to the current policy of health zone type categorization.

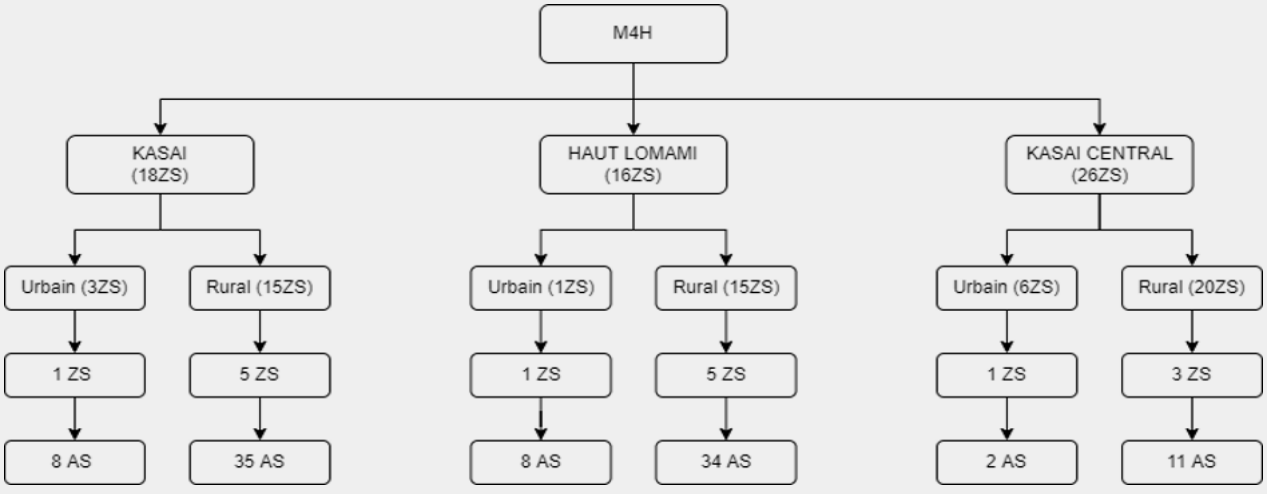
SELECTION OF HEALTH ZONES

For our sampling, we considered 30% of the total number of health zones for each stratum. To do this, we carried out simple random sampling using the Android application “randomizer”.

SELECTING OF HEALTH AREAS

For our sampling, we considered 30% of the total number of health areas for each health zone. To do this, we carried out simple random sampling of Health Areas within the previously randomly selected Health Zones using the Android application “randomizer”.

FIGURE 2: REPRESENTATION OF THE SAMPLING OF HEATH AREAS



FOR THE CONTROL PROVINCE

In the control province, we used the same sampling method and considered 15% of the total number of health areas for each stratum and 15% of the total number of health areas for each zone.

DATA COLLECTION

At the Province and Health Zone levels, data collection was done through in-depth interviews recorded using dictaphones. The focus of these interviews was on the acceptance and use of geospatial data for immunization planning. A total of 19 interviews were conducted. Before each interview, the interviewers presented the objectives of the evaluation to the participants and obtained their consent. Recruitment of participants was facilitated by the workshop organizers. Interviewers made appointments with each respondent, according to availability. Individual written consent was sought and obtained from each respondent before the interview, both to participate in the study and to record the interview on a Dictaphone. Data collection with the various target groups was carried out in French.

At Health Area and health facility levels, data collection techniques included: (1) a structured survey; (2) direct observation of maps and geo-referenced microplan; (3) document review; and (4) semi-structured interviews with key informants.

Quality control was carried out on an ongoing basis, at various stages of the study as follows.

Prior to the data collection

Interviewers with previous research experience were recruited and underwent a two-day training course on the objectives of the study and data collection using the CAPI (Computer Assisted Personal Interview) system. Interviewers were then selected to guarantee data quality. The questionnaire was digitized using SurveyCTO with automatic filters, constraints, and relevance criteria for certain questions to control data entry.

During data collection

The supervisors organized a group field trip to the main town and surrounding area to ensure that each interviewer collected data at least once. The supervisor developed a follow-up plan for the field teams. The supervisors ensured that the interviewers were in the various assignment zones. Field supervisors completed a supervision form to report on field progress, including the number of interviews completed as well as any problems encountered in the field. All teams were linked by a WhatsApp group for rapid sharing of information in the field. Automatic checks of completed and sent questionnaires were carried out by the coordinator in charge of data processing and analysis. If necessary, the provincial supervisor was alerted to take corrective action.

After the data collection

Data editing was carried out during data collection to ensure data quality, notably by searching for “I don’t know” or “refusal” responses and by cleaning the database prior to analysis.

DATA PROCESSING AND ANALYSIS

The content of the in-depth interviews and open-ended survey questions was analyzed using ATLAS TI software. Through an inductive and iterative process, a list of thematic codes and sub-codes was developed. The initial list of codes was based on the themes and questions contained in the interview guides. Two Data Analysts coded each transcript to compare codes in order to develop a comprehensive codebook and also ensure consistency in coding. All transcripts were coded using the approved coding list. Once coded, we developed matrices to identify emerging themes and sub-themes in the data, and to properly organize quotations that illustrate the themes. We looked for codes that were related to or influenced each other. We looked for subgroups to highlight specific experiences and the reasons for those experiences. The results have been included below as a conceptual framework for the themes and responses to specific research questions by providing illustrative quotes.

The intervention strength survey data collected by the interviewers was transferred to the server after verification by the field supervisor. Secondary data editing (data cleansing) was carried out using SurveyCTO software. Data analysis was performed using SPSS Version 25 software. Data were downloaded on a regular basis by the investigator team to check their quality, using a working file. To check data quality, frequency tables were produced for each variable to identify out-of-range values and missing responses.

The data were analyzed to produce expected frequencies for categorical variables, and for continuous variables, the measure of central tendency (mean or median) and dispersion (standard deviation or interquartile range) according to the normality of the distribution. The Chi-square test was used to test for association, with an alpha of 0.05.

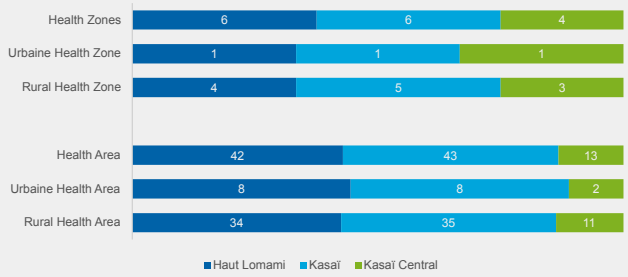
In order to achieve the objectives of the coverage and equity study objectives, secondary analyses of immunization coverage and equity survey data were conducted. The data extracted covered Haut-Lomami, Kasaï, and Kasaï Central. The extraction of the data was done manually. Once extracted from the ECV databases, the data was subjected to a descriptive statistical analysis. The variable measured was zero-dose prevalence. As a reminder, the zero-dose prevalence of children aged 12-23 months is defined as those who have not received at least one dose of the diptheria, tetanus, and pertussis containing vaccine. To measure the extent of deviation, the standard deviation of each prevalence was associated with each variable. The analysis was then carried out in two stages. First, the general evolution of the overall percentage of zero-dose children was described. Then, from a socio-economic equity perspective, the percentage of zero-dose children in Haut-Lomami, where geospatial data had been in use by the EPI program for at least 12 months was compared over time with its evolution in the two other provinces, using data from the Vaccine Coverage Survey (ECV) from 2020 to 2022, across different household wealth quintiles, telephone use by the head of household, and the urban or rural residence of the household.

Results by Study Aim and Objectives

The overall goal of the study was to assess the use of Mapping for Health (M4H) data for microplanning and routine immunization program implementation and associated impact on immunization coverage, equity, and cost-effectiveness. In particular, the study tested the hypothesis that the effective use of M4H geospatial data can increase immunization coverage and equity through the identification of missed settlements (and zero-dose children) and optimization of vaccination strategies and supply distribution. It also took a gender-sensitive research approach and included a gender sub-study to assess gender-specific interventions in a sub-set of Health Zones and Health Areas in Kasai as part of Gavi's intensified strategy to address gender inequity.

The overall structure of the research study included one province selected for inclusion of gender-specific activities in a subset of Health Zones and Health Areas, namely Kasai; another M4H province selected to assess the effects of GRID3 interventions without gender, namely Haut-Lomami; and a control site to compare both intervention sites against, namely Kasai Central. In addition, the protocol includes prioritization and segmentation of primary research participants for the intervention strength survey and qualitative in-depth interviews (where possible engaging with equal numbers of male and female EPI managers, supervisors, and vaccinators) as well as in the secondary analyses of immunisation coverage and equity surveys (gender-disaggregated analyses of birth cohorts).

FIGURE 3: HEALTH ZONES AND HEALTH AREAS INVESTIGATED BY PROVINCE



The survey took place in 3 provinces, 15 health zones including 3 HZ urban and 12 HZ rural; in 98 health areas including 15 urban HA and 80 rural HA. (As a reminder, there are a total of two intervention provinces (Haut-Lomami and Kasaï provinces) and one control province (Kasaï Central Province). This description is illustrated in Figure 3.

TABLE 1: QUALITATIVE RESEARCH STUDY POPULATION AND SAMPLE

	Haut-Lomami	Kasai	Kasai Central	Together
	n=46 (%)	n=49 (%)	n=16 (%)	n=111 (%)
Sex				
Male	39 (85)	43 (88)	16 (100)	98 (88)
Feminine	7 (15)	6 (12)	0 (0)	13 (12)
Total	**46 (100)**	**49 (100)**	**16 (100)**	**111 (100)**
Age range				
< 25 years	1 (1)	0 (0)	0 (0)	1 (1)
25 – 34	15 (33)	5 (10)	5 (31)	25 (23)
35 – 49	18 (39)	26 (53)	9 (56)	53 (48)
≥50	12 (26)	18 37)	2 (13)	32 (29)
Total	**46 (100)**	**49 (100)**	**16 (100)**	**111 (100)**
Level of Study				
Secondary	13 (28)	15 (31)	4 (25)	32 (29)
Higher or University	33 (72)	34 (69)	12 (75)	79 (71)
Total	**46(100)**	**46(100)**	**16 (100)**	**111(100)**
Marital status				
Married	44 (96)	45 (92)	16 (100)	105 (95)
Bachelor	1 (2)	3 (6)	0 (0)	4 (4)
Widower widow	1(2)	1 (2)	0 (0)	2 (2)
Total	**46 (100)**	**49 (100)**	**16 (100)**	**111 (100)**
Function				
IT	17 (37)	44 (90)	8 (50)	69 (62)
IS/EPI Supervisor	3 (7)	3 (6)	3 (19)	9 (8)
MCZ	0 (0)	1 (2)	0 (0)	1 (1)
Other	26 (57)	1 (2)	5 (31)	32 (29)
Total	**46 (100)**	**49 (100)**	**16 (100)**	**111 (100)**

In Table 1 are the socio-demographic characteristics of the study sample. Despite a proactive approach to include equal numbers of male and female research participants, the EPI program is largely male, and therefore we had a higher number of male study participants than female.

Almost all of the respondents were male, i.e. 98%. The modal class of respondents in all three provinces is 35-49 years old with a total of 48% of all respondents interviewed. More than three out of four respondents had a higher or university level of education and almost all were married, i.e. 95%. Three-fifths of respondents assumed the role of Nurse, or 62% of cases, except in the Province of Haut-Lomami where a little more than half assumed other functions, or 57%.

STUDY AIM 1

Conduct a process evaluation to understand the program and implementation context, and identify the mechanisms through which geospatial data use influences immunisation coverage

OBJECTIVE 1.1: CONDUCT KEY INFORMANT INTERVIEWS AND SECONDARY ANALYSIS OF PROGRAM DATA TO ASSESS THE PROCESS THROUGH WHICH M4H GEOSPATIAL DATA IS CREATED.

With regard to the contribution of the various participants to the development of the vision for the mapping intervention, it emerged from the interviews that the majority were not involved in the development of the vision for the design of the mapping intervention, as most of the project participants incorporated it into the implementation phase. Consequently, they did not master much of the information at the outset. Content analysis of the interviews categorized by level revealed certain differences in the participation or contribution of the various stakeholders. At the central level, it appears that not all the Ministry's stakeholders at this level have had the same degree of participation or contribution to the project.

By way of illustration, one participant said: *"Personally, I didn't work directly on this, but I can say that in the planning ... it was planned to also plan these activities relating to mapping. In that sense, I can say that I contributed to that, but not really to the project.* Another participant said: *Yes, I'm a member of the cartography office, especially as they're currently working on health cartography, which is an area specific to the Ministry of Health, and they're there to support us technically and financially, which is why we're participating.*

At the provincial level, it appears that participation or contribution was not at the project design level, but in the planning and implementation phase, where this level accompanied the various stages of data collection and validation. As one participant said: *"Before this activity could be effectively implemented, there were a number of prerequisites that had to be met, i.e. the project needed to have an exhaustive list of ZSs, ASs, ZS managers, AS managers and their contact numbers. These were the elements we made available to the project. This is perhaps the key element, but there were a lot of documents. It must be said that it took a long time. We've been providing these elements practically since 2020.*

As far as the GRID3 staff are concerned, it appears that some of those who were there at the outset left the project along the way, while others joined it later, after it had been conceived. However, the project's main designers are still active in the project. One participant said: *"So I wasn't involved in the development of the project per se, in the design of the project, but I did join the project at the beginning, or at least after 3 months from the start, from the launch of the project.*

INTEGRATION OF GENDER ASPECTS AND SOCIAL INCLUSION IN DIFFERENT STAGES OF THE MAPPING INTERVENTION

With regard to the gender and social inclusion component of the mapping intervention, the interviewees noted that the project's objectives took account of the gender aspect from the point of view of the service providers and concrete implementation. This was evidenced by the identification of vaccinated children by sex and age. Equity is the principle that characterizes the conduct of all field vaccinators. They took into account all social strata, even those far from the city. All children had to be reached to be included in the vaccination.

Thus, we note that for almost half of the participants, the gender and social inclusion component was taken into account in the design of the intervention while the other half were not aware of this component. A content analysis by respondent category according to health system levels revealed a difference in perception of the gender and inclusion aspect.

At the central level, the gender intervention was clearly known at this level, and the various stakeholders recognized this dimension in the intervention and also contributed to it in the training aspects of the field teams.

One respondent said: *"I know that in this project they have several axes among which there is a part that takes care of gender aspects. I'm from the EPI and the activities of the EPI or the program are not the same as those of the project. In our PAO, there are activities that plan to provide financial support for the implementation of GRID3, which has several axes, including one that takes into account immunization and gender aspects".*

At the provincial level, the gender and social inclusion dimension is perceived differently by the various stakeholders at this level. Some seem to have clear ideas about it, others seem to have understood it belatedly, and still others have not understood or perceived it at all. One respondent stated, *"It has to be said that from the very beginning, these are aspects that we didn't really have in detail, in a clear way. So, the gender and social inclusion aspect didn't appear. So it's here that I think you saw even the Division Manager insists on it, because in fact, the idea we had at the start was to draw up health maps for space management. But as for the gender and social inclusion aspect, we've come to find out about it. It's been left unsaid in relation to this activity, but for us I think it's a good thing".* Another respondent stated, *"We have to admit that we didn't start taking this dimension into account very long ago because we were already beginning to identify how many children by sex were vaccinated and to identify the gap between children by sex who would not be vaccinated. But social inclusion is a principle of equity in vaccination, and we take into account all social strata, even those who are very far from our cities. We look for them in the swamps, in the islets, so that everyone is taken into account in vaccination."*

For GRID3 staff, the gender and social inclusion dimension is omnipresent in the interviews, but they recommend that certain aspects be rethought, especially in the way this is integrated into the mapping process. As one respondent put it: *"Yes, it's also the same, it's a deliverable from this project. The gender part was worked on with the project's gender team, we had a colleague who is no longer here, who had really initiated the design of the activities at the time of the project proposal, we then recruited a consultant and I don't know if you've ever heard of who was really the person who took charge of the design and implementation of the gender and equity dimension. So the*

idea was to take this project, which was originally really focused on geospatial data, and give it a gender and equity dimension. It's true that it wasn't necessarily obvious that geospatial data in itself would be gender- and equity-based, so that's why we created other activities such as... training, preparation of guides that are complementary to the geospatial data and mapping work, and the idea being that obviously producing the best geospatial data ... that allows us to have better information on populations and therefore to better adapt strategies." Another respondent said: *"Well, I suppose so, because one of the main thrusts of the project was indeed devoted to the gender and equity aspect, so this had been validly followed up and implemented. And as we saw during the presentation of the project's results at the workshop on geo-referenced micro-planning, we talked at length about this aspect."*

PERCEPTION OF THE PROBLEMS UNDERLYING THE DESIGN OF THE HEALTH MAPPING INTERVENTION

When asked what problems this intervention was intended to solve, it emerged from the interviews that the biggest technical problem to be solved was controlling the number of the target population and therefore improving the denominator. This project therefore aims to help the health system, and the EPI in particular, to fulfil its mandate of vaccinating all children. The design of the geospatial and gender data set-up has made it possible to effectively identify where the targets are, and finally to put in place mechanisms and means to reach them and vaccinate them according to EPI guidelines. The project has also resolved the problem of imprecise Health Area and Health Zone boundaries, as well as the location of populations overlooked during vaccination activities.

Generally speaking, all respondents emphasized that mapping enables the identification of the population wherever it is, in order to organize vaccination activities to combat vaccine-preventable diseases. In this way, it enables EPI Program staff to see how to direct immunization-related interventions in the community to provide them with the services they need. Mapping therefore enables the program to properly direct interventions by knowing how to target people and when to carry out these activities. It's the impact of this health mapping on health activities that should be improved.

During an interview, one respondent indicated that: *"it was more the collection of data on the geospatial location of health facilities, the boundaries of health areas and health zones to better organize the vaccination of all social strata of children that was the problem to be solved"*.

INFLUENCE OF THE DRC HEALTH SYSTEM ON THE DESIGN AND IMPLEMENTATION OF MAPPING INTERVENTIONS

Interviews with various respondents revealed that the involvement of managers at all levels had a positive impact on the design and implementation of mapping interventions in that two important committees were set up. The first was the Steering Committee, responsible for monitoring the progress of project activities. The secretariat of this committee was made up of various members, including the general secretariat, which provided oversight on the progress of all activities, and the technical committee, whose mission was to monitor activities related to data collection and quality analysis. To this end, the project called on the expertise of other partners working in this sector. One interviewee said: *"Overall, things have progressed normally, and now there are some validation aspects that should be progressing properly. In particular, base cards have been distributed to the various zone head doctors to receive feedback on everything that has been collected as data. Ensuring that the data has been correctly collected and that there are no faults, will enable things to be taken up to the next level for validation."*

PROJECT STAKEHOLDERS: INVOLVEMENT, PARTNERSHIP AND INTERVENTION REINFORCEMENT

With regard to the various stakeholders involved in the development and deployment of the interventions, most respondents noted that all levels of the health pyramid were involved in all these activities, i.e. from the bottom to the top of the health system. There was also the population and the members of the community outreach cells (CACs) who had carried out the enumeration activities in the households. There were also the head nurses of the health areas who had coordinated the activities in their health areas. At the health zone level, the entire management team was involved, along with the zone's chief medical officer and the various supervisors who oversaw the data collection and validation activities.

At the branch level, the head doctor and his team, the logistician, the data manager and others also contributed. At the provincial level, the Head of the Division and the DPS team also contributed, as did the data validation and mapping session chaired by the Provincial Minister of Health. So, at the provincial level, the whole chain of managers involved in the activity was involved, from data collection to validation. The first maps produced followed the same levels of stakeholder engagement. At the central level, ANICIIS and DSNIS were actively involved. There were also partners such as the WHO, and the Red Cross, which produced geo-spatial data on location and health facilities at the national level in several provinces. Some of the partners involved are active in the health sector in the DRC.

COMMUNITY CONTRIBUTION TO THE DEVELOPMENT AND MONITORING OF THE MAPPING PROCESS

As far as the community's contribution is concerned, it emerged from the interviews that it had taken part through the community animation cells with the agreement of the local authority. Knowing the principle that "whatever you do without me, you do against me". The head nurse, working with members of the CAC, organized meetings and briefings to enlighten community members on the merits of mapping with the support of the local authority and CAC members, who accompanied the head nurse to enable him to do a good job in the field.

However, the community was both a barrier and an enabler, as this population had not been involved in a participatory process during the design or development of the project. The result was mistrust on the part of this population, which is not accustomed to seeing sophisticated materials or technological devices. In some provinces, the local population believed that they were being expropriated from their land, requiring explanations at all times despite the authorization of the village chief. In some cases, the population forbade the activity or even bought the equipment outright. This situation could have been avoided if this segment of the Congolese health system had been taken into account during the design stage.

Here's an illustration taken from the interviews, *"In terms of ease of use, it's the community that knows the boundaries, because the Registered Nurse doesn't necessarily come from where it is. From a social point of view, you had to see the chief, because when you say, for example, "Where does your village end?" he's the one who should say, "My land goes as far as here", and you think, "That's the boundary you have to cross". In terms of barriers, it has to be said that we live in an environment that isn't very advanced. Most of our community is in villages and when we see an activity where we have to use*

fairly technological equipment, we wonder what the purpose is and that's the barrier of reticence that we could feel. There were questions such as: "Are you looking for these coordinates so that I can have something concrete at the end? But much more positive elements came to the fore."

MAPPING ACCEPTANCE, CHALLENGES, AND PROSPECTS

With regard to the acceptance of the mapping, it emerged from the interviews that the mapping was well accepted by various stakeholders. Positive aspects include the production of better-quality maps, enabling more accurate location of sites compared with the old handwritten maps, and the production of more accurate population estimates and population densities, enabling better planning of vaccination activities.

Negative aspects related to the imperfection of the maps, which had some omissions or inaccuracies of certain customary landmarks. Respondents also noted that there had been a few errors, such as a mountain, swamps, and geographical barriers that had not been included. In terms of boundaries, there are a few that have not been respected in the production of these documents. For certain health zones, some health areas had almost disappeared. This was the case for the Kitenge health zone and the Kinkondja health zone in the Haut-Lomami province, for which the respondents would like these maps to be included.

INTRA- AND INTER-SECTOR PARTNERSHIPS: CHALLENGES AND PROSPECTS

Participants noted that the greatest challenge was to bring all stakeholders together to share a common vision of the importance and usefulness of mapping, especially in the field of child immunization, taking into account the gender aspect and the inclusion of all social strata. Another challenge was to share data via a platform accessible to all institutions. Indeed, although there is such a platform, the "Référentiel Géographique Commun" (RGC), used by all the institutions working in the health sector and producing geographical data, there is still an asymmetry of information between the different institutions due either to the retention of updated data by certain partners, or to updating difficulties, or to incompatibility between the platforms. The principle, therefore, was that available data should be shared between institutions in order to pool them and draw up a common operational activity plan.

In terms of the types of cross-sectorial engagement that could be beneficial, the study found that the participation of all community development sectors is paramount, followed by the strengthening and involvement of community participation structures where all members of the community participate to provide solutions to multiple health problems, taking into account all social strata. Respondents indicated that working with these community participation structures and civil society organizations, by enabling them to play their role in the health sector, especially with regard to mapping, would make it possible to reach all children targeted for immunization. For this to happen, this intersectoral participation needs to be strengthened so that it can make a truly effective contribution to improving immunization activities in the community. One participant stated, *"It's in these health committees from the grassroots upwards where the community participates in meetings with the provider, so it's organized as such there's a meeting every month, with health workers and community members to discuss the progress of activities in our sphere of action and everyone brings their contribution to the development of health activities."*

TECHNOLOGY AND ARCHITECTURE: SUITABILITY OF THE INTERVENTION

With regard to the mapping intervention's response to the needs of health system users, the data collected showed that this intervention came at the right time to resolve certain questions or problems that had long been pending. It helped with planning as well as micro-planning, and the health zone management teams needed the project's data because, although it's estimated, it's closer to reality, making it easier to implement planned activities and monitor and evaluate activities in the field.

The project's data enabled us to control the community's demographics, as there was a problem of over- and underestimation of total populations, which led to errors in certain health zones, and the indicators suffered. In some cases, the management teams exceeded their objectives due to a lack of control over the target population. As one interviewee put it: *"I think it goes some way to solving the problem of equity of service. It's a really crucial issue. You have the realities of different zones and different health areas. But when you have to plan by imagination, that's a problem, but when you know that there's such and such a population and such and such a workforce in such and such a corner that's not easily accessible, you already put in what kind of means to solve the problem. I think it could also solve these problems, we'll say equity, accessibility, needs, and all that...we'll be able to respond effectively and efficiently"*.

BENEFICIARIES OF THE HEALTH MAPPING INTERVENTION

Generally speaking, all respondents indicated that the Government and the Ministry of Health are benefiting directly because they currently have reliable data that enables better planning of immunization activities, taking into account the gender and social inclusion aspect. The population benefits indirectly, as there will be a clear improvement in the reach and quality of immunization services.

OPTIMAL FUTURE FOR MAPPING FOR HEALTH DATA

On the subject of the optimal future for M4H data, respondents indicated that the project has come to solve the problem of vaccination to put an end to over- and under-estimation of the target population and that the future is promising. One participant commented: *"It's a promising future, but it's only the first step. I think that these will be dynamic maps that can be updated as we go along because when I see our green spaces in Lubumbashi, they are in the process of being occupied. So if the maps were made in February or March, you understand that this is not the real situation at the moment. So, the project will have to see how to establish a certain periodicity for updating these maps, which in fact also change according to the movement of populations, as there are quarries and mines that have been identified. But these quarries are closed at some point and people move around, so you understand that if you have a map, you say there's a mine with a certain population. If the quarry closes, people are going to have to move, and there won't be anyone left.*"

OPERATIONS: IMPLEMENTATION OF MAPPING INTERVENTION

A key aspect of the implementation of the intervention is that there is the notion of geospatial intervening with the use of new technologies that help to have precise details on all the specificities of the spaces whereas before they resorted to sketches. Field teams can use the GPS of a cell phone to

locate a house where there's a target child by making maps or satellite images and you have the configuration of the plot directly. This gives this activity a certain specificity compared to what was done before. This specificity gives us greater precision in relation to the reality on the ground.

MONITORING AND ASSESSMENT: STAKEHOLDER FEEDBACK ON THE MAPPING PROCESS

It emerges from this study that feedback is bottom-up, starting from the community base, at the level of the health area IT who manages the village. They send the information to the central office level, the central office sends it to the intermediate level, and where there are EPI antennas and the Provincial Health Division, at their level, they transmit all the information to the central level for possible arrangements.

Here's an illustration taken from an interview: *"It's true that the work has been done, but we've had, the province was in copy with more directed messages at the level of the ECZS with different mappings so that the HZ can validate these mappings and can send the return. But what happened was that some of them got together with the Registered Nurses who printed out these maps and started to validate them with the Registered Nurses if they really corresponded to reality on the ground, and were able to share them directly with the project, while copying us. It has to be said that I didn't have the time to see some of the feedback from the mappings because it was while I was here, but for the moment we're following up a few areas that haven't yet sent in their feedback to improve the mappings.*

And as soon as we've finished, the project promises to send us the maps as soon as the feedback from the HZs has been integrated. At that point, I think we'll be able to exchange ideas with the zones, but at least if we still have an opportunity to meet the ECZS, we'll be able to show them these aspects of advanced strategy planning, using the Kikuanda SA as an example, We'll be able to show them these aspects in relation to the planning of advanced strategies, mobile strategies based on the declarations that have obviously been made, while also integrating the gender aspect, so that the HZ can really reassure themselves that the feedback they've given has been exhaustive, or if there are elements that they'd like to complete based on what we're going to tell them, as the project says, they can send them to us around January-February. In December, these zones will be able to contribute to the final maps, which will incorporate all the feedback from the HZs."

With regard to gender, the feedback was that zone management teams were previously faced with data that did not take the gender dimension into account. However, in the current immunization register, the gender dimension is taken into account. In view of this change, community members, head nurses and members of the zone management teams have been ensuring for some time that the gender aspect is taken into account in the recruitment of community relays.

THE COMMUNITY'S ROLE IN MONITORING MAPPING AND THEIR CONTRIBUTION TO MAPPING INTERVENTION

Communities play a major role in monitoring mapping, because they are the ones who know the names of villages, village boundaries and localities, and know that such and such a corner or bush is in their health area, and that there are populations there. To do this, they take only people from the communities to carry out a vaccination activity because they can't import a community relay because they won't have the information.

LESSONS LEARNED FROM THE MAPPING INTERVENTION

For the participants, mapping remains today a very powerful tool in decision-making, especially in disease control (apart from the field of vaccination), surveillance, and estimating population movements using telephone networks. They added that geospatial data can help to identify where the population movement is happening to prevent certain diseases and monitor them or to organize vaccination to recover those lost to view. A key lesson, as always in public health, is community participation, which is of vital importance in planning and organizing health activities to help the population.

OBJECTIVE 1.2: CONDUCT DIRECT OBSERVATION AND KEY INFORMANT INTERVIEWS AT THE NATIONAL AND PROVINCIAL LEVELS AND SECONDARY ANALYSIS OF PROGRAM DATA TO ASSESS THE PROCESS THROUGH WHICH M4H GEOSPATIAL DATA IS SHARED FOR USE IN MICROPLANNING PROCESSES.

EXPERIENCE IN ROUTINE MICRO-PLANNING OF IMMUNIZATION ACTIVITIES AND PARTICIPANTS IN GEO-SPATIAL DATA COLLECTION

Most of the respondents have already worked for more than 10 years, directly or indirectly, in the micro-planning of routine immunization activities. They are therefore experienced resources in this field.

An illustration from an interview: *"I've been with the EPI since 2003, 18 years. Although I had to do 2 years outside the civil service, I was a consultant at UNICEF for 2 years. I had the opportunity to attend the School of Public Health, vaccinology. I also have experience outside other provinces where we were requisitioned for routine micro-planning activities for campaigns, to accompany almost all the Tanganyika, Haut Lomani and Lualaba provinces. But at UNICEF, I had the opportunity to visit Kasai in its former configuration, Tshikapa and so on."*

It's the stakeholders at the operational level who have been more active in collecting data. Everything started with the health areas, which were supported by the health zones. The Registered Nurses and the community (community relays, community animation cells and health development committees) took an active part in the micro-planning of their respective health areas, right up to their transmission to the central office level. These micro-plans were then consolidated at the level of the various EPI branches after each health zone had been reviewed and either corrections/ updates requested. Upon acceptance of the data by the EPI branches, from there, everything was transmitted to the coordination and central levels.

USE OF GEOSPATIAL DATA IN ROUTINE IMMUNIZATION AND MICRO-PLANNING, FACILITATING FACTORS AND OBSTACLES

At the operational level, several structures have not yet begun to use geo-referenced data in routine immunization and micro-planning, since in several provinces where the intervention has been implemented, they are only at the stage of validating and correcting maps or data. The following considerations were perceived as facilitators for the use of geospatial data for routine immunization and micro-planning: the existence of a legend that makes it easy to read a map; attraction to technology; transition from analogue to digital; the desire to do things differently and to do them better; the fact that users were involved in the design first, so they understand what they have

to do; user support; buy-in and use of the tool by the service provider.

For some provinces, the following were perceived as obstacles: the problem of connecting to the Internet (network constraints); lack of knowledge of the tool; lack of training, unavailability of logistical and financial resources; the fact that most of the tools used in vaccination are analogical; most of the tools are intended for people who are not too literate in terms of technology; technological tools require a substantial investment in terms of equipment but also in terms of training and support; barriers in terms of habits; logistical, financial and economic constraints in implementation.

VERIFICATION OF DATA RELIABILITY AND ACCURACY

Generally speaking, there was an appreciation for the rigorous protocol and triangulation with previous databases to cross-reference data and make comparisons at several levels. This demonstrated that the data were reliable and accurate. Some data was collected by telephone and shared with the central server via an Internet connection, which the experts could use to produce maps. In this way, ACASUS supported the project in improving performance by monitoring vaccinators in the field. The maps also underwent a validation process and, once validated, were made available to all levels.

COMMUNITY INVOLVEMENT IN DATA USE

Based on the interviews, it appears that the communities are involved at the micro-planning level, and are expected to be able to work in the same way as in routine activities. It should be noted, however, that their role has not been clearly presented in the project; but as an actor in the health system, they are involved. For the future, however, it is recommended that the community needs to be involved in the design, implementation, and evaluation. *"In the design of the maps, the communities were there to identify the entities, health facilities; there were community representatives and now in the use part as in micro planning, there are always community representatives. It's especially in the communication aspect, when we talk about CAC, we see the community. They're the ones who know the terrain, who have all the information to pass on to the CAC, from the CAC to the central office.*"

ADAPTABILITY AND UPDATING OF MAPPING DATA

As one participant put it: *"We'll always have to keep the data up to date, because nothing is static in everything we see, whether in urban or rural areas, as new buildings are built and things are added. What we do today, 6 months later things will certainly be added, and 2 years later it will no longer be valid, because we'll be missing certain information. And even in rural areas, there are sometimes even villages that disappear; after a while you can see that there was a population here and after a while it's no longer there. At that point, if you haven't updated it, you're going to target something that no longer exists; so it's useful and worth updating. Yes, it's part of a dynamic population."*

PERCEIVED BENEFITS OF USING GEOSPATIAL DATA IN MICRO-PLANNING

The interviews reveal that for almost all respondents, geospatial data in micro-planning had been beneficial for several reasons, including the identification and location of people to be vaccinated, the accuracy of representations of health areas and zones, the distribution of villages, the identification of natural obstacles on maps and the distribution of source data according to equity.

One respondent said: *"The use of geospatial data is beneficial because the aim of the EPI is to vaccinate people. That's why we need to locate them where they are. Mapping makes it possible to identify and locate these people. Even identifying where they are is very beneficial for us. We had made plans for additional vaccination activities during the campaign, but we still didn't know a large part of the population. The teams were vaccinating a good proportion (we said we'd even reached 120%), sometimes with perhaps a pocket of the population not taken into account. Mapping, on the other hand, allows us to identify even the limits, because there are certain populations that have been abandoned."*

Another respondent said: "*If the card allows me to identify well and especially if the updates are done, it's very advantageous; unless we find something else better than that."* Respondents felt that until then, this was the best option.

OBJECTIVE 1.3: CONDUCT DIRECT OBSERVATION AND KEY INFORMANT INTERVIEWS AT THE NATIONAL AND PROVINCIAL LEVELS AND SECONDARY ANALYSIS OF PROGRAM DATA TO ASSESS THE PROCESS THROUGH WHICH M4H GEOSPATIAL DATA IS USED AS PART OF MACROPLANNING PROCESSES AND PLANNING FOR MICROPLANNING AT HEALTH ZONE LEVEL.

Due to the inability to align the research study period with macro-planning, the research team was unable to collect data concerning objective 1.3 of the study, relating to the information on the quantities and distribution of vaccine stock at national and province levels.

OBJECTIVE 1.4: CONDUCT DIRECT OBSERVATION, INTERVENTION STRENGTH SURVEY WITH QUALITATIVE QUESTIONS WITH HEALTH ZONE EPI MANAGERS AND SECONDARY ANALYSIS OF PROGRAM DATA TO ASSESS THE PROCESS THROUGH WHICH M4H GEOSPATIAL DATA IS USED AS PART OF MICROPLANNING PROCESSES. DOCUMENT HEALTH ZONES WITH HIGH ACCEPTANCE AND USE OF M4H DATA, MODERATE ACCEPTANCE AND USE OF M4H DATA, AND/OR LOW ACCEPTANCE AND USE OF M4H DATA IN MICROPLANNING.

USE OF GEO-REFERENCED DATA BY SERVICE PROVIDERS DURING MICRO-PLANNING

All health zones as well as all health areas surveyed in the Kasai province received the geo-referenced data. Almost the entire Haut-Lomami province, 98%, received the geo-referenced data; no structure in the Kasaï Central Province, which is a control province, received the geo-referenced tools (Figure 4). The different maps were observed by the research team to be taped to the office walls of almost all (98%) of the Health Zones and Areas investigated in the Kasaï province and on almost 3/4 of the walls of the Haut-Lomami province (Figure 5).

These quantitative results are supported by the qualitative data. The majority of respondents claimed to have taken part in the creation of geo-referenced maps both for those at the intermediate level (the EPI branches) and at the peripheral level (the health zones and health areas). These exercises were facilitated by GRID3, which had the role of ensuring the training of the facilitators of each entity. Unanimously, the respondents mentioned their satisfaction and also affirmed that these cards were of capital use in general and that their use in vaccination activities made it possible to improve their knowledge and

FIGURE 4: DISTRIBUTION OF HEALTH ZONES AND HEALTH AREAS REPORTING HAVING RECEIVED GEO-REFERENCED DATA

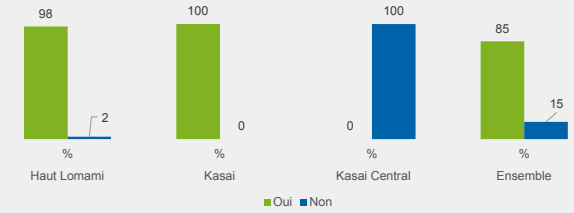
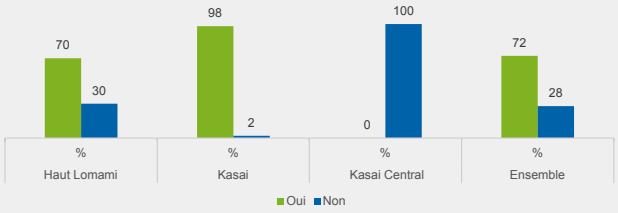


FIGURE 5: DISTRIBUTION OF HEALTH ZONES AND HEALTH AREAS WITH DISPLAY OF GEO-REFERENCED DATA ON THE WALL



acquire more information on the respective entities. This also made it possible to resolve conflicts over the delimitation of the geographical spaces of the health areas.

> *"The creation of this map initialization exercise, in any case, has helped us a lot, because before, we didn't do a very good job of dividing up the vaccination sites. Now, thanks to this map, we're able to divide up the vaccination sites properly and know our target by site, and reach that target if we have any missed children to recover." (Respondent 18, AS, Kasaï)*

> *"We were very pleased because we had had a few difficulties, especially in identifying certain villages that we didn't know about, and then the distribution of certain households, because we still had a few difficulties throughout the health zone". (Respondent 03, BCZ, Kasaï)*

However, certain difficulties were reported by respondents in relation to this new experience. If for some the maps perfectly described the geographical location of the entity (health area), for others, the limits defined on these tools did not reflect the reality on the ground.

> *"At one point, we realized that certain health areas in a given zone were not within the boundaries of the zone. Some health areas, or some health area structures,*

TABLE 2: DISTRIBUTION OF STUDY PARTICIPANTS RESPONSIBLE FOR THE MICRO-PLANNING TOOL USED IN THE PROVINCE OF HAUT-LOMAMI, KASAÏ, AND KASAÏ CENTRAL IN 2023

	Haut-Lomami	Kasai	Kasai Central	Together
	Num (%)	Num (%)	Num (%)	Num (%)
Responsible for micro planning tool conservation				
IT(Registered Nurse)	40(88.9)	42 (85.7)	10(62.5)	92(83.6)
Male nurse	7(15.6)	5 (10.20)	1(6.3)	13(11.8)
IS/EPI Supervisor	4(8.9)	3 (6.1)	3(18.8)	10(9.1)
Others	0(0.0)	7 (14.3)	1(6.3)	8(7.3)
MCZ	2(4.4)	4(8.2)	1(6.3)	7(6.4)
RECO	1(2.2)	3(6.1)	0(0.0)	4(3.6)
Do not know	0(0.0)	1(2.0)	1(6.3)	2(1.8)
The nature of the micro planning tool				
Paper	44(97.8)	49 (100)	15(93.8)	108 (98.2)
Electronic	7(15.6)	1 (2.0)	2(12.5)	10(9.1)
Where to keep the paper micro planning tool				
In a folder	23(60.5)	13(27.1)	2(14.3)	38(38.0)
In a cupboard	11(28.9)	18(37.5)	5(35.7)	34(34.0)
In a binder	6(15.8)	7(14.6)	4(28.6)	17 (17.0)
In a box	1(2.6)	6(12.5)	3(21.4)	10(10.0)
Other (s) to be specified	3(7.9)	6(12.5)	1(7.1)	10(10.0)
Do not know	1(2.6)	4(8.3)	1(7.1)	6(6)
Those who have access to the micro planning tool				
IT (Registered Nurse)	40 (88.9)	45(91.8)	12(75.0)	97 (88.2)
Male nurse	19 (42.2)	18(36.7)	6(37.5)	43(39.1)
Others	0(0.0)	22(44.9)	6(37.5)	28(25.5)
RECO	9(20.0)	17(34.7)	1(6.3)	27(24.5)
IS/EPI Supervisor	5(11.1)	6(12.2)	6(37.5)	17(15.5)
MCZ	4(8.9)	5(10.2)	4(25.00)	13(11.8)

were outside the boundaries of either the health area or the health zone. We shared these with the health zones, and the maps were corrected on the basis of the health zones. And since we sent them to Kinshasa, I think to the partner, I don't know if the corrections have been made or if these difficulties still persist". (Respondent_02, EPI)

"In relation to geo-referenced maps, these are good maps that help us plan vaccination activities. Except that since we started sending them out, there have been little problems here and there. I think it's been 3 times since we've sent out these maps, but there are always little problems. We're perhaps waiting for the latest version if it's really going to be done exactly as we want it, but if not, there are always little problems here and there; but generally speaking, it helps us to organize well and especially to organize well the vaccination sessions, fixed, advanced and even mobile" (Respondent_01, EPI).

"First of all, there was no precise definition of the boundaries of certain health areas, certain health zones, and there were also villages that were even allocated to

TABLE 3: DISTRIBUTION OF MICROPLAN USERS AND REPORTED GEO-REFERENCED DATA AND USES

	DPS Haut-Lomami	DPS Kasai	DPS Kasai Central	Together
	Num (%)	Num (%)	Num (%)	Num (%)
Micro plan Users				
IT (Registered nurses)	41(91.1)	45(91.8)	12(75.0)	98(89.1)
Male nurse	23(51.1)	15(30.6)	1(6.3)	39(35.5)
RECO	14(31.1)	11(22.4)	1(6.3)	26(23.6)
Others	2(4,4)	17(34.7)	2(12.50)	21(19.1)
IS/EPI Supervisor	5(11.1)	5(10.2)	6(37.5)	16(14.5)
MCZ	4(8.9)	3(6.1)	3(18.8)	10(9.1)
What was the source of information before Geo-referenced data?				
Routine data	18(40.0)	42(85.7)	8(50.0)	68(61.8)
EPI	23(51.1)	2(4.1)	6(37.5)	31(28.2)
Other (s) to be specified	4(8.9)	5(10.2)	2(12.5)	11(10.0)
Type of geo-referenced data included in the tools				
Target population (new denominator)	38(84.4)	43(87.8)	N / A	81(84.5)
Distribution of the target population by site or location (number)	34(75.6)	43(87.8)	N / A	77(77.3)
Identification of vaccination sites	34(75.6)	34(69.4)	N / A	68(72.7)
New villages, neighbourhoods, hamlets and/or camps identified (on the map)	34(75.6)	32(65.3)	N / A	66(69.1)
Identification of advanced strategy vaccination sites	30(66.7)	32(65.3)	N / A	62(64.5)
Other (s) to be specified	8(17.8)	13(26.5)	N / A	21(20.9)
Seasonal movement of the target population	11(24.4)	6(12.2)	N / A	17(16.4)
What planning need is solved in Georeferenced Tools				
Location of the target population	39(86.7)	45(91.8)	N / A	84(89.4)
Number of doses to plan	26(57.8)	37(75.5)	N / A	63(67.0)
Reliable denominator	20(44.4)	18(36.7)	N / A	38(40.0)
Others	7(15.6)	11(22.4)	N / A	18(19.1)
Geo-referenced data actually used as reported by microplan users				
Target population	37(82.2)	42(85.7)	N / A	79(84.0)
Distribution of the target population by site or location	32(71.1)	41(83.7)	N / A	73(77.7)
Identification of vaccination sites	35(77.8)	36(73.5)	N / A	71(75.5)
Identification of advanced strategy vaccination sites	32(71.1)	27(55.1)	N / A	59(62.8)
Identification of villages, neighbourhoods, hamlets, camps (mapping)	31(68.9)	27(55.1)	N / A	58(61.7)
Seasonal movement of the target population	2(4.4)	10(20.4)	N / A	12(12.8)
Others	4(8.9)	3(6.1)	N / A	7(7.4)

another health area, so others thought it was a village for the other area and others said it was for the other area, but now, with the geo-referenced map, everyone really knows these boundaries. And even when it comes to vaccination cures, you can have two health areas, but you can see that a population from one health area is easily accessible in another health area to benefit from vaccination services. It's the geo-referenced map that has woken us up to this spirit of vaccination activity". (Respondent_04, HA, Haut-Lomami)

Overall, micro-planning tools are kept by the registered nurses in 83% of the healthcare establishments visited: respectively 89% and 86% in the two provinces of intervention of Haut-Lomami du Kasaï, and 63 % in the Kasai Central province.

Almost all micro-planning tools (98%) were in paper format. A little more than a quarter of tools are kept in cabinets in the Haut-Lomami province (29%) and a little less than two-fifths in the Kasaï province (38%). The micro-planning tool is accessible in most cases to full-time nurses in 88% and to other nurses in 39% of the establishments visited (Table 2).

In the two provinces of intervention, the main users of the micro-planning tool are the regular nurses in 92% of cases compared to 75% in the control province. The other users are nurses and community relays in 36% and 24% of cases respectively (Table 3). Overall, before the introduction of geo-referenced data, half of the healthcare institutions in Haut-Lomami Province used data from the expanded vaccination program (51%) when developing their micro plan. While more than four-fifths of Kasai Province (86%) and half of Kasai Central establishments (50.0%) used routine data. Overall, 10% of establishments used other sources (Table 3).

The geo-referenced micro-planning process address the following needs in the two provinces of intervention, 1) the location of the target population in 89% of cases; 2) the number of doses to be provided in 67% of cases (with a slightly higher percentage (76%) for the province of Kasaï compared to 58% in that of Haut-Lomami), and 3) the availability of a reliable denominator in 40.0% of cases (Table 3).

In the two intervention provinces, in more than three-quarters of health facilities, geo-referenced data were used in the micro plan as a denominator in 85% of cases (76% for Haut-Lomami and 88% for Kasaï) and the distribution of target populations in the sites in 77% of cases. At least three-fifths of facilities mentioned the identification of new sites in 69% of cases with a preponderance for Haut Lomami in 76% of cases and the identification of sites for updating the vaccination strategy or advanced strategy in 65% of cases (Table 3).

In the two intervention provinces, the geo-referenced data actually used are the estimate of the target population (84.0%), the distribution of the target population by site or location (78%), the identification of the sites of vaccination (76%), the identification of new villages (62%) and for the identification of vaccination sites for updating the vaccination strategy or advanced strategy (63%) (Table 3).

According to the qualitative analyses, it emerges from the interviews, respondents, particularly at the zonal and intermediate level, thanks to managed referenced data, support for vaccination activities has significantly improved. With the tracking system, this made it possible to improve the supervision and control of vaccination activities and therefore to assess vaccination coverage at the health area level.

"As EPI when we go to MASHAKO supervision monthly at the central office level and the latter supervises the HAs. The health workers do the tracking, and this often causes problems when the phones break down. When this happens, vaccination coverage drops. Where the phone doesn't pose a problem, coverage is good". (Respondent_01, EPI Antenna)

Apart from the numbers of the target populations which experienced variation in the direction of increase (Kasaï Province) or decrease (Haut-i Lomami Province), other data from the health areas in terms of the number of hamlets, fixed or advanced sites, neighbourhoods remained almost the same before and after the use of geo-referenced data (See Table 4).

TABLE 4: DISTRIBUTION OF LOCATION TYPES AND SITES BEFORE AND AFTER THE SYSTEMATIC COLLECTION OF GEOSPATIAL DATA IN THE PROVINCES OF KASAÏ, HAUT-LOMAMI AND KASAÏ CENTRAL

	Haut-Lomami	Kasai	Kasai Central	Together
	Median (IQR)	Median (IQR)	Median (IQR)	Median (IQR)
Before geo-referenced data				
Hamlets	0 (0-0)	1 (0-3)	1 (0-3)	0 (0-3)
Villages/Neighbourhoods	7 (6-13)	10 (7-18)	13 (11-19)	10 (6-16)
Target population (Denominator)	544 (348-996)	660 (66-7454)	3904 (633-13079)	653 (277-7651)
Fixed vaccination sites	4 (2-6)	4 (2-5)	6 (4-12)	4 (2-6)
Advanced Strategy Vaccination Sites	4 (2-5)	4 (3-5)	4 (4-13)	4 (2-5)
After geo-referenced data				
Hamlets	0 (0-3)	1 (0-4)	N / A	0 (0-3)
Villages/Neighbourhoods	7 (6-14)	10 (8-18)	N / A	9 (6-17)
Target population (Denominator)	476 (295-827)	698 (79-5600)	N / A	588 (86-3020)
Fixed vaccination sites	4 (2-8)	4 (2-4)	N / A	4 (2-6)
Advanced Strategy Vaccination Sites	4 (2-5)	4 (2-4)	N / A	4 (2-4)

OBJECTIVE 1.5: CONDUCT INTERVENTION STRENGTH SURVEY WITH QUALITATIVE QUESTIONS AND SECONDARY ANALYSIS OF PROGRAM DATA TO ASSESS THE PROCESS THROUGH WHICH M4H GEOSPATIAL DATA IS USED AS PART OF ROUTINE IMMUNISATION PROGRAMME IMPLEMENTATION.

Our results show that almost all (94%) of health facilities in the intervention provinces use geo-referenced data during vaccine distribution campaigns in their health areas. This use is more pronounced in the Haut-Lomami Province (96%) compared to that of Kasaï (92%) (Figure 6).

These results are supported by the interviews carried out which unanimously emphasized, the respondents that geo-referenced data was of capital importance in the planning process. They made it possible to improve information relating to the different vaccination strategies, the number of vaccines to order, the availability and location of refrigerators and the size of the population to be covered in the context of vaccination activities.

> *"Geo-referenced data are used in planning because each health area has villages, and each village has vaccination sites. From the sites identified by the geo-referenced map, the Registered Nurse needs to know how many sessions to plan to reach each site represented by the geo-referenced map. In any case, this map helps us a lot with our planning, and it's a basis we're currently using to improve planning within a health area". (Respondent_02, EPI Antenna)*

> *"Some villages were far away or some villages or some health areas depended on a storage site that was far away, but with the closer proximity it really helped so that each health area could have well-stocked vaccines within its radius of action". (Respondent 03, BCZ, Kasaï)*

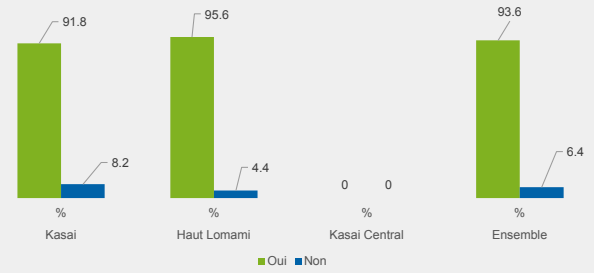
> *"Yes it allows us to identify each population, each village and the distance, and the target population of each village, and even the vaccine to use. If I go somewhere in a small village that is, I don't know, 65 kilometres away with its target, I can already plan the vaccine I need to take, the tools I need to use, the means I need to use and how long I need to take. It's our map, it allows us to do a lot of things, and it makes it easier for us to do a lot of things". (Respondent_28, HA, Haut-Lomami)*

> *"This strategy has changed our way of covering or locating our vaccination areas, because when we didn't have any, we could have children coming to take the vaccines in a planned health area, but now with this strategy, the community understands that when we've sensitized that part, the others have to wait for the moment when we sensitize in their vaccination site to bring the children so they can be vaccinated". (Respondent_15, HA, Kasaï)*

According to respondents, geo-referenced data was not used to improve distribution for vaccine delivery and logistics at the health facility level and/or for vaccination activities. However, the population estimates informed supply requests and tracking made it possible to ensure rapid control and therefore saved time in supervising the activities of health areas and health zones.

> *"…the geo-referenced data so far has not yet given us the mapping of cold chain equipment. But it is true in relation to the structure, the structure knows that in such a place there is a certain population, and this population the Registered Nurse must calculate the target which is there and estimate the needs of this target, it 'is based on these geo-referenced data'." (Respondent_02, EPI Antenna)*

FIGURE 6: DISTRIBUTION OF HEALTH FACILITIES ACCORDING TO THE USE OF GEO-REFERENCED DATA DURING THE DISTRIBUTION OF VACCINES



> *"We are not equipped with computer equipment, we are simply equipped with documents such as SNIS, registers, scorecards and the like, after each session, we write down the report and we send it to the central office, they are the ones who encode the data. But the distribution of time concerning all these aspects is in relation to the weeks, each week we have one or two vaccinations, it depends on the periods the period of the rainy season if you have scheduled the session on Wednesday and that this is prevented by the rain because it is inevitable you can postpone this session the next day to still cover the population." (Respondent_08, HA, Kasaï)*

A small group of respondents reported that the use of DGRs made it possible to improve distribution in terms of the number of vaccines to be requisitioned according to the consumption.

> *"The geo-referenced data, yes, they contributed in relation to the number of sessions carried out per health area. This is why it also influenced the distribution of vaccines because there are three methods to calculate for the estimation of vaccine need: the target population method, the vaccination session method and the previous consumption method. If the Registered Nurse really before we had the geo-referenced data it consumed less now with the georeferenced data, it is starting to do a lot of sessions and even the distribution will be based on that because the geo-referenced data has shown it that you really need to increase even the number of vaccination sessions. If someone uses the vaccination centre method with geo-referenced data, we have increased the number of vaccinations. You saw even the sites which were at 10, now with the georeferenced data have increased to 65 in progress. So all of this really influences even vaccine distribution." (Respondent_04, ZS)*

VACCINATION SERVICE PROVIDERS' PERCEPTION OF GEO-REFERENCED DATA

The majority of respondents, i.e. 69.1%, declared that the geo-referenced managed tools are very easy to use. More than three out of four people are at least satisfied with the information contained in the tool and the use of this tool in their activity planning. The majority of respondents agree that the geo-referenced tool has reduced their working time and improved data quality.

According to the qualitative results, respondents unanimously stated that the tool had more advantages than disadvantages. One of the biggest benefits mentioned by respondents is reaching zero dose children in each health area. This is thanks to better control of health area and the increase in the number of vaccination sessions. At the intermediate level, the tool helped improve the planning, implementation, and supervision

of vaccination activities. In addition to the paper-based geo-referenced micro-plans provided in Kasai and Haut-Lomami, a digital too for reporting and supervision of immunization activities was introduced in Haut-Lomami. Although, out of scope for this research study, some respondents mentioned some of the benefits and drawbacks of the digital tool.

"The advantages are what I've just said: it's helped us to plan activities well; it already encompasses almost everything. When I say planning, I mean identifying a population that was forgotten, how to calculate coverage, how to calculate the number of vaccination sessions, how to calculate quantities, in other words, it encompasses everything. In other words, it helps us plan vaccination activities. That's a real advantage". (Répondnat_05, BCZ, Haut-Lomami)

"It allows us to calculate in which village there are so many children aged 0 to 11 months directly, you take the quantity of vaccines you need to bring there to avoid wasting vaccines during vaccination sessions". (Respondent 01, BSZ, Kasaï)

"Yes-yes, many of the advantages, first we have village identification with their distance, target populations with each village. Very remote villages with obstacles to overcome, natural barriers that we have to cross, it's from this map that has helped us a lot to find solutions before going into vaccination activities". (Respondent 28, HA, Haut-Lomami)

"It's to enable us to know the distances to be covered and the number of advanced and fixed sites we have in our health area and the expected population." (Respondent_08, HA, Kasaï)

However, handling difficulties and faulty devices were mentioned as possible disadvantages by some respondents for the digital tool in Haut-Lomami.

"The tool is useful, but it needs to be updated so that it's really 100% effective. Because there are other health areas where there were really big gaps between the populations, between the population that the health area uses and the population that the map showed, there were really gaps. In other health areas, one health area

TABLE 5: DISTRIBUTION OF PARTICIPANTS ACCORDING TO THEIR SATISFACTION WITH THE INFORMATION CONTENT OF THE GEO-REFERENCED TOOL AND ITS USE

	Haut-Lomami	Kasai	Kasai Central	Together
	n= (%)	n= (%)	n= (%)	n= (%)
Is the tool easy to use				
Easy to use	34 (75.6)	31(63.3)	N / A	65 (69.1)
Very easy	5 (11.1)	13 (26.5)	N / A	18 (19.1)
Not easy to use	4 (8.9)	5(10.2)	N / A	9 (9.6)
Easy enough	2 (4.4)	0(0,0)	N / A	2 (2.1)
Are you satisfied with the information contained in the geo-referenced micro planning tool?				
Satisfied	26 (57.8)	33(67.3)	N / A	59 (62.8)
Very satisfied	13(28.9)	11(22.4)	N / A	24 (25.5)
Somewhat satisfied	3 (6.7)	5(10.2)	N / A	8 (8.5)
Unsatisfied	3 (6.7)	0(0,0)	N / A	3 (3.2)
Are you satisfied with using this tool?				
Satisfied	26 (57.8)	33(67.3)	N / A	59 (62.8)
Very satisfied	13(28.9)	12 (24.5)	N / A	25(26.6)
Somewhat satisfied	5 (11.1)	3 (6.1)	N / A	8 (8.5)
Unsatisfied	1 (2,2)	1 (2.0)	N / A	2 (2.1)
The reason for not satisfying the information contained in the micro plan				
Too long	3 (100)	0(0,0)	N / A	3 (100)
Difficult to use	3 (100)	0(0,0)	N / A	3 (100)
The micro planning tool reduced your working time				
All right	22 (48.9)	26(53.1)	N / A	48 (51.1)
Totally agree	10 (22.2)	17(34.70)	N / A	27(28.7)
Disagree	7 (15.6)	2(4,1)	N / A	9 (9.6)
Fairly agree	6 (13.3)	3 (6.1)	N / A	9 (9.6)
not agree at all	0(0,0)	1 (2.0)	N / A	1 (1,1)
Will the micro planning tool improve the quality of your data				
All right	30 (66.7)	31(63.3)	N / A	61 (64.9)
Totally agree	10 (22.2)	13(26.5)	N / A	23 (24.5)
Fairly agree	3 (6.7)	2(4,1)	N / A	5 (5.3)
Disagree	1 (2,2)	3(6,1)	N / A	4 (4.3)
not agree at all	1 (2,2)	0(0,0)	N / A	1 (1,1)

takes into account villages that are not in its health area, but in another health area. These are small problems that need to be sorted out to really help us 100%". (Respondent_04, BCZ, Haut-Lomami)

"Yes, this tool has disadvantages in terms of logistics, because it doesn't provide for logistics". (Respondent 28, AS)

"There are always drawbacks. When equipment or telephones break down, they have to be replaced to keep the structure running". (Respondent 01, EPI Antenna).

"There are no inconveniences, just that we said there are corners that haven't yet been taken into account; there are structures that are outside the limits that we need to improve. That's what we asked GRID 3/ ACCASSUS, all those people who work on Geo-referenced mapping, to help us improve. Otherwise, the information produced by the structure which is not within the limits can be analysed elsewhere than in the health area where this population is located". (Respondent 02, EPI Antenna).

TOOL INFLUENCE ON WORK

According to respondents, the use of the M4H tool has significantly influenced their work, increasing the workload related to vaccination activities. And this has made it possible to improve indicators linked to vaccination at all levels.

"I've liked it a lot since we got an integrated one. Lazy Registered Nurses are now starting to give themselves over to vaccinating because if they vaccinate according to this tool and even the motivation it will have in the fixed strategy, in the advanced strategy, it will be a bit high. They're starting to respect that." (Respondent 03; HZ)

"It's helped us more, so it's improved our work". (Respondent_11, HA, Kasaï)

MAP ADAPTABILITY

If the use of cards in vaccination activities has made it possible to significantly improve vaccination indicators, this has not always been effective in certain other SAs. It was reported by respondents that these maps were less precise and presented certain gaps in terms of information on the content of geographical spaces. This made their use difficult and disrupted, to a certain extent, vaccination activities in the health areas concerned. Suggestions for improving problem maps were made but this has still not been the case for certain health areas.

One respondent said the following:

"Yes, it helped us to discover this, but not totally, because the geo-referenced map that exists there gives less details about lakes, mountains, rivers... maybe with the next improvement it will help us, where someone who doesn't know the environment can see it like that and say here there's a lake, over there there's a mountain and there's I don't know what other natural obstacle". (Respondent 02, EPI Antenna).

In addition to the aforementioned limitations of geo-referenced maps, some respondents, particularly those at the intermediate level, also mentioned as a limitation the difficulty that some Nursing staff experience with new technologies. A minority of nursing staff were unable to handle Android phones. An official said the following:

"...there's a problem at the HA level, where some nursing staff don't know how to handle android phones.... Where telephones are not a problem, coverage is good". (Respondent_01, EPI Antenna).

OBJECTIVE 1.6: CONDUCT A RAPID ETHNOGRAPHIC STUDY TO DOCUMENT AND IDENTIFY ASSOCIATIONS WITH ACCEPTANCE AND USE OF M4H DATA THROUGH THE GENDER INTERVENTION IN KASAI

GENDER TRAINING

Interviews with all gender training participants (14/14) revealed that this was a good training course based on gender analysis. It helped a great deal, as field teams are now starting to disaggregate data in terms of gender. The workers' knowledge has improved in the sense that gender principles are now involved in vaccination activities, and the use of geo-referenced data has facilitated cohabitation for better vaccination coverage.

A key informant also shared that:

"The idea with this project is that both parents can share responsibilities, because before, we only saw the woman who was very interested in the child's vaccination, but with this project it gave us the idea that men can also take an interest in their children's vaccination. When we raised awareness, the dads understood too, and a large number of them understood and came to respond, even if the mother wasn't present; the father himself came with the child so that he could be vaccinated". -Gender intervention respondent

Most of the community workers who took part in this study recognized that this training helped to solve the problems of inequality between women and men, which had indirect consequences on vaccination, which is why gender training helped to solve many of the problems linked to inequality and discrimination between men and women in the community. This is what justified the reason for the training, which just showed that women should not suffer from any inferiority complex in front of men in the community, given that women are also capable of occupying leadership roles in an institution for the good of the whole community.

Regarding the provision of immunization services, participants in the focus group discussions felt that all children (girls and boys) should be given the same opportunities, as teams of vaccinators have been trained to apply gender principles to facilitate the involvement of all social strata in the community in improving immunization coverage.

As for the contribution of this training, all the participants in the interviews and focus group discussions recognized that the gender training has brought about a change in the fact that at the time it was more men who went out to vaccinate children in the health areas. Now, some women are also involved in vaccination activities in the community. This is producing good results because men and women are working together to vaccinate children, and this shows that gender has brought about a change in the community.

A participant in a focus group discussion noted that:

"I too find that gender or parity has helped a lot, even at the level of vaccination teams. Back then, it was mainly men who went around vaccinating children in the health area, but now we also see women giving vaccines. We find that even when a mother has a baby, she first gives custody of the baby to another person before going to do the vaccination. We're happy to see the woman and the man vaccinating together, and that proves that gender has brought about a change in the community". -Gender intervention respondent

For most of the participants in the study, the introduction of the new mapping system has strengthened this involvement and complementarity, while also putting an end to the disarray that had plagued the vaccination field, as it has clarified the boundaries of each health area while facilitating the integration and involvement of all CAC members.

These comments were backed up by statements from a key informant:

> *"We do the same work, you can find the man with the register registering, the woman carrying the vaccine cooler vaccinating the children, or the woman with the register and the man carrying the cooler. In vaccination activities, men are not numerous, you can find only one man, but the majority is made up of women." -Gender intervention respondent*

For most of the key informants at the provincial level (4/4), the application of gender principles in the various community animation cells has helped to reinvigorate the gender-based power that once influenced decision-making, as well as the greater family responsibilities for female staff who are exposed to pressures due to professional, family or household burdens. The focus on gender was seen as a source of motivation to combat socio-cultural norms and gender-related barriers affecting men and women in different immunization activities.

This was attested to by the statements of one participant during a group discussion:

> *"You can't have a team in the field, men alone, or women alone, no! You have to bring them together. We do the targeting with IT, so that in a team, we must have at least one woman and one man so that the work can progress to improve our immunization coverage and to reach all boys and girls". -Gender intervention respondent*

However, regarding the ratio of women to men, the majority of participants (6/10) felt that all the authorities, with the support of partners at all levels, should work to meet this challenge, to enhance women's capacities and skills, as they are in a position to contribute to the recovery of immunization service provision in the community. A key informant noted that:

> *"In our health zone, I declare, there are no female PRESICODESA. All twenty-eight are men. So we've made a plea to our partners to help us revitalize the CODESAs, to see where there are shortcomings so that we can get back on track with competent women. Some women have already been identified". -Gender intervention respondent*

While a minority (4/10) noted that after training on gender aspects, the male/female ratio had improved in the sense that women are now involved in awareness-raising and vaccination activities, even if they still need support from men to ensure that women are fully integrated into positions of responsibility and command at CAC and health zone level.

Concerning the role of gender in the implementation of micro-planning to improve the delivery of immunization services within the M4H framework, it emerged from the interviews that most of the key informants and participants in the focus group discussions indicated that gender obviously occupies a large place because in the past it was men who took precedence in everything and for everything, but now, thanks to awareness-raising, women also have a large place. So, thanks to awareness-raising activities, the health authorities are fighting to ensure that women also have access to everything that men do when it comes to providing vaccination services. For the participants in the group discussions, the gender aspect plays a major role in the planning of immunization service provision, in that it constitutes an approach that ensures that the needs of women and men are taken into account in the process of implementing immunization activities.

HOW DOES GENDER AFFECT HEALTH WORKERS' USE OF SPATIAL MAPPING AND GEO-REFERENCED DATA?

To the question of how gender affects health workers, most respondents acknowledged that this new material has enabled them to put into practice this new strategy involving women and men in micro-planning, awareness-raising and mobilizing mothers for immunization. They also noted that complementarity between women and men is essential to reach children lost to follow-up, zero-dose children and incompletely vaccinated children in the community.

Regarding the use of spatial mapping and geo-referenced data, most of the respondents to the interviews and focus group discussions acknowledged that the new mapping had greatly helped them to overcome difficulties in locating or recognizing boundaries between health areas, and in planning activities to cover the most remote villages. All the health workers noted that the use of the new geo-referenced maps helped them to detect villages and/or neighborhoods that were missing from the old maps. The new strategy that had been put in place using GPS made it easier to determine the latitude and the longitude making it possible to understand that such a village was missing from the old map. This also enabled us to identify children who had missed out on vaccination. The new maps clearly show the boundaries of each health area and put an end to any disputes over the boundaries of health areas.

For the gender distribution in training in the production of spatial maps and estimates of vaccination target populations, interviews and group discussions revealed that in each health zone, there were a total of twenty (20) people, i.e. fifteen (15) women and five (5) men. The training sessions were organized by GRID3 partners over three days at the Hotel Paradis.

For the production and use of geo-referenced data available in the health area or zone, it was clear to all participants that all the women had carried out the process of capturing data by GPS, so that they could have the matrix to demonstrate to the other members of their CAC.

GEOSPATIAL DATA USE BY GENDER

Regarding the impact of gender on health workers' immunization planning and conduct of routine immunization, most of the group discussions revealed that today, immunization campaigns are prepared using telephones, which means that health workers have a very good grasp of the boundaries of their health areas, as well as the targets to be immunized in the health area. They added that with this new strategy, the problem of children escaping vaccination has been solved, and the results are expected to be very good.

A key informant said:

> *"First of all, it's a fast way for us to transmit immunization data, the number of expected children is already in the Geo referencing system. You can't imagine that I have to wait for so many children, all the expected ones are already there. And now, when you vaccinate, the smartphone will already say: you've already reached this number, you have this number of children left. And you yourself will now be asking the question: which of these children have I not reached, and how can I reach them now? On top of that, we have the time to give the report promptly. With the geo system, it won't take you long to transmit the data. As long as you're working, you'll be able to send the data directly to the head nurse. This also makes our task easier, i.e. you'll be sending the data without having to do any other data. And on top of that, you won't have to give imaginary data, you will be giving data that is reliable and clean. That's what we have found really helping us to give really reliable data".- Gender intervention respondent*

Respondents noted that the representation of men and women facilitated the participation and complementarity of all health workers in all upstream and downstream activities to achieve good results. Everyone is involved in the use of spatial mapping, as they have all received training. And the work is carried out according to the principle of complementarity in the use of data. Teams produce reliable data to ensure complete immunization coverage, and data is transmitted promptly. Planning is carried out in concert with all health workers, and tasks are shared out fairly. The villages where there are children to be vaccinated are located using the new technology, and the expected targets are all reached because there are no longer any children escaping routine vaccination.

During a group discussion, one participant pointed out that:

> *"When we plan activities, if the women aren't there and it's only the men, it doesn't work well. There are partners who like the presence of women and refuse men. And in terms of vaccination, for example, you'll find that when a woman administers the vaccine, people are so happy. And even when we include men, the population is happy, so it's vice versa, there are always positive influences. So, when we're planning, even in mapping, women also travel distances to pick up children, even when there are also men. So there are always positive influences". -Gender intervention respondent*

Taking into account the gender aspect, the use of geo-referenced data in micro-planning helps to understand the number of target children expected at the next immunization activity and also facilitates the preparation of this activity in terms of antigens and inputs to be prepared for routine immunization. In addition, the M4H data help to intensify awareness-raising, since all the boundaries are known and the villages are also identified. Vaccines are requisitioned according to the number of children expected, and no child escapes vaccination any longer.

Most of the providers (10/10) noted that the data helped a lot because when you analyze the report, you can see how many boys and how many girls have been vaccinated in the health area. If it turns out that it's the boys who have been vaccinated more than the girls, you're going to step up awareness-raising in the community to make parents see that girls are just as important and just as entitled to vaccination as boys. And this is done based on reports that the head nurses receive from the health workers.

For the use of geo-referenced data in the organization of immunization, most respondents (health workers, providers, and key informants at the provincial level) believe that it has greatly helped the system and strengthened the capacity of providers in awareness-raising activities and mobilization of mothers/caregivers. It contributed to the choice of the best vaccination strategy based on the data obtained from the new mapping, the adaptation of vaccination session schedules, the composition of vaccination teams, the composition of CODESA and CAC teams, the facilities granted to women to achieve good results, and all the children expected. To this end, most respondents indicated that all providers (women and men) work in harmony to achieve the targets expected when planning activities in the community.

Taking into account the gender aspect, the provincial players believe that the use of M4H data from health zone micro-planning has facilitated the adoption of the new geo-referenced mapping technology so that it can be popularized in all the health zones of the Kasaï provincial division. The provincial players believe that this is a commendable and salutary initiative for obtaining reliable data, given that the boundaries of the health areas are known, and this would prevent some children from escaping mass vaccination campaigns following fixed or advanced strategies.

A key informant said:

> *"Gender plays a big role in raising awareness, and in the completeness and promptness of immunization activity data. Gender has really shaken up micro-planning activities at the operational level, and now we're following suit at our level so as not to be left on the side-lines. Gender has enabled health workers and parents to cooperate and familiarize themselves with child immunization, with good results". -Gender intervention respondent*

Interviews show that provincial players are committed to using M4H data from digital micro and/or macro plans, in the sense that the provincial database, after amendment, validation and certification, is transmitted directly to the national level for use in providing recommendations and guidance in any cases that may arise. Also, during meetings of provincial or national players in epidemiological surveillance in the various health zones, the authorities insist on the gender aspect to involve women and men in the provision of vaccination services.

Most of those interviewed said that the geo-referenced data had been used to reinforce immunization strategies, such as fixed and advanced strategies to choose the right strategy in a village to reach all children eligible for immunization. It was also used to determine vaccine quantities because there is an increase in the number of children eligible for immunization. This is because the new maps have made it possible to detect villages whose children were escaping vaccination. The data also facilitated the location of vaccination sites, taking into account all socio-cultural representations to integrate the gender aspect into awareness-raising and achieve the expected results.

A key informant said,

> *"Just when you're working out the micro plan, you determine the strategies, you determine the populations that are at different distances and that allows you to calculate the doses of vaccine to be sent per site." -Gender intervention respondent*

Regarding the results of the combination of gender capacity building and geo-spatial mapping for the health workers involved, most of those interviewed felt that this combination produced good results in that there was a surplus of cases of children being vaccinated in the health areas. This was facilitated by mapping, which enabled the delimitation of health areas to be clearly seen, and the number of children targeted for vaccination to be controlled. Similarly, the gender approach facilitated access to areas hostile to vaccination to raise parents' awareness of the importance of having their children (girls and boys) vaccinated and to contribute to the abolition of socio-cultural norms and discrimination to establish social harmony in families for the benefit of the children.

A key informant said:

> *"There were other health areas that were inaccessible. But with the new mapping, we were obliged to go and vaccinate the children, as the boundaries were very well known. A mobile team in the advanced strategy was sent to cover the health area whose children escaped vaccination. This was also an unexpected or unintended result of our planning. A farm or village that had been forgotten, children who had escaped our notice, and then there were villages where we had difficulty implementing CACs. But with the combination of two approaches, we go down to these villages to set up a cell, and then we organize elections to have some community relays with a recommendation to have women on the CAC management team." -Gender intervention respondent*

On the subject of gender-related constraints in the implementation of micro-planning, the majority of respondents

(10/14) noted that there are no constraints because gender has come to boost the delivery of immunization services to reach all children eligible for immunization, while a minority (4/14) think that gender is still confronted with socio-cultural constraints, discrimination and inequalities suffered by women in Kasai. To achieve this, a great deal of awareness-raising work needs to be done to get men to accept the representation of women in the design, development, and implementation of micro-planning of immunization activities in communities, as this is the point we can expect to see in improving immunization coverage.

As one participant put it:

> *"At the moment, there are no gender-related constraints, and they don't arise very often, because women are in the majority and there aren't many men who give their all. So there aren't often any difficulties arising from this." -Gender intervention respondent*

> Another took the opposite view: *"Yes, there are still gender constraints on the socio-cultural level, where women don't have total autonomy. We are working to improve gender in the province, and we need help to do so". -Gender intervention respondent*

Concerning how gender can impact the use of geo-referenced mapping, immunization micro-planning and the conduct of routine immunization, participants in this assessment indicated that with the involvement of both women and men, there will be good results, and all children who escaped immunization will be found and vaccinated. In addition, awareness-raising and mobilization will be stepped up to reach all targets eligible for vaccination. Complementarity and the participation of women and men will be effective. In addition, the long-term impact of gender training will improve vaccination coverage data, and there will no longer be any zero-dose, unvaccinated or incompletely vaccinated children in the communities.

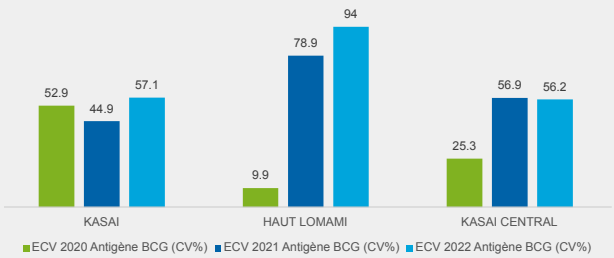
A key informant revealed that:

> *"Well, gender matters in a positive way, so when gender is represented, there is a way of having reliable results, so the data will be of quality, because it is almost all the parties that are represented and we know we have reliable data. The community also appreciates it when both sexes are represented". -Gender intervention respondent*

This new experience of Geo-referenced data collection was appreciated by all the participants in this study, as they felt considered and involved in the whole process. The new geo-referenced map gave the teams the tools they needed to better plan vaccination activities in the community. The boundaries of the health areas are very well known, and the targets are clearly identified before going into the community. Men and women are now working together to achieve a clear improvement in immunization coverage performance.

Socio-cultural norms are gender-related barriers to the delivery of immunization services. The challenges and obstacles created by deep-rooted social and cultural norms concerning the roles and responsibilities of men and women prevent children from accessing and using immunization services. These barriers to immunization affect both caregivers and health workers, and influence the provision, demand and use of immunization services. While childcare responsibilities fall mainly on women, decisions on the use of household resources are generally made by men. This limits women's autonomy in finding services for children eligible for vaccination. Vaccination stakeholders believe that in order to achieve coverage and equity targets, it is important to work towards eliminating gender-related barriers to immunization.

FIGURE 7: POINT ESTIMATES OF BCG ANTIGEN VACCINATION COVERAGE INDICATORS ACCORDING TO THE VACCINATION MAP FOR CHILDREN AGED 12 TO 23 MONTHS IN THE PROVINCES OF KASAÏ, KASAÏ CENTRAL AND HAUT-LOMAMI IN THE DRC IN 2020, 2021 AND 2022



Source: Vaccination coverage survey in DRC 2020, 2021 and 2022

STUDY AIM 2

Conduct a quasi-experimental design study in three provinces (two intervention- one with gender activities, one without gender activities, and one control) to determine the associated effects of the acceptance and use of M4H data by Health Zones and Health Areas on immunisation coverage and equity (especially zero-dose children)

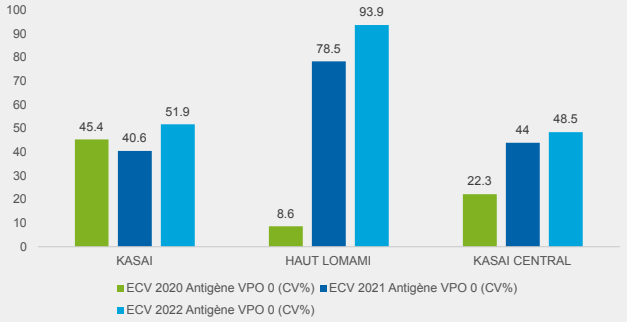
For these analyses, it is important to note that the intervention had not been implemented for sufficient time in Kasai to contribute to improvements in immunization coverage or equity. Geo-referenced micro-plans were distributed in Kasai in 2023 and would need at least 12 months of implementation to contribute to changes in immunization outcomes. However, the comparison of experiences between Haut-Lomami and Kasai and Kasai Central indicate that the GRID3 intervention and use of geospatial data for immunization may have contributed to a sustained increase in immunization coverage, increase in identification and immunization of zero-dose children, and minimal dropout. For these analyses, Kasai should be viewed as a second control to the Haut-Lomami. Future analyses of Kasai and Kasai Central will be needed in 2024 and 2025 with Kasai as the intervention site and Kasai Central as the control site to assess any associated changes in immunization outcomes of the use of geospatial data for immunization on immunization outcomes in Kasai. It is recommended that Gavi invest in this additional analyses to evaluate the differential contribution of the targeted gender intervention in Kasai on immunization outcomes in comparison to the improvements observed in Haut-Lomami.

OBJECTIVE 2.1 USE DATA FROM EPI PROGRAMME IMMUNISATION COVERAGE AND EQUITY SURVEYS OF CHILDREN 12-23 MONTHS OF AGE TO DETERMINE CHANGES IN IMMUNISATION COVERAGE AND TIMELINESS AFTER 12 MONTHS OF IMPLEMENTATION IN TWO INTERVENTION PROVINCES AND IN ONE CONTROL PROVINCE.

Data on initial vaccination coverage from the 2020 ECV survey, and from ECVs carried out in 2021 and 2022, for BCG and OPV 0 antigens in the three provinces of Kasaï, Kasaï Central and Haut-Lomami, show identical trends for all antigens, with clear progress on one side and stagnation on the other.

A clear improvement in BCG antigen vaccination coverage was observed in Haut-Lomami province (intervention province),

FIGURE 8: POINT ESTIMATES OF OPV 0 ANTIGEN VACCINATION COVERAGE INDICATORS ACCORDING TO THE VACCINATION MAP IN CHILDREN AGED 12 TO 23 MONTHS IN THE PROVINCES OF KASAÏ, KASAÏ CENTRAL AND HAUT-LOMAMI IN THE DRC FROM 2020, 2021 AND 2022



Source: Vaccination coverage survey in DRC 2020, 2021 and 2022

with coverage rising from 9.9% (ECV 2020) to 78.9% (ECV 2021) and then to 94% (ECV 2022). Kasaï Central (control province) saw an improvement in BCG antigen coverage from 25.3% in 2020 to 56.9% in 2021, and stagnation at 56.2% in 2022. On the other hand, Kasaï (control province) showed an improvement in BCG antigen coverage, with a "V"-shaped evolution over the three years, i.e. a drop from 52.9% in 2020 to 44.9% and then an improvement to 57.1% in 2022. (Figure 7).

With regard to OPV 0 antigen, the trend remains the same as that observed with BCG antigen, except for the province of Kasaï Central (Control). In fact, OPV 0 coverage rates showed a clear improvement in the three provinces of Haut-Lomami (Intervention), Kasaï (Control) and Kasaï Central (Control). This improvement has been maintained for Haut-Lomami and Kasaï Central provinces, with respectively 8.6% in 2020 to 93.9% in 2022, and 45.4 in 2020 to 51.9%. Kasaï province, on the other hand, although having improved its OPV 0 antigen coverage from 45.4% in 2020 to 51.9% in 2022, recorded a drop in 2021 (40.6%).

With regard to OPV 0 antigen, the trend remains the same as that observed with BCG antigen, except for the province of Kasaï Central (Control). In fact, OPV 0 coverage rates showed a clear improvement in the three provinces of Haut-Lomami (Intervention), Kasaï (Control) and Kasaï Central (Control). This improvement has been maintained for Haut-Lomami and Kasaï Central provinces, with respectively 8.6% in 2020 to 93.9% in 2022, and 45.4 in 2020 to 51.9%. Kasaï province, on the other hand, although having improved its OPV 0 antigen coverage from 45.4% in 2020 to 51.9% in 2022, recorded a drop in 2021 (40.6%).

VACCINATION COVERAGE OF PENTAVALENT 1 AND PENTAVALENT 3.

ECV vaccination coverage data for 2020, 2021 and 2022 in relation to Penta 1 and Penta 3 antigens in the three provinces of Kasaï (Control), Haut-Lomami (Intervention) and Kasaï Central (Control) show differences according to each province.

For Pentavalent 1 antigen, the vaccine coverage rate observed for the three provinces showed an improvement when considering the percentage for 2020 compared with that for 2022. In Haut-Lomami province, coverage has risen from 9.9% in 2020 to 78.5% in 2021 and 93.6% in 2022. Also, for the provinces of Kasaï and Kasaï Central, comparing the 2020 rate with that of 2022. For both provinces, the rate rose from 51% in 2020 to 58.3% in 2022, and from 26.3% in 2020 to 59.3% in 2022. However, the Pentavalent 1 antigen vaccination coverage rate fell in 2021 to 48.1% for Kasaï and was higher at 61.1% for Kasaï Central province.

For Pentavalent 3 antigen, the observed vaccine coverage rate showed an improvement for Haut-Lomami and Kasaï Central provinces. It rose respectively from 8.9% in 2020 to 92% in 2022 and from 21.8% in 2020 to 43.8% in 2022. On the other hand, the dropout rate for Kasaï province fell from 45.3% in 2022 to 38% in 2022.

With regard to the dropout rate, there has been a net increase in the dropout rate in the two provinces of Kasaï (Control) and Kasaï Central (Control), i.e. 5.7% in 2020, 13.7% in 2021 and 20.3% in 2022 for the intervention province, and 4.5% in 2020, 13.9% in 2021 and 15.5% in 2022 for the control province. On the other hand, the drop-out rate has changed little in Haut Lomami province. It rose from 1% in 2020 to 1.7 in 2021 and 1.6% in 2022. The relatively low dropout rates require additional exploration. It is not clear if it is associated with the use of geo-referenced micro plan data and/or the digital supervision tool or some other reason.

OBJECTIVE 2.2 USE INTERVENTION STRENGTH DATA AND SECONDARY ANALYSIS OF COVERAGE SURVEY DATA TO ASSESS THE IMPACT OF M4H DATA USE AS COMPARED TO THE STATUS QUO ON ITS EFFECTIVENESS TO INCREASE IMMUNISATION COVERAGE AND TIMELINESS.

BCG AND OPV 0 VACCINATION COVERAGE

Initial vaccination coverage data from the ECV survey in 2020 (6) and those from the ECV carried out in 2021 and 2022 for BCG and OPV 0 antigens in the three provinces of Kasaï, Kasaï Central and Haut-Lomami reveal a certain disparity between provinces.

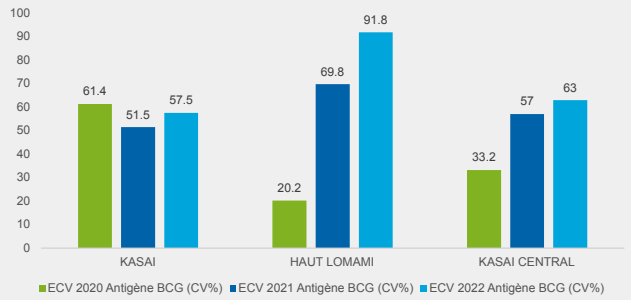
Improvements in BCG antigen vaccination coverage rates were observed in the two provinces of Haut-Lomami (intervention province) and Kasaï Central (control province), which

TABLE 6: POINT ESTIMATES OF PENTA 1 AND 3 VACCINATION COVERAGE INDICATORS IN CHILDREN AGED 12 TO 23 MONTHS IN THE PROVINCES OF KASAÏ, KASAÏ CENTRAL AND HAUT-LOMAMI IN THE DRC IN 2020, 2021 AND 2022

	ECV 2020			ECV 2021			ECV 2022		
	Penta 1 (%)	Penta 3 (%)	Drop-out rate (%)	Penta 1 (%)	Penta 3 (%)	Drop-out rate (%)	Penta 1 (%)	Penta 3 (%)	Drop-out rate (%)
Kasaï	51	45.3	5.7	48.1	34.4	13.7	58.3	38	20,3
Haut-Lomami	9.9	8.9	1	78.5	76.8	1.7	93.6	92	1.6
Kasaï Central	26.3	21.8	4.5	61.1	47.2	13.9	59.3	43.8	15.5

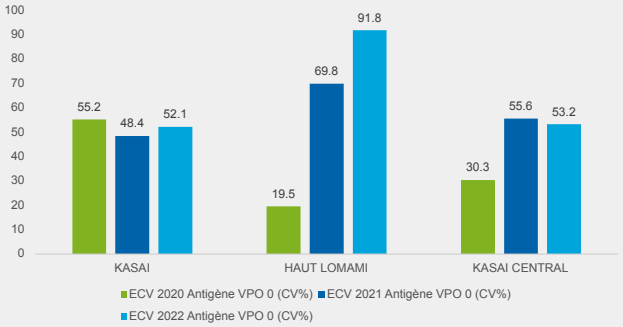
Source: Vaccination coverage survey in DRC 2020, 2021 and 2022.

FIGURE 9: POINT ESTIMATES OF BCG ANTIGEN VACCINATION COVERAGE INDICATORS ACCORDING TO THE VACCINATION MAP FOR CHILDREN AGED 6 TO 11 MONTHS IN THE PROVINCES OF KASAÏ, KASAÏ CENTRAL AND HAUT-LOMAMI IN THE DRC IN 2020, 2021 AND 2022



Source: Enquête de couverture vaccinale en RDC 2020, 2021 et 2022

FIGURE 10: POINT ESTIMATES OF OPV 0 ANTIGEN VACCINATION COVERAGE INDICATORS ACCORDING TO THE VACCINATION MAP FOR CHILDREN AGED 6 TO 11 MONTHS IN THE PROVINCES OF KASAÏ, KASAÏ CENTRAL AND HAUT-LOMAMI IN THE DRC IN 2020, 2021 AND 2022



Source: Vaccination coverage survey in DRC 2020, 2021 and 2022

respectively increased from 20.2% (ECV 2020) to 91.8% (ECV 2022) and from 33.2% in 2020 to 63% in 2022. Kasaï Province (control province) showed a marked drop in BCG antigen coverage, from 61.4% in 2020 to 51.5% in 2021, and to 57.5% in 2022. (Figure 7).

With regard to OPV 0 antigen, the trend remains the same as that observed with BCG antigen. In fact, OPV 0 coverage rates have improved significantly in the two provinces of Haut-Lomami (Intervention) and Kasaï Central (Control). They have respectively risen from 19.5% in 2020 to 91.8% in 2022, and from 30.3% in 2020 to 53.2% in 2022, starting from a higher rate of 55.6% in 2021. In Kasaï Province (Control), on the other hand, OPV 0 antigen coverage fell from 55.2% in 2020 to 48.4% in 2021 and 52.1% in 2022. (Figure 8).

ROLE OF GEO-REFERENCED DATA IN LOCATING ZERO-DOSE CHILDREN

It emerged from interviews with key informants that, generally speaking, the use of geo-referenced data made it possible to improve the involvement of healthcare establishments not taken into account in vaccination activities and consequently to reach the children who missed vaccination days. In addition, this made it possible to improve the vaccination catch-up which was carried out previously by the RECOs and to reach children with zero doses, according to the respondents. A few nursing staff stated the following:

> *"This mapping even targets villages that were unknown, where we couldn't reach." (Respondent_14, HA, Haut-Lomami)*

> *"You know the establishments not taken into account, the fact for example that health centres can have a health post which is more than 15 km away and it does not vaccinate or not. But the day when the nursing staff starts moving with vaccines, when it arrives there, you see all these children who were zero doses will come to be vaccinated and even this establishment will start to also be interested in vaccination. Because nurses will come, he has to find the children with the timetable they are going to give. So, it does not influence negatively but positively the reduction of zero doses and even the involvement of other establishments in vaccination." (Respondent_04; HA, Haut-Lomami)*

> *"Yes, Georeferenced data has changed our system, because there are these villages that we didn't even know about, but compared to our Georeferenced data, we had to discover villages and strategies that we should do". (Respondent 21, HA, Haut-Lomami)*

> *"...the card helped us determine the number of vaccination sessions. Because we noticed before there was an inadequacy in the planning of the sessions; with the map we have improved planning in terms of number of sessions. So when we increased the number of sessions, we tried to reach areas that were not reached before." (Respondent 02, EPI Antenna)*

> *"It influences them because the structures not taken into account now know the program or already know the calendar although in such a period or such date, the vaccination will be in their site and they are ready to prepare the children zero doses and the community or the community relays will pick up these children to bring them to the site on the scheduled date." (Respondent_11, HA, Kasaï)*

On the other hand, in Kasai, some respondents reported difficulties linked to recurrent population movements. This makes vaccination activities tedious in locating target children, with the consequence of uneven vaccination indicators. For example, one respondent said:

> *"The obstacles that we often experience is movement, we are in a purely mining health zone where the population is moving at all times, you will find that there are some children who are insufficiently vaccinated and when they move with their parents pose problems for them to be fully vaccinated, these are really the difficulties that we are encountering with the movement of the population." (Respondent _09, BCZ, Kasaï)*

VACCINATION COVERAGE IN PENTAVALENT 1 AND PENTAVALENT 3.

Pentavalent 1 and pentavalent 3 antigen coverage rates in Haut-Lomami Province (intervention) in 2020 were 20.3% and 17.8% respectively, representing a dropout rate of 2.5%. By 2021, these rates had risen to 69.1% and 63.8% respectively, representing a drop-out rate of 5.3%. In 2022, these rates reached 91.6% and 87.6% respectively, for a drop-out rate of 4%. From 2020 to 2022, vaccine coverage rates for pentavalent 1 and 3 antigens improved, with a wavering dropout rate.

In Kasaï (control), Pentavalent 1 and Pentavalent 3 antigen coverage rates from 2020 to 2021 were 60.9% and 51.3%

TABLE 7: POINT ESTIMATES OF PENTA 1 AND 3 VACCINATION COVERAGE INDICATORS IN CHILDREN AGED 6 TO 11 MONTHS IN THE PROVINCES OF KASAI, KASAI CENTRAL AND HAUT-LOMAMI IN THE DRC IN 2020, 2021 AND 2022

	ECV 2020			ECV 2021			ECV 2022		
	Penta 1 (%)	Penta 3 (%)	Drop-out rate (%)	Penta 1 (%)	Penta 3 (%)	Drop-out rate (%)	Penta 1 (%)	Penta 3 (%)	Drop-out rate (%)
Kasaï	60.9	51.3	9.6	61.7	38.4	23.3	52	25,3	26,7
Haut-Lomami	20.3	17.8	2.5	69.1	63.8	5.3	91.6	87.6	4
Kasaï Central	34.6	26.3	8.3	72.4	50.5	21.9	64.6	41.5	23.1

Source: Vaccination coverage survey in the DRC 2020, 2021 and 2022.

respectively, with a dropout rate of 9.6% in 2020. These rates were 61.7% to 38.4%, or a drop-out rate of 23.3% in 2021, then 91.6% to 87.6%, or a drop-out rate of 4 in 2022. The dropout rate for Kasaï province has increased in 2022 compared with 2020.

In the control province of Kasaï Central, vaccine coverage rates for pentavalent 1 and 3 antigens were 34.6% and 26.3% respectively in 2020, representing a drop-out rate of 8.3%. These rates were 72.4% to 50.5% in 2021, with a dropout rate of 21.9%, and then 64.6% to 41.5%, with a dropout rate of 23.1%. As in Haut-Lomami province, the dropout rate increased from 2020 to 2022.

OBJECTIVE 2.3 USE INTERVENTION STRENGTH DATA AND SECONDARY ANALYSIS OF COVERAGE SURVEY DATA TO ASSESS THE IMPACT OF M4H DATA USE AS COMPARED TO THE STATUS QUO ON EQUITY IN TERMS OF REACHING THE MOST MARGINALIZED CHILDREN 0-23 MONTHS (GIRLS/BOYS) AND THE MAIN CAREGIVERS - WOMEN AND ADOLESCENT GIRLS IN THEIR REPRODUCTIVE YEARS (15-49 YEARS OF AGE) PARTICULARLY THOSE IN THE POOREST AND POORER SOCIOECONOMIC STRATA, AND CHILDREN OF LOW-LITERATE AND INNUMERATE CAREGIVERS (MAINLY FEMALE, BELOW 25, 25 AND OLDER), ETC.

Concerning objective 2.3. the data collected and secondary data were not sufficiently disaggregated to obtain information related to assessing the impact of using M4H data versus the status quo on reaching the most marginalized people children aged 0-23 months (girls/boys) and primary caregivers - women and adolescent girls of childbearing age (15-49 years) especially those in the poorest and most deprived socio-economic strata, and children of low-literate and unnamed caregivers. The following equity analysis was conducted with available data.

From an equity point of view, the zero dose situation seems to be influenced by the three prioritized variables retained in terms of both relative distribution and evolution over time.

Following the distribution of quintiles, for Haut-Lomami, the percentages of zero doses tend to decrease overall, except for households located in the first quintile (the poorest) and the fourth quintile. The strongest decrease is observed for households in the middle quintile, i.e. from 35.9% in 2021 to 10.4% in 2022 (25.5 points) compared to a minimal decrease for households in the richest quintile, i.e. 26.4% in 2021 to 22.2% in 2022 (4.2 points). The strongest increase is observed for households located in the fourth quintile (11.5% in 2021 to 48.3% in 2022, or 36.8 points).

For the other two control provinces (Kasaï and Kasaï Central), the general trend is upwards in the percentages of zero doses for households located in all quintiles except for those in the fourth and fifth.

Taking into account the variable possession of a mobile phone by the head of the household, the influence of the economic dimension remains dominant, but the trends in the evolution of zero dose are quite contrasting when comparing the provinces. Indeed, for the Haut-Lomami intervention province, from 2021 to 2022, the percentage of zero doses has fallen sharply for households whose head has a mobile phone, going from 61.3% to 23.5% respectively then this percentage tends to double from 38.7 to 76.5 for households whose head is without a mobile phone. On the other hand, for the two other control provinces, the situation is completely the opposite: the percentage of zero doses tends to decrease for households whose head is without a mobile phone while it has sharply increased for households whose head has a mobile phone.

Regarding the area of residence, the percentage of zero dose tends to decline sharply in urban areas (6.6% in 2021 to 3.3 in 2022, or half in one year) in the province of intervention while it tends to increase slightly in rural areas (93.4% to 96.7%). On the other hand, in the province of Kasai, then the percentage of zero dose follows the same trends as in Haut-Lomami in both environments, we observe a diversified trend in Kasai Central with a strong upward trend (almost triple) in urban areas (7.8% in 2021 to 20.3% in 2022) and a downward trend in rural areas (92.2% to 79.7% respectively).

TABLE 8: PERCENTAGE OF ZERO DOSES (95% CI) AMONG CHILDREN AGED 12-23 MONTHS AFTER INTERVENTION ACCORDING TO SOCIO-ECONOMIC CHARACTERISTICS

	Haut-Lomami		Kasai		Kasai Central	
	2021	2022	2021	2022	2021	2022
Overall	2.4 (1.7-3.5)		24.6 (21.4-28.2)		12.6 (10.7-14.9)	
Household wealth level (quintile)						
The poorest	5.6 (1.0-25.7)	12.2 (3.6-34.1)	5.4(3.0-9.6)	27.5(20.8-35.3)	4(1.8-8.3)	41.9(30.8-53.8)
The second	20.5 (7.5-45.2)	6.9 (1.8-23.4)	13.5(9.3-19.2)	27.3(21.4-34.1)	9.4(6.0-14.4)	22.9(13.5-35.9)
The third	35.9(17.4-59.9)	10.4(3.2-29.3)		30.1(23.9-37.2)	16(10.7-23.3)	18.2(12.2-26.2)
The fourth	11.5(3.2-33.7)	48.3(28.4-68.7)	47.3(38.5-56.4)	12.1(7.3-19.2)	29.3(22.1-37.7)	10.6(5.9-18.1)
The richest	26.4(11.9-48.9)	22.2(7.1-51.5)	15.7(9.8-24.2)	3(1.2-7.7)	41.3(30.5-53.0)	6.6(1.7-22.1)
Access to the household mobile phone						
Without mobile phone	38.7(18.0-64.6)	76.5(60.7-87.2)	61.5(52.3-70.0)	48.3(40.9-55.8)	63(51.9-72.9)	37.2(28.9-46.2)
With mobile phone	61.3(35.4-82.0)	23.5(12.8-39.3)	38.5(30.0-47.7)	51.7(44.2-59.1)	37(27.1-48.1)	62.8(53.8-71.1)
Household area of residence						
Urban	6.6(0.9-35.0)	3.3(0.5-20.0)	25.6(16.3-37.7)	15.9(10.3-23.7)	7.8(3.3-17.4)	20.3(8.6-40.8)
Rural	93.4(65.0-99.1)	96.7(80.0-99.5)	74.4(62.3-83.7)	84.1(76.3-89.7)	92.2(82.6-96.7)	79.7(59.2-91.4)

Conclusion

The situation of “zero-dose” children in the Democratic Republic of Congo (DRC) is a major concern. Zero-dose children are those who have not received any dose of vaccine against diphtheria, tetanus and pertussis. The overall objective of the study was to evaluate the use of Mapping for Health (M4H) for the micro-planning and implementation of routine immunization programs, and the associated impact on immunization coverage, equity and household economic status. To this end, a mixed methods evaluation was conducted. However, due to the unavailability of data related to the costing of the activities in Haut-Lomami and Kasai, objectives 3.1 to 3.5 of the economic study was not undertaken.

The results indicate that the geo-referenced micro-plans in Haut-Lomami and Kasai were well received, used, and led to changes in the delivery of vaccination services. In addition, the gender ethnographic study in Kasai indicates that the gender intervention led to the greater inclusion of women in immunization activities. Due to the delayed time of geo-referenced micro-plan adoption and use, we transitioned Kasai to a control site for immunization coverage and equity analyses. Consistently across analyses, we observed a significant positive trend in Haut-Lomami in immunization outcomes, including an increase in overall coverage, identification and immunization of zero-dose, and reduced dropouts.

According to the results of the equity analyses, wealth level is a factor that influences zero-dose cases. For households in the second and third wealth quintiles, the intervention had a positive downward impact on the percentage of zero-dose cases in the intervention province, whereas it had an upward impact in the two control provinces. In other words, the intervention had no impact on the poorest household strata, which showed the same upward trend in zero-dose rates in all three provinces. Possession of a telephone may prove an opportunity to identify zero-dose and reduce their number.

Taking a gender lens for the overall study and including a gender sub-study, identified positive contributions to the intervention and the evaluation. In the delivery of immunization services today, it is imperative to include transformative and equitable gender strategies that take into account the aspirations of all gender identities in society, taking into account the socio-cultural contexts in which health workers and caregivers live. Gender mainstreaming must be carried out at all levels of micro-planning implementation, the use of geo-referenced mapping, immunization micro-planning and the conduct of routine immunization, and monitoring and evaluation.

To achieve this, awareness is needed at national and sub-national levels of why and how to reduce gender-related barriers to immunization. And put in place a regular communication strategy on gender-related barriers to immunization and the challenges they present to find mechanisms to overcome them. It is recommended to conduct further analyses in Kasai in 2024/2025 to evaluate the effects of the gender intervention on immunization coverage and equity outcomes at which time a cost-effectiveness component should be feasible.