Meeting Technical Report

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Online Repository

All the meeting materials, including presentation files, meeting agenda and other related documents discussed in this report are available on a UNICEF Team Site.

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Contents

List of Acronyms

AeHIN	Asia eHealth Information Network (AeHIN)
BMGF	Bill and Melinda Gates Foundation
CDC	Centers for Disease Control and Prevention
CRVS	Civil Registration and Vital Statistics
DHS	Demographic and Health Surveys
EPI	Expanded Programme on Immunization
GAVI	Global Alliance for Vaccines and Immunization
GIS	Geographic Information System
GRID	Global Resource Information Database network
GPS	Global Positioning System
HDC	Health Data Collaborative
NHIS	National Health Information System
InSTEDD	Innovative Support To Emergencies Diseases and Disasters
MACEPA	Malaria Control and Elimination Partnership in Africa
MCSP	Maternal and Child Survival Program
MFL	Master Facility List
MoH	Ministry of Health
NGO	Non-Governmental Organization
OpenHIE	Open Health Information Exchange
REC	Reach Every Community
RED	Reach Every District
SIA	Supplementary Immunization Activities
UNEP	United Nations Environment Programme
UNICEF	United Nations Children's Fund
USAID	U.S. Agency for International Development
WHO	World Health Organization

1 Executive Summary

The technical meeting "Improving Immunization Coverage and Reducing Inequities: Use of GIS in Immunization Programs" took place at UNICEF Headquarters, New York City, on 25-26 October 2016 through funding from GAVI Data Strategic Focus Area (SFA). The meeting brought together global, regional, and national experts with experience using Geographic Information Systems (GIS) to strengthen immunization systems, including country program experts, development partners and technical experts from academia, nonprofit and the private sector.

The purpose of the meeting was to share lessons and identify future opportunities for the use of GIS for immunization programs from a review of international experiences and to develop strategies and guidance to enhance the use of geospatial data and GIS in immunization programs. Particular emphasis was put on the impact of use of GIS in increasing overall immunization coverage and reducing inequities, and on the sustainable integration of GIS in existing immunization activities by Expanded Programme on Immunization (EPI) in Ministries of Health (MoH).

GIS allows for the integration of data from many sources using geography as a unifying element, including but not limited to population and health surveys, routine health information systems, census data, environmental and infrastructure data. It therefore offers the opportunity to combine data sources that previously may not have been used together, providing a richer picture and deeper insight of the context in which health programs operate, capturing patterns in health outcomes and their association with socio-economic, political and environmental factors, and identifying areas of high priority for investment and interventions.

Building on a review of existing knowledge and activities concerning the use of GIS in immunization programs, the meeting explored the following key themes:

- Use of geospatial tools for mapping health resources and population
- Use of spatially modeled estimates of population and immunization indicators to identify inequities in immunization coverage and health outcomes
- Use of spatial analysis techniques to map availability and accessibility to immunization services
- Integration of geospatial data and GIS into National Health Information Systems (NHIS)
- Integration of geospatial data and GIS with routine, administrative and surveillance immunization data

There was consensus during the meeting that the integration of geospatial data and GIS in immunization programs offers significant potential to accelerate progress towards global vaccination goals, by facilitating the quantification and location of the target population for immunization, and by assisting in identifying missed populations. For instance, accurate and up-to-date geospatial data on population settlements allows remote and isolated communities, frequently missed by vaccination activities, to be made visible and adequately accounted for during planning. By allowing near real-time monitoring of vaccination activities, GIS also ensures better accountability, improved coverage and efficient investment of resources with minimum waste.

Spatially modeled estimates of population and immunization coverage at the subnational level provide unique opportunities to improve estimates of population denominators to complement routine and administrative data sources, and triangulate data to improve coverage estimates. Moreover, they can strengthen identification of geographic inequities of coverage at the subnational level, providing better evidence of gaps in immunization programs to inform decision making around targeting immunization resources. Participants also highlighted the opportunity provided by GIS to linking immunization system analysis with other components of health, infrastructure and environmental systems, using geography as

the connecting element. Such integration can provide deeper insights into the barriers and factors limiting the access to immunization services. The multi-sectorial data integration supported by GIS can foster collaboration and data sharing across government departments, health system sectors and other sectors, allowing a more comprehensive identification of gaps in immunization systems and more holistic intervention approaches.

Country case studies evidenced the ongoing progress in the integration of GIS into immunization programs in Nigeria, Rwanda, Cameroon, Papua New Guinea, India and Kenya, where a number of geospatial data and GIS enabled strategies ensured better identification of target population and communities, increase in immunization coverage and disease eradication. Country representatives highlighted amongst the most successful strategies government involvement in mapping activities and direct investment into human resources and GIS technologies, strong collaboration of stakeholders, including different government departments, universities, national statistics offices, and utilization of local health workforce for low-cost, sustainable acquisition and update of geospatial data on immunization systems.

Based on the lessons learned, participants identified a number of priority areas to strengthen the integration of GIS in immunization programs, highlighted below.

Establishment of national registry of health facilities (or Master Facility List – MFL) including geolocation information and supporting GIS functionalities should be prioritized: A complete listing and up-to-date registry of facilities (including private and public) is a crucial component of the planning, monitoring and analysis of immunization delivery and other programs, allowing accurate session plans based on geographic catchment areas, accurate analysis of accessibility to health services and therefore more efficient allocation of resources relative to target population. Interoperability of MFL with other registries (immunization, communities, health workforce, and pregnancy) based on common data standards, unique electronic identification and integration of GIS functionalities in registries will allow leveraging geography as the linking factor between components of the health system.

Bottom-up, participatory mapping approaches should be pursued: Utilization of local workforce for mapping activities has the multiple benefits to reduce the cost of data collection and increase local capacity for geospatial data collection and maintenance, resulting in improved sustainability of the acquisition, maintenance and use of maps and geospatial datasets. Adequate communication of the long-term benefits of the integration of GIS to local government, program managers, and health workforce was also suggested as an important practice to ensure participation and absorption of the new practices.

Government leadership and involvement in geospatial data collection, management, and updating should be promoted: Active engagement of government from the early stages of projects, as well as direct investment of government in providing the human, technical and financial resources for GIS activities, was demonstrated to increase local capacity and improve use of geospatial data and mapping products. It was suggested that a successful strategy to improve government engagement and reduce investment from external partners is to pursue partnerships between government and other local stakeholders, including universities, national statistics offices and the private sector.

A more holistic and systemic approach to immunization system strengthening should be promoted: The potential of GIS for cross-cutting data integration should be leveraged by promoting and strengthening practices and platforms for data collection and sharing, as well as mechanisms for co-financing, and multisectoral planning. This will require improving the quality and compatibility of geospatial data, strengthening interoperability between different health-related information systems using geocoded registries, and building centralized datasets of core geospatial data and base maps of relevance across health system sectors, such as MFL, satellite images, settlements, road infrastructures etc.). Complete and

up-to-date repositories of core geospatial data will also reduce the time lag associated with spatial data gathering and processing, improving responsiveness for decision-making.

Capacity building activities to strengthen trust and absorption of GIS at the programmatic level should be undertaken: Investment should be directed to provide training not only on geospatial data management and GIS but also on the use of spatially modeled surfaces and their integration with routine and administrative data for estimation of population denominators and immunization coverage. This will increase the trust in the added value of such products at the programmatic level, and provide guidance on appropriate interpretation and use of spatial products, their uncertainties, and limitations. It was suggested that the integration of GIS in curriculums of health schools and university should be part of this capacity building process.

The potential of novel GIS technologies should be explored: Upcoming technologies with the potential to address current limitations of traditional immunization data and GIS should be promoted and funded. For example, the use of drones to improve mapping of settlements and landscape features in remote areas or security-restricted areas, and the nascent use of mobile phones geotagging and nighttime light satellite images to account for the impact of migration on population denominators, which are not currently captured by spatially modeled surfaces and censuses.

A detailed summary of the meeting content and outcomes are included in this report. The recommendations drawn are directed to countries MoH and EPI Programs, as well as to the global community of development partners, NGOs, and donors.

2 Introduction

Immunization is a core primary health care intervention critical to assuring the health of children and communities. During 2015, about 86% (116 million) of infants worldwide received 3 doses of diphtheria-tetanus-pertussis (DTP3) vaccine, protecting them against infectious diseases that can cause serious illness and disability or be fatal[1]. Yet, 19.4 million children did not receive 3 doses of DTP. Most of these children come from the poorest families in the world and are most vulnerable.

As we enter a new phase of development, underpinned by the Sustainable Development Goals (SDGs), we are presented with a historic opportunity to advance the rights and well-being of every child, especially the most disadvantaged, and secure a healthy planet for today's children and future generations. However, there can be no sustainable development, prosperity or peace without equity – namely, a fair chance for every child. If the most disadvantaged children do not share in progress, it will not be sustained. More and better data is needed for monitoring progress towards many of the SDGs and our global vaccination targets of 90% national coverage and 80% in every district for all vaccines by 2020[2].

Strong inequities are hidden behind global and national figures of vaccination coverage. These are associated with differences in urban/rural place of residence, wealth and education status, gender and remoteness. In order to address such inequities, the Reach Every District (RED)[3] and Reach Every Community (REC)[4] frameworks have been introduced by the World Health Organization (WHO) and partners to address common obstacles to increasing immunization coverage, with a focus on decentralized planning and monitoring. Such approaches are currently mainly implemented using hand drawn maps, which fail short to accurately account for all communities to be reached and result in inefficient allocation of resources due to inaccurate information on distance, geographic access and catchment areas. Moreover, in absence of reliable Civil Registration and Vital Statistics (CRVS) data, the estimation of population denominators rely on infrequent or unreliable census data, and in the case of communities and villages, even on history or local knowledge. As a consequence, many communities and children are chronically missed because they are 'invisible' to the health system.

GIS can help make the communities where these children live 'visible' and accounted for in the health system, and therefore offers an important tool to fulfil the rights of children and achieve equitable immunization coverage. In the last decade, there has been an increased uptake of GIS in immunization programs, in concomitance with an exponential increase in the availability of georeferenced data, GIS software solutions, and tools for geospatial data collection, management, and sharing. Consequently, the number of immunization studies and publications reporting the use of GIS has increased steadily from the mid-2000s. In particular, complex spatial analysis techniques are becoming as common as qualitative descriptions of maps for the identification of subnational level heterogeneities in immunization coverage and modeling their environmental, geographical and socio-economic determinants[5–7]. Recently, a handful of promising experiences with the application of Global Positioning System (GPS)-enabled devices and smartphones in conjunction with satellite and aerial imagery has provided strong evidence of the potential of increasingly available low-skill, low-cost field technologies to revolutionize the microplanning and monitoring of immunization[8–10].

Despite this relative increase, the full potential of GIS for planning, monitoring, and evaluation of immunization programs is far from being realized. Amongst the greater challenges to be addressed are strengthening and institutionalizing GIS technical capacity of MoH for them to be in the position to acquire, update, manage and use geospatial data on population and health systems in an efficient way, and consolidating mechanisms for sharing and leveraging such data between actors.

3 Meeting Overview

On 25-26 October 2016 the technical meeting "Improving Immunization Coverage and Reducing Inequities: Use of GIS in Immunization Programs" was convened at UNICEF Headquarters, New York City, through funding from the GAVI Alliance Data Strategic Focus Area (SFA). The meeting gathered global, regional, and national experts with experience using GIS to strengthen immunization systems with the objective to identify opportunities, leverage lessons learned, and develop guidance materials to enhance the sustainable use of geospatial data and GIS for immunization services planning, monitoring, and evaluation by EPI and MoH.

There were a total of 42 participants representing a mix of international organizations, Non-Governmental Organizations (NGOs), universities, MoH and private sector, representing a broad spectrum of GIS technical expertise and experience in implementation of GIS in country programs. A detailed list of participants is available in Appendix A.

The meeting was designed to achieve the following objectives (see schematic in Figure 1):

- Review lessons and experiences on the use of geospatial data and GIS for planning, monitoring and analyzing immunization programs, with focus on their impact on improving immunization coverage and reducing subnational inequities;
- Discuss challenges and opportunities for sustainable integration of geospatial data and tool in country immunization programs
- Provide guidance and identify strategies for enhancing integration of geospatial data and tools along the entire immunization program cycle in a sustainable manner.

Figure 1. Schematic diagram of meeting objectives

The meeting resulted in the following main outcomes and deliverables. These are discussed in detail in the relevant sections of this report as indicated below.

1. Review of lessons, opportunities, challenges and potential solutions for the sustainable use of geospatial data and GIS in immunization programs to increase immunization coverage and reduce subnational inequities (Section 4)
2. Review of country-specific successful strategies and challenges for integration of geospatial data and GIS in immunization programs (Section 5)
3. List of country-level recommendations for the integration of geospatial data and GIS in immunization programs (Section 5.1)
4. Areas of priorities and follow-up activities for regional and global action (Session 6)
5. Draft guidance document to support countries in the application of best GIS practices for the planning, monitoring, and analysis of immunization delivery (Section 7)
6. Draft technical working paper, including a review of past and upcoming publications in the use of GIS for immunization analysis (Section 8)
7. Knowledge sharing and increased coordination of immunization systems stakeholders related to the use of GIS for immunization programs (Section 9)
8. Showcase software, tools and platforms for geospatial data acquisition, management, visualization and analysis (Section 10)

3.1 Meeting Structure

Day 1 was dedicated to reviewing lessons and experiences in the use of geospatial data and GIS for immunization planning, monitoring, and analysis, identify opportunities offered by GIS to enhance immunization programs, and discuss the technical and programmatic challenges in order to enhance the integration of geospatial data and GIS in country immunization programs in a sustainable manner.

Day 1 was structured based on the main steps through which immunization is planned, delivered and monitored following the Reach Every District (RED)[3] and the Reach Every Community (REC)[4] approaches, as shown in Figure 2.

Following this conceptual structure, Day 1 was organized in four thematic sessions as shown in Figure 3. Each session was initiated by a number of case study presentations and followed by group and plenary discussions to discuss opportunities and identify challenges and possible solutions for the enhanced use of GIS in each thematic area.

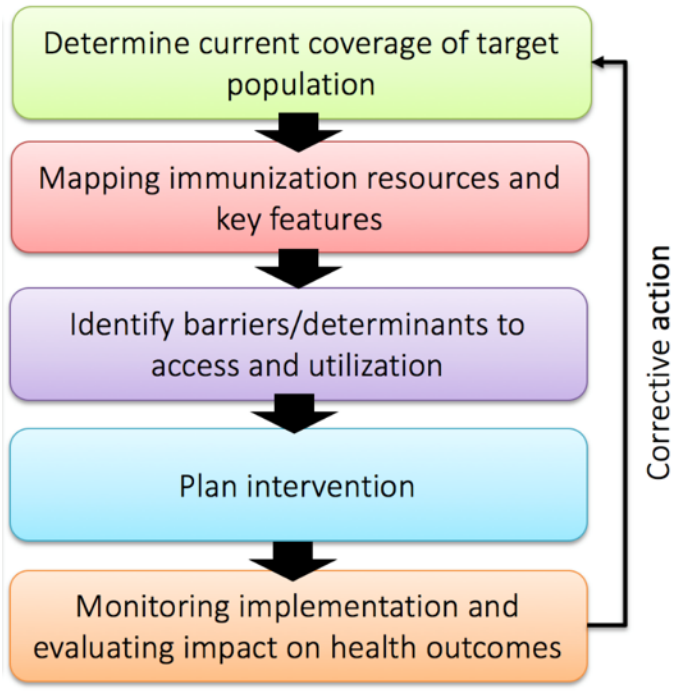


Figure 2. Schematic workflow of Reach Every District (RED) and Reach Every Community (REC) immunization strategies

Day 1 was concluded by an interactive showcase session where participants were presented demonstrations of the use of six software, tools and platforms for geospatial data acquisition, management, visualization, and analysis.

Figure 3. Meeting thematic structure

Day 2 focused on reviewing country-specific experience in the integration of GIS in immunization programs. The day was initiated by a number of case study presentations by representatives of five countries: Cameroon, India, Kenya, Papua New Guinea, and Rwanda, followed by a panelist Q&A sessions that explored the country-specific successes, strategies, and challenges in the integration of GIS in immunization programs.

During the following country-specific group discussion, participants were assigned to five groups to identify potential strategies and solutions to enhance the use of GIS in the specific contexts of Cameroon, India, Kenya, Papua New Guinea and Rwanda, based on the insights and lessons acquired in Day 1 and the country case studies.

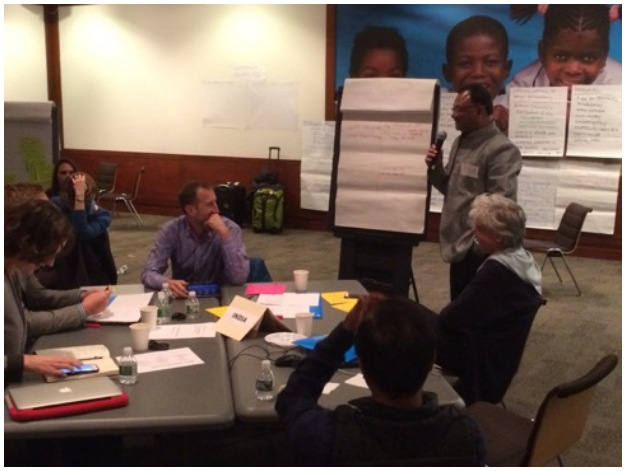
In the following session, the participants reviewed and discussed the content and structure of a guidance document currently being drafted, which will provide guidance, reference material, and resources to guide countries in the use of geospatial data and GIS for the planning, monitoring, and analysis of immunization delivery.

The meeting was concluded by a session which summarized all the lessons learned and the discussions from previous sessions into a list of country-level recommendations for integration of geospatial data and GIS in immunization programs, and identified a number of suggested priority areas and follow-up activities

for regional and global action to strengthen the use of GIS in immunization programs. The detailed meeting agenda is available in Appendix B.

Thematic session presentations

Plenary discussion



Small group discussion

Software interactive demo

4 Lessons, Opportunities, Challenges and Potential Solutions for the Use of Geospatial Data and GIS in Immunization Programs

This section provides, for each thematic session of Day 1, a summary of the group and plenary discussion around the sustainable use of geospatial data and GIS in immunization programs. After review of the lessons, opportunities and challenges identified in each thematic session, the solutions proposed are summarized in section 4.5.

The group discussions focused on the set of questions listed in Figure 4.

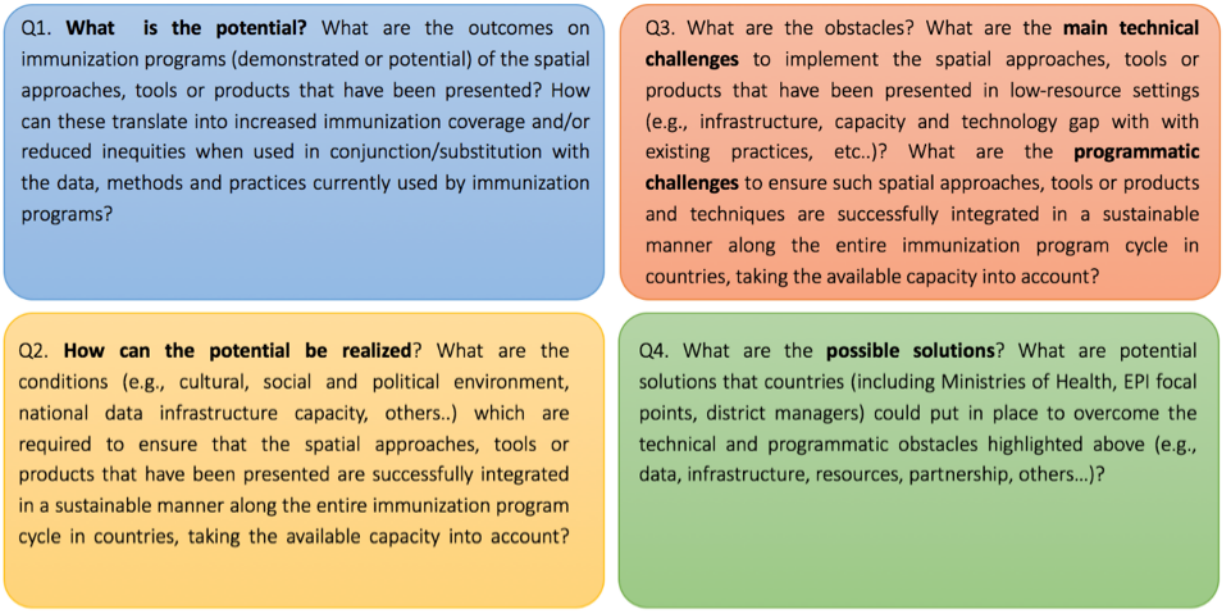


Figure 4. Topics of group discussion in Day 1 thematic sessions

4.1 Session 1: Mapping Immunization Resources and Key Features

Session 1 reviewed experiences with the use of geospatial data and tools aimed at the acquisition of geospatial information on immunization resources and other key features relevant to the planning, monitoring, and analysis of immunization delivery for district and facility level microplanning. Topics covered by presentations included specifically:

- Establishing geocoded registries of health facilities and Community Health Workers (CHWs) in Kenya, Niger, Malawi, Liberia, and Sierra Leone
- Using CHWs to map location of villages and other resources in Rwanda
- Use GPS devices and GPS-enabled mobile phones and tablets to acquire information on coordinates and characteristics of all health facilities, refugee camps, villages and other relevant features in India
- Use satellite imagery to map settlements (towns, villages, hamlets), delineate facilities catchment areas and geographic features such as lakes, rivers, forests and mountain in Cameroon

The case studies provided evidence of the significant experience in the use of GIS tools in a variety of immunization contexts and highlighted the strong potential offered by geospatial data and GIS to strengthen immunization programs. Most notable was the significant potential for up-to-date and accurate maps of health resources and population distribution to support the identification of inequities in immunization coverage and to make remote and isolated communities/settlements frequently missed by vaccination activities identified and accounted for (see example in Figure 5). Having accurate geospatial data was also shown to be a powerful tool for compelling advocacy on the allocation of funding and resources, and a crucial step toward linking immunization system/programs with other components of the health system using geography as the connecting element.

The realization of such benefits is however subjected to the availability of financial and human resources required to scale up at national level the mapping projects which are frequently restricted to districts or regions, the difficulty in mapping hard-to-reach and insecure areas, and the need to find mechanisms to ensure geospatial data are routinely maintained and updated using existing staff/resources. Moreover, it

was pointed out how in order to ensure maximum Interoperability between health systems/programs and other sectors, an essential pre-requisite is the establishment of interoperable geocoded registries (MFL, immunization registries, communities etc..) with a unique electronic identification of health resources (health facilities, community health workers), and target population (communities, children) and established common definitions (e.g. what constitutes a health "resource"?).

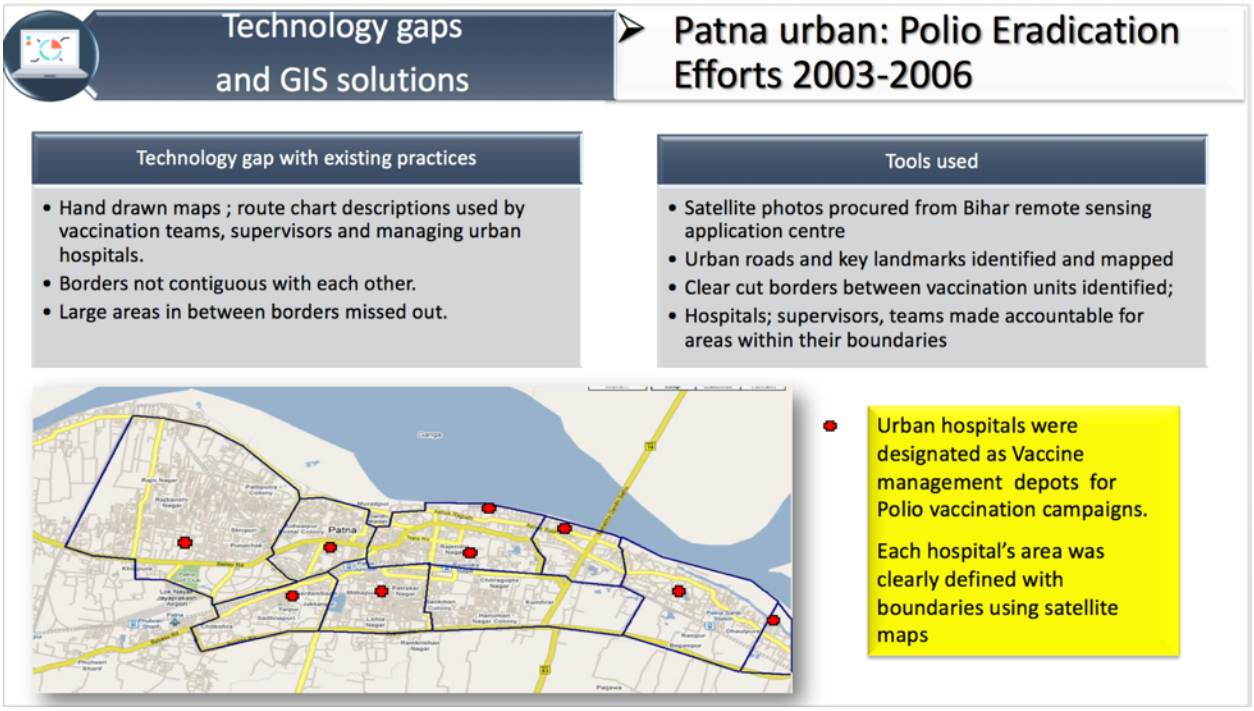


Figure 5. An example application of GIS for mapping immunization resources and key features, from Pradhan, N., "Use of satellite images and GPS for boundaries/facility mapping", available in the online repository (Session 1)

Provided that these challenges can be solved, for example by ensuring involvement of existing local workforce in mapping activities (see section 4.5), the availability of up-to-date and accurate maps of health resources and population will result in better rationalization of the supply, reduction of waste, and ultimately lead to health benefits which will result in savings for the MoH and partners. Although exact costs will depend on the approach (government led with capacity-building or not), the size of country, terrain and season, examples from district and national level mapping in Rwanda, Liberia, Niger and Sierra Leone presented indicated costs between US$8,000-30,000 per district when government and local workforce is engaged in the mapping effort.

The complete list of identified opportunities and challenges in session 1 is listed in Figure 6. All the presentations are available in the online repository (Session 1).

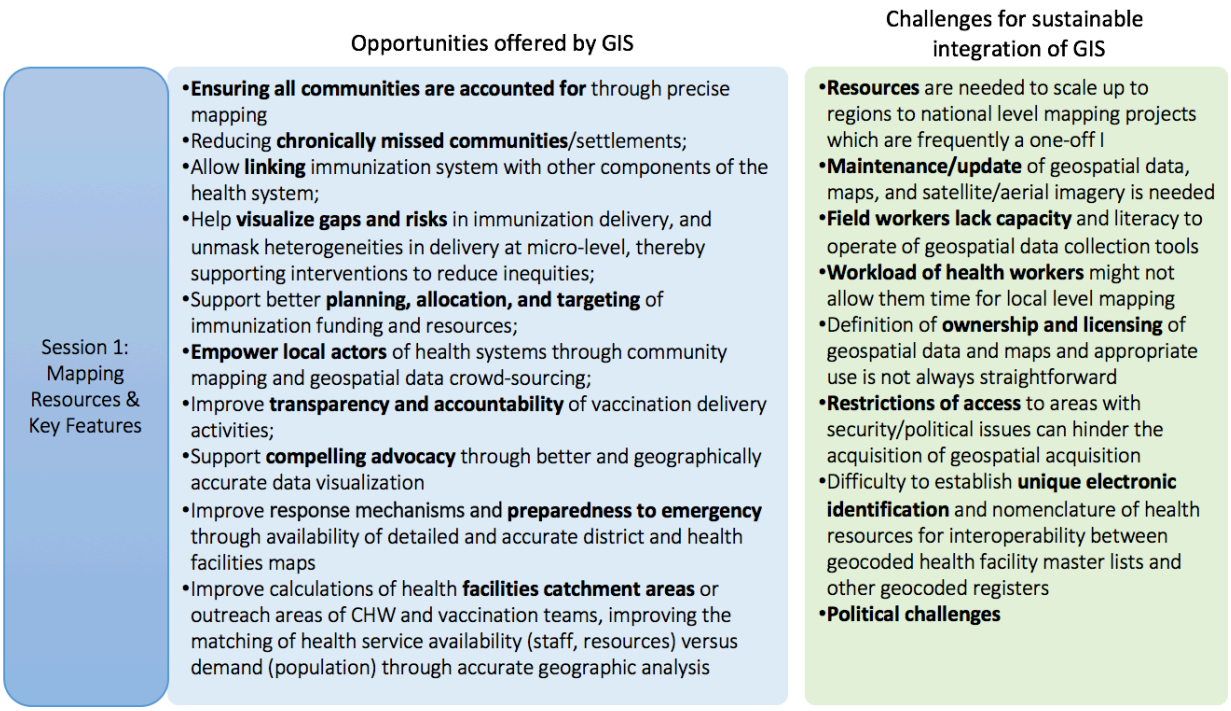


Figure 6. Opportunities and challenges for sustainable integration of GIS identified in thematic session 1

4.2 Session 2: Improving Mapping of Target Populations and Immunization Coverage

This session presented examples of spatial approaches and spatially modeled products for estimating subnational variability in the distribution of target populations distribution and immunization coverage. Topics covered by the presentations included specifically:

- Spatially modeled population estimates (WorldPop)
- Spatially modeled surfaces of coverage and health indicators from Demographic and Health Surveys (DHS)
- Using spatial triangulation of different data sources to improving estimates of coverage and immunization burden at subnational level

These novel spatially modeled surfaces provide a significant opportunity to improve the identification of populations in need and the vaccination burden, and their variability at subnational and sub-district levels (see example in Figure 7). Moreover, the use of modeled surfaces in conjunction with surveillance and administrative data through data triangulation can improve population denominators estimates for routine vaccination and further support compelling advocacy of inequities and gaps in immunization coverage.

However, it was noted that in order to fully realize the potential of these innovative spatially modeled products, their uptake in programmatic context needs to be strengthened. This is currently limited by the lack of trust and evidence about the added value of model-based products at programmatic level, particularly in relation to the appropriate scale (e.g., region, district, or health area) and the issue of time lag between the acquisition of survey data they derive from and the availability for decision making. Another crucial remark was to address the lack of in-country capacity and expertise to absorb, interpret and use such spatial products, including the ability to understand the information contained in them, as well as their uncertainties and limitations.

The complete list of identified opportunities and challenges in session 2 is listed in Figure 8.

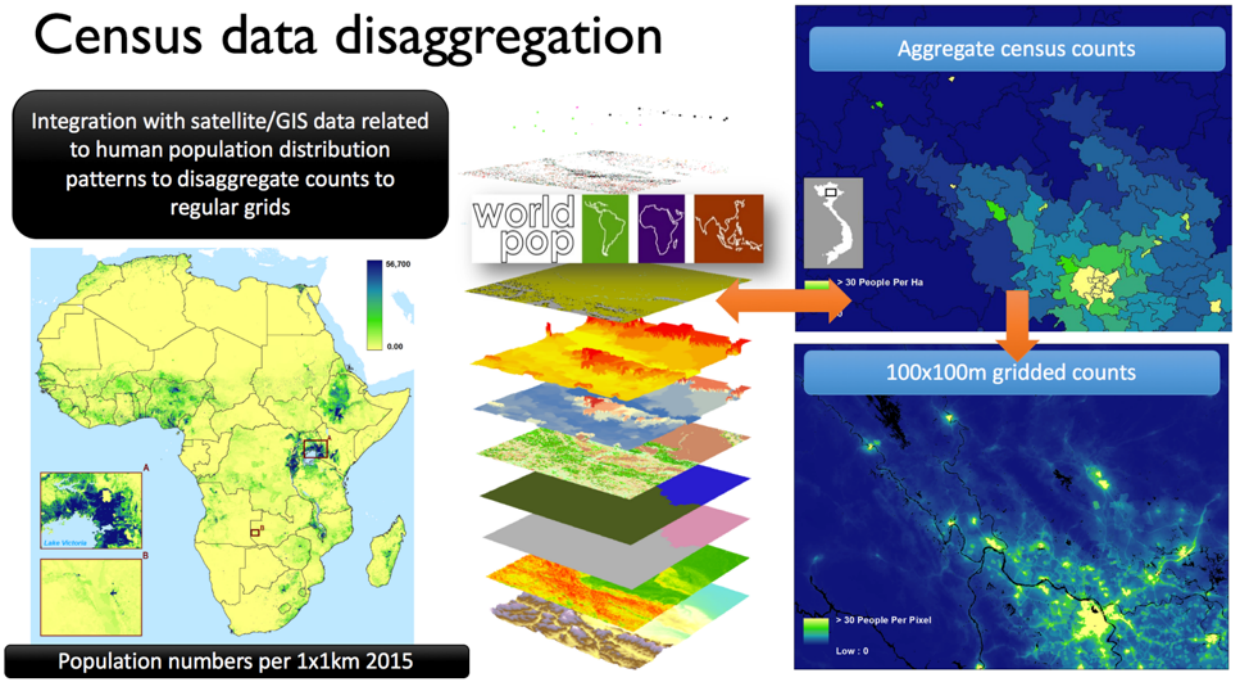


Figure 7. An example application of GIS for mapping population distribution, from Tatem, A., "Mapping denominators and target populations", available in the online repository (Session 2)

	Opportunities offered by GIS	Challenges for sustainable integration of GIS
Session 2: Improving mapping of target populations and immunization coverage	•Improve identification of **population in need** and vaccination burden and identification of subnational inequities •Improve identification of **population denominators** for routine vaccination systems • Use spatial **triangulation of multiple data sources** (e.g., routine immunization, Supplementary Immunization Activities (SIA), DHS surveys) to provide additional insights into vaccination coverage through •**Standardization of spatial products** at regional and global level, thereby facilitating use and integration with other data sources •Support **compelling advocacy** to highlight inequities in performance of immunization programs	•Lack of **capacity and expertise to absorb, interpret & use** spatially modeled surfaces at the programmatic level (Understand information, uncertainties, and limitations) •Lack of **experience in the use of modeled surfaces** at programmatic level**,** and the need to understand the appropriate scale at which such products can be used (e.g., regional, district, facility catchment level) •**Lack of trust and comfort** in the spatially modeled surfaces by national and local level heath workforce •**Uncertainty about value added** of spatially modeled surfaces at programmatic level •**Academic-to-programmatic gap** between academic studies and programmatic level application of such products •insufficient **temporal interval** of availability of spatial products based on census and surveys, outdated or unreliable census data •Extended **time lag** between survey data acquisition and availability of products for decision making (2-3 years time lag for products derived from DHS survey) •Difficulty in providing **micro-level insights** with spatially modeled surfaces

Figure 8. Opportunities and challenges for sustainable integration of GIS identified in thematic session 2

4.3 Session 3. Identifying Determinants of Immunization Coverage and Inequities

Session 3 reviewed spatial analysis techniques used to identify the factors affecting immunization coverage, with a specific focus on gaps and inequities in the availability and access to immunization services. The topics covered by the presentations were:

- Mapping physical accessibility, geographic coverage, and service utilization
- Using GIS to assess the vaccine distribution network and its impact on vaccine availability

The presentations and discussion highlighted the opportunity provided by GIS to integrate, visualize and analyze data on immunization resources, population distribution and the connecting geographic environment (e.g. transport network, geographic barriers), as well as model accessibility to health services. This provides a powerful tool improve the identification of gaps and inequities in access to immunization services, and to support better decision making around targeting immunization resources (see example in Figure 9). It was also observed that the integrating power of GIS should help strengthen collaboration and data sharing across government departments, health system sectors and other sectors based on common geospatial datasets.

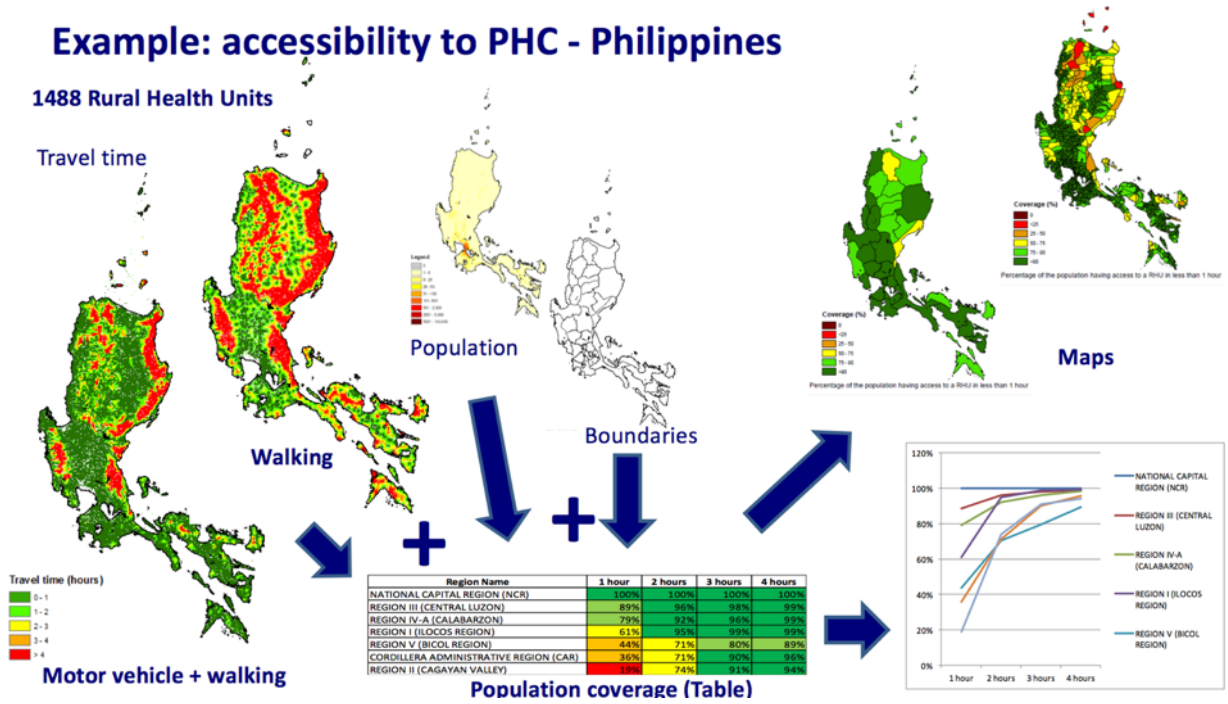


Figure 9. Example application of GIS for mapping accessibility to Primary Health Care (PHC) services, from Ebener, S., "Assessing physical accessibility and geographic coverage using GIS", available in the online repository (session 3)

The challenge to realize the full integrating potential of GIS lies in adopting a more holistic and systemic approach to health system strengthening, where geographic analysis is used to connect elements of immunization to the wider health, population, and environment systems. Other more practical challenges discussed were the sustainability of the integration of such spatial techniques at the programmatic level, the significant capacity and time required for gathering and processing the large amount of input spatial data needed, and the need to account for the seasonality and dynamics of health and human systems (e.g., of population migration, vaccine stocks) in the spatial analysis.

The complete list of identified opportunities and challenges in session 3 is listed in Figure 10.

	Opportunities offered by GIS	Challenges for sustainable integration of GIS
Session 3: Identifying determinants of immunization coverage and inequities	•Support **compelling advocacy** for inclusion of GIS in immunization programs to highlight subnational disparities in access to vaccination •Support better targeting of immunization resources where most needed •Improve **identification of gaps and inequities** in access to immunization resources through geographic data integration •**Integrate multiple components** of health and human systems using geography •Support **collaboration and data sharing** across government departments, health system sectors and other sectors based on common geographic datasets •Support **multi-sectorial planning and co-financing** by leveraging shared geographic data •Support a more **holistic approach to health system strengthening** using geographic as connecting element •**Improve decision-making** about vaccine investment and resources	•Need to look at whole **theory of change** to consider determinants of coverage in a holistic approach by integrating multiple data sources (i.e., Geographic access is not the only barrier to seeking care) •Limitations due to **seasonality and temporal change** (e.g. of population dynamics, of vaccine stocks) versus stationary of analysis •**Sustainability** of use of spatial approaches at programmatic level •**Uncertainty about value added** and relevance of outcomes of spatial analysis at programmatic level •Need to **accelerate adoption** of spatial approaches at country level •Issue of **capacity and resources** needed for gathering and processing the large amount of input spatial data needed for country-wide spatial accessibility analysis and modeling

Figure 10. Opportunities and challenges for sustainable integration of GIS identified in thematic session 3

4.4 Session 4. Monitoring Implementation and Measuring Impact on Health Outcomes

The session presented examples of the application of geospatial tools and spatial analysis techniques for monitoring immunization programs implementation, and measuring the impact of vaccination programs on health outcomes (i.e., disease prevalence). The topics covered by the case studies included specifically:

- Use of satellite images and GPS devices to identify missed communities and track Polio Vaccination team activities in Nigeria
- Development of high-resolution modeled estimates of changing child mortality across Africa.
- Spatial analysis of the impact of vaccination activities on disease prevalence in Bangladesh and India

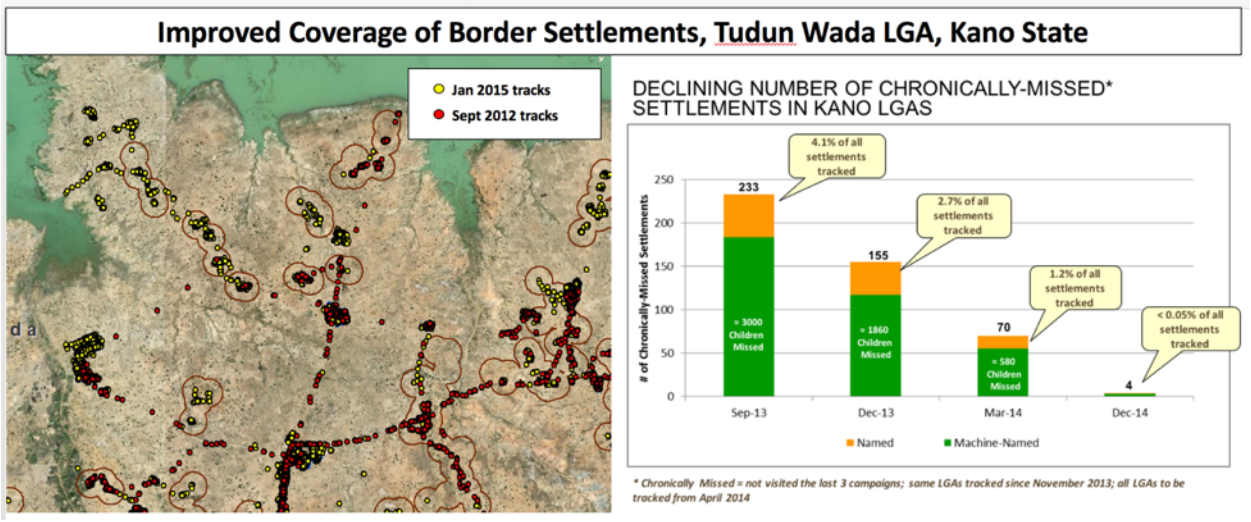


Figure 11. Example application of GIS for improving coverage of remote settlements in Nigeria, from Seaman, V., "GIS Applications to Support Polio Eradication in Nigeria", available in the online repository (Session 4)

One presentation highlighted strong evidence of the impact of using GPS tracking and satellite image interpretation methods for planning and near real-time monitoring of vaccination delivery in Nigeria. By improving identification of all communities to be included in microplans, and subsequently supporting monitoring of vaccination teams, the use of GIS technologies was shown to ensure all communities are visited by vaccinators, and thereby to significantly reduce the risk of chronically missing communities (see example in Figure 11). Moreover, it was discussed how spatial analysis provides compelling evidence to show subnational disparities in vaccination outcomes that can support better targeting of vaccination resources where needed.

It was also noted that some of the geospatial data used for immunization analysis can be relevant to other health sectors as well (e.g. geolocations of health facilities, outreach sites, CHWs, population and community mapping). This can support multi-sectorial planning and co-financing between government departments through multiple streams of funding at the programmatic level by leveraging the shared geospatial data.

In order to achieve a sustainable integration of such spatial procedures at programmatic level it is crucial to ensure the availability of good quality base maps and core geospatial datasets (e.g., transportation infrastructure, health facility master list, geographic barriers), to reduce the time lag associated with data gathering and analysis and thereby increase preparedness to intervention.

The complete list of identified opportunities and challenges in session 4 is listed in Figure 12.

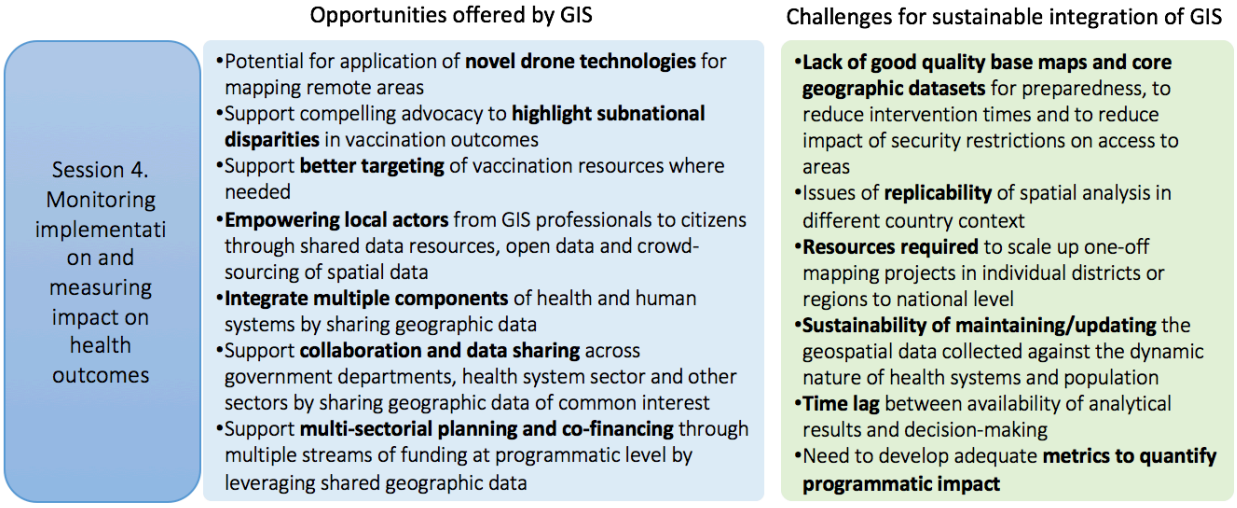


Figure 12. Opportunities and challenges for sustainable integration of GIS identified in thematic session 4

4.5 Potential Solutions

The four thematic sessions of Day 1 highlighted a number of challenges, both at technical and programmatic levels, to be faced to enhance the sustainable integration of geospatial data and GIS into immunization programs. These can be broadly classified into four categories: limitation of available **resources,** lack of **in-country capacity,** need for strengthened **health information systems interoperability** and limitations with the **temporal interval & spatial granularity** of mapping data and model-based products.

Following discussions in each of the thematic areas, a list of potential strategies and solutions were suggested to address the challenges in each category (see Figure 13). The most prominent and cross-cutting solutions identified were:

- Use of **bottom-up, participatory mapping approaches** and maximum involvement from local, to national levels, to reduce cost of data collection, improve sustainability of maintenance and update of maps and geospatial datasets by using local workforce, and increase local capacity for geospatial data collection and maintenance;
- Direct **investment of government** in human and technical resources required for geospatial data collection, maintenance, and analysis, to increase local capacity, data ownership and data use;
- **Creation of use cases** of the application of spatially modeled surfaces and spatial analysis for immunization programs, in order to demonstrate the value added and the impact on coverage levels and inequities reductions. It will also increase trust in the novel data sources, and provide guidance on appropriate interpretation and use of spatial products;
- Consider the potential of **new GIS technologies** (e.g., high-resolution satellite imagery feature extraction, drones, mobile phones geotagging and nighttime light satellite images) to address limitations associated with outdated or unreliable census data, limitations on access to remote areas or security-restricted areas, and to account for population movements which are not captured by spatially modeled surfaces;
- Promote a more **holistic and systemic approach to health system strengthening** using geography as connecting element between different health information systems but also other sectors, by promoting data quality and standardization, data sharing, co-financing, multisectoral planning and interoperability between different information systems using geocoded registries (of health resources, communities, pregnant women, etc.), core geospatial datasets and base maps.

Challenges	Potential solutions
(a) Resources • Scale up mapping projects to regions to national level •Workload/added burden of data collection for health workforce •Maintenance/update of geospatial data and maps	•**Bottom-up, participatory mapping approaches** and maximum involvement at the local, regional and national levels to reduce cost of data collection and facilitate data update using local workforce •**Government direct investment** in human and technical resources to increase capacity, data ownership, and data use •Consider the potential of **upcoming technologies** (e.g. drones to solve issues of security access to areas) •Look for cross-disciplinary opportunities for geospatial **data sharing and co-financing** between government department and other sectors
(b) Capacity & absorption •Bridging gap between knowledge and technology: Operation of geospatial data collection tools •Trust, absorb, interpret & use spatial products and analysis at programmatic level •Gathering and processing spatial data •Replicability of spatial analysis in different country contexts	•**Government direct investment** in human and technical resources to increase capacity, data ownership, and data use •Create **use cases of spatially modeled surfaces** to demonstrate value added, use, interpretation and impact at programmatic level •Record and **share country successful experience** so that they can be reproduced •**Bottom-up, participatory mapping approaches** and maximum involvement at the local, regional and national levels to increase trust and absorption of spatial data and analysis •**Align incentives to support countries in GIS adoption** and advocate for investments be put GIS into NHIS plans and coordination and harmonization of immunization programs with NHIS •Support **multi-sectoral planning, co-financing and data sharing** across government departments, health system sectors and other sectors based on common geographic datasets •Creation of **regional GIS centers** providing shared knowledge and resources, continuous in-country support and capacity building •Integration of a **GIS in curriculums** in the schools of Public Health and universities

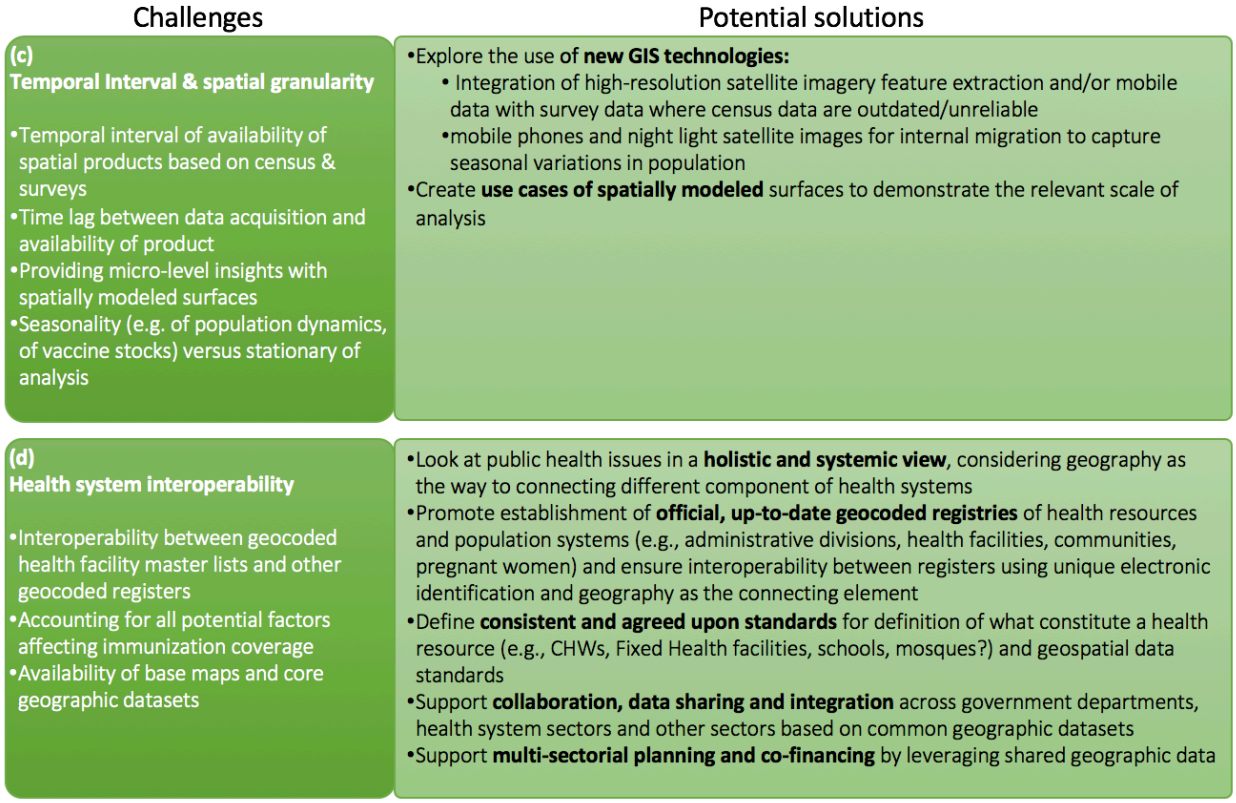


Figure 13a-d. Summary of challenges and potential solutions for sustainable integration of GIS in immunization programs

5 Country-specific Successful Strategies and Challenges for Integration of Geospatial Data and GIS in Immunization Programs.

Day 2 started with an introductory presentation on the benefits of geo-enabling the National Health Information System (NHIS) as a way to strengthen in countries GIS capacity and how the AeHIN GIS Lab is using this approach in Asia and the Pacific. This presentation was followed by country-specific case studies of successes, strategies and challenges in the integration of GIS in immunization programs in Cameroon, India, Kenya, Papua New Guinea, and Rwanda. Table 1 summarizes the country case studies, including the strategies and factors identified by country representatives as being crucial to the project success, the main challenges faced during implementation or for the future sustainability of the activities and, where explicitly quantified, evidence of results and outcomes for immunization programs. The matrix was compiled by summarizing insights from presentations by country representatives, panelist Q&A session, and outcomes of country group discussions.

Notable success stories came from India and Nigeria, where the use of GPS and satellite mapping in polio eradication programs resulted in eradication of polio in the state of Bihar from 2010, and the reduction of chronically missed settlements in Nigeria from 4.1% to <0.05% in just one year. Other good examples are illustrated through the experience in Kenya, where implementation of a national master list of health facilities integrated into the MoH information system is paving the way for interoperability between health

system components. Another interesting experience is in Rwanda, where the use of CHWs demonstrated a significant cost reduction in mapping activities when using local workforce.

Table 1. Summary of country case studies on integration of GIS in immunization programs

Case study	Results/outcomes for immunization program	Successful strategies and factors crucial to achieving outcomes	Main challenges for sustained use, scale up, & integration into routine programming
India Use of satellite images and GPS for catchment areas and facility mapping planning for polio vaccination intervention in urban and hard-to-reach areas (Bihar)	• Polio eradicated from Bihar in 2010, thanks to successful reach of SIA vaccination teams in hard-to-reach areas • Urban outreach immunization activities led to the rise of full immunization coverage from 32 % (2005-6) to over 70% (2013) in Patna Urban.	• Clear vision, high political will, good leadership, consistent efforts and partner support	• Lack of government ownership/investment in human resources, and technology provided by partners rather than government itself; • Low linkages with government remote sensing and health departments.
Rwanda Low-cost mapping of villages using Community Health Workers (CHWs)	• Cost of data acquisition reduced by 50% relative to uing GIS professionals • Village-based map analysis facilitated advocacy for increased health resources	• Involvement of local level workforce • Collaboration/ data sharing between University, MoH, National Statistics office.	• Training/building capacity of community health workers
Cameroon National update of health area and district shapefiles and maps, and integration in DHIS2	• 70% of high-quality country district maps made available to districts for planning	• MoH leadership and funding • Central and regional level GIS training	• Poor participation of local level workers and use/absorption of maps • Security/accessibility issue to some districts • Acquisition of smartphones for facilities
Nigeria Satellite images for vaccination planning and GPS tracking of vaccination teams for coverage monitoring	• Reduced chronically missed settlements from 4.1% to <0.05% in 1 year	• Near real-time GIS monitoring	• Lack of government ownership, poor absorption of data • Cost of scaling up
Papua New Guinea National mapping of health resources using local workers	N/A	• Involvement of local level workforce	• MoH capacity to maintaining GIS web-applications in NHIS
Kenya Implementation of master facility list integrated in NHIS	N/A	• MoH leadership • Effective collaboration of stakeholders and local level workforce • Adoption of web-based applications	• GIS capacity for technical maintenance in MoH

In terms of successful strategies for sustainable integration of GIS in country immunization programs, the country case studies clearly highlighted the importance of ensuring **government leadership** and **involvement** in mapping activities from the start, including **direct investment** of government into human resources and technologies required for data acquisition and management, resulting in better sustainability, data use and capacity. Effective **collaboration of stakeholders**, including different government departments, universities, and national statistics offices was also highlighted as a factor of success in several countries. Major challenges, beside the lack of government involvement, included difficulty in ensuring **participation of local health workers and managers** in programs and effective use of maps.

More details about the country case studies can be found in the online repository (Session 5).

Panelist Q&A after country case studies

5.1 List of Country-level Recommendations for Integration of Geospatial Data and GIS in Immunization Programs

Building upon the solutions identified during the thematic session and the country specific cases, the following actions were identified as recommendations for MoH or EPI to ensure a sustainable integration of geospatial data and GIS into country immunization programs:

1. Ensure **government leadership and involvement** in geospatial data collection, management, updating, sharing and use;
2. Ensure government **direct investment** in providing the human, technical and financial resources to sustain geospatial data management and GIS activities as well as data use;
3. Use of **bottom-up, participatory mapping approaches** and maximum involvement at the local, regional and national levels, to reduce cost of data collection, improve sustainability of maintenance and update of maps and geospatial data using local workforce, and increase local capacity for geospatial data collection and maintenance;
4. Establish a **national registry** of health facilities and other registries (administrative divisions, villages, immunization, communities, health workers, pregnant women etc.) and enforce their use across the health system to improve data compatibility as well as facilitate the use of geography

and GIS as a common integrating platform allowing for a more holistic and systemic approach to health system strengthening;

5. Strengthen **data sharing and partnership** between entities producing this data, including, but not limited to: government, universities, and national statistic offices;
6. Explore **multi-sectorial use** of geospatial data across government departments;
7. Integrate a **GIS in curriculums** in the schools of Public Health and universities;
8. Consider the potential of **new technologies** (e.g. high-resolution satellite imagery feature extraction, drones, mobile phones geotagging and nighttime light satellite images) to address limitations associated with outdated or unreliable census data and access to remote areas or security-restricted areas, and to account for population movements which are not captured by spatially modeled surfaces; and
9. Ensure mapping projects meet the **needs of local managers** to strengthen their participation in mapping projects.

This list of measures and recommendations will be included in the guidance document currently in draft on the use of geospatial data and GIS for the planning, monitoring and analysis of immunization delivery (see details in 7) and will serve as guidelines for country in replicating successful strategies for integration of GIS, as presented by the countries represented at the meeting.

6 Priority Areas and Follow-up Activities for Regional and Global Action

A plenary discussion was undertaken to summarize the lessons learned in the previous sessions and consolidate them into priority areas and follow-up activities for regional and global action and for consideration in the 2017 round of GAVI alliance DATA SFA proposals. The following areas of priorities emerged from the discussion:

1. Produce **use cases** of the application of spatially modeled products on population and immunization coverage at the programmatic level, in order to build trust on the relevance and value added of such products for programmatic interventions, and to provide global and regional guidance on the integration of the products in immunization programs;
2. Promote a more **holistic and systemic approach to health system** strengthening using geography as connecting element, not only between different health information systems but also information systems maintained by other sectors, by promoting **data quality and standardization, data sharing, co-financing, multisectoral planning and interoperability** between the different information systems, using geocoded registries (of health resources, communities, pregnant women, etc.), core geospatial datasets and base maps;
3. **Align incentives** to support countries in accelerating GIS adoption;
4. Advocate **investments** in the integration of geospatial data management and GIS into NHIS plans; and
5. Create **regional centers of expertise** and regional or in-country **GIS experts' rosters**, providing shared knowledge and resources, continuous in-country support and capacity building in geospatial data management and GIS. A replicable model of this is the existing Asia eHealth Information Network (AeHIN) GIS Lab (http://aehin.org/Resources/GISLab.aspx).

6.1 Follow-up Activities

Of the areas of priorities outlined above, the group identified as follow-up activities, relevant to the mandate of the Health Data Collaborative (HDC), that of promoting a more holistic and systemic approach

to support health system strengthening through cross-cutting use of geospatial data. The priority tasks in this sense were identified as:

- Support countries in establishing official, complete, up-to-date, uniquely coded and georeferenced national health facility and other registries (e.g. administrative divisions, villages, pregnant women, immunization registries, community registries) as an absolute priority. This will require defining common data standards, supporting the unique electronic identification of health resources across systems and strengthening the mechanisms for interoperability between systems based on geography.
- Explore and promote opportunities for co-financing, data sharing and collaboration within government departments, within health system sectors and with other sectors, to leverage geospatial data and GIS of importance across different sectors; and
- Promote the creation of centralized base map and core geospatial databases, including geospatial data needed across different element of immunization system or other sectors (e.g. coverage of satellite maps, maps of settlements, road infrastructure, etc.).

It is suggested that these activities be advocated for through the nascent spatial working group of the HDC. The participants to the workshop expressed interest in being involved in these follow-up activities through the HDC. However, it was recommended that a clear mandate, strategic roadmap, work plan and key outputs should be defined early on and clearly for the spatial group.

Finally, a discussion was conducted around the need to engage additional stakeholders in these follow-up activities to strengthen the sustainability of GIS in immunization programs, such as:

- Decision-makers and final users from national to local level
- Donor community, including World Bank, Bill and Melinda Gates Foundation, and other GAVI Alliance partners
- Local universities
- Software and information system producers (e.g., DHIS2)
- Private sector, local telecommunication companies
- Health communication, knowledge management, and research translation specialists

7 Review of Guidance Documents on Use of GIS for the Planning, Monitoring, and Analysis of Immunization Delivery

The participants reviewed and provided feedback on the content and structure of a draft guidance document, designed to provide recommendations, protocols, reference material and resources to guide countries in the use of geospatial data and GIS for the planning, monitoring, and analysis of Immunization delivery. The guidance document will be developed based on the feedback provided by the participants in the coming months.

A number of existing guidance document were also reviewed in view of their relevance to the collection, maintenance and use of geospatial data for health. These documents will serve as references or support documents when completing the guidance on the use of GIS for immunization.

- **AeHIN GIS Lab**: "Guidance Documents for the Collection and Use of Geospatial Data in Health"[11]. A series of guidance documents aiming at homogenizing and improving the quality of geospatial data in the health sector, including key elements and processes of the geospatial data management chain.

- **USAID:** "Using Geospatial Analysis to Inform Decision Making in Targeting Health Facility-Based Programs: A Guidance Document"[12]. The document providing guidance for using GIS to inform decision making about allocating resources for facility-based health services;
- **USAID:** "Guidance for Use of The DHS Program Modeled Map Surfaces"[13]. Provides users with a deeper understanding of The DHS Program modeled surfaces and their potential use in decision-making.
- **USAID:** "Master Facility List Resource Package" (draft). A guidance for countries or individuals who want to establish or strengthen a MFL (in draft, will be accessible via the DHS Program website: www.dhsprogram.com);
- **Scott Teesdale & OpenHIE:** "Facility Registry Implementation Guide"[14]. The guide provides a methodology for implementers to create and support a national health facility registry based on the best practices, lessons learned and including tangible outputs from existing facility registries.
- **WHO:** "Collecting, Assessing, and Using Immunization Data" (draft). Provides guidance on the collection, assessment and use of immunization data, with a focus on routine immunization coverage monitoring, supply chain management and session planning and monitoring.

All presentations in the guidance session are available in the online repository (Session 6).

8 Review of Past and Upcoming Publications in the Use of GIS for Immunization Analysis

A list of published material concerning the use of GIS for immunization system planning, analysis, and monitoring was compiled before the workshop and presented to attendants. Through feedback from the meeting attendees the review was completed with additional publications and studies in preparation. A technical working paper will be produced based on this updated list in the coming months.

The list of publications is available in the online repository ("Meeting documents" section), together with the presentation of the findings of the review (Session 0: Introduction).

9 Knowledge Sharing and Increased Coordination of Immunization Systems Stakeholders Related to Use of GIS for Immunization System Analysis

The workshop provided a venue for international experts, country representatives, and EPI focal points to share knowledge and experiences around the use of geospatial data and GIS in immunization programs. Specific outcomes in terms of strengthened coordination included:

- The initiation of a roster of GIS experts, which will serve as the foundation for the follow-up activities outlined in section 6.1). The roster is available in the online repository ("Meeting documents" section).
- A review of ongoing projects related to the use of GIS for immunization planning, analysis, and monitoring. The review is available in the online repository ("Meeting documents" section).

10 Software, Tools, and Platforms for Geospatial Data Acquisition, Management, Visualization and Analysis

Day 1 concluded with a software showcase session that provided participants with the chance to interact with six software, tools and platforms for geospatial data acquisition, management, visualization and analysis. Participants were engaged in small group interactive software demos, which allowed a first-hand experience with the software functionalities.

The tools presented provide low or no-cost geospatial solutions focused on usability, and therefore represent strong opportunities to bridge the technology gap which is an obstacle to sustainable absorption of GIS in low-literacy settings:

1. **EPISample (for Android):** a software for all-in-one field data collection, sampling, and navigation developed by PATH for the Malaria Control and Elimination Partnership in Africa (MACEPA). The code is open-source and available on GitHub. The user guide is available at https://github.com/MACEPA/episample/wiki).
2. **Healthsites.io:** A free, open, collaborative platform for creation and maintenance of geocoded health facility master list (https://healthsites.io/).
3. **Resource Map:** A free, open-source tool developed by Innovative Support To Emergencies Diseases and Disasters (InSTEDD) allowing collaborative recording, tracking, and analysis of health resources using live web-mapping (http://resourcemap.instedd.org/en).
4. **AccessMod:** A stand-alone open-source application developed by WHO to perform different analysis pertaining to the geographic aspect of Universal health Coverage): physical accessibility, geographic coverage, referral, scaling-up of health service delivery, etc. (http://www.who.int/ehealth/resources/accessmod/en/).
5. **PlanWise:** A software tool jointly developed by Concern International and InSTEDD. Planwise makes use of publicly available data to map geographic accessibility to obstetric care to support health planners and decision makers (http://www.concernusa.org/story/planwise-a-data-driven-tool-for-placing-help-where-its-needed/).
6. **CARTO builder:** A powerful cloud-based GIS platform allowing a wide variety of spatial analysis tasks, including customized dashboards and web-publishing of maps (https://carto.com/)

Participants expressed strong enthusiasm and interest in the software showcased. The session also served as a networking tool, stirring discussion and collaboration amongst specific groups on overlap or potential integration between different tools.

11 Conclusions & Future Work

As a follow-up to the meeting, UNICEF will pursue the following actions:

- Contact the HDC steering committee regarding the possibility of kick-starting the work of the spatial working group by building on the lessons learned during the meeting, in particular the follow-up activities outlined in section 6.1. This activity will also involve the network of GIS expertise initiated through the GIS roster in section 9;
- Update the proposal for GAVI Strategic Focus Areas (SFA) 2017 in line with the recommendations developed in the workshop for submission in November 2017;

- Compile the technical working paper with a systematic review of past and ongoing experiences in the use of GIS for immunization analysis, including the feedback and publications gathered during the workshop, for submission by January 2017;
- Produce the guidance document to support countries in the application of best GIS practices for the planning, monitoring, and analysis of immunization delivery, based on the feedback and recommendations provided by the workshop participants. It is envisioned that this document will be drafted by February 2017.
- Communicate with GAVI the list of country-level recommendations for integration of geospatial data and GIS in immunization programs, which were compiled following country group discussions (section 5.1). These recommendations will serve as guidelines for countries at the initial stages of the integration of GIS in their immunization programs.

During the wrap-up, participants expressed that the meeting provided a useful, productive and engaging forum for review and exchange of current knowledge, identification of existing challenges and barriers, and identification of strategies and recommendations to strengthen the integration of geospatial data and GIS in country immunization programs. Participants expressed appreciation for the opportunity to gather as a group, and particularly for the opportunity to discuss the applicability of GIS in programmatic contexts and to identify the existing barriers to the application of GIS in operational contexts. Participants also expressed interest in being involved in the follow-up activities resulting from this meeting.

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Appendix A: Participant List

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2. **Mohammad Ali**
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   UNICEF
8. **Richard Duncan**
   UNICEF
9. **Steeve Ebener**
   AeHIN GIS Lab
10. **Gérald Sume Etapelong**
    WHO-Cameroon
11. **Matt Ferrari**
    Penn State
12. **Santiago Giraldo**
    Carto
13. **Jan Peter Kamiel Gravendok**
    WHO
14. **Benjamin Hickler**
    UNICEF
15. **Andrew Inglis**
    MCSP/USAID(JSI)
16. **Debra Jackson**
    UNICEF
17. **Eduardo Jezierski**
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18. **Justin Lessler**
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19. **Jessica Metcalf**
    Princeton University
20. **Godwin Mindra**
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38. **Scott Teesdale**
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40. **Maya Van den Ent**
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41. **Katie Waller**
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42. **Danzhen You**
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Appendix B: Final Meeting Agenda

Technical Meeting:
Improving Immunization Coverage and Reducing Inequities: Use of GIS in Immunization Programs
AGENDA
October 25-26, 2016 - Labouisse Hall, UNICEF

Purpose:
The meeting will provide a venue for global, regional, and national experts with experience using GIS to strengthen immunization and health data/information systems. More specifically, the meeting aims at:

1. Reviewing lessons and experiences on the use of geospatial data and GIS for planning, monitoring and analysing the performance of immunization programs, with focus on their impact on improving immunization coverage and reducing inequities;
2. Discussing challenges and opportunities for sustainable integration of geospatial data and tool in country immunization programs
3. Providing guidance and Identifying strategies for integrating the use of geospatial data and tools along the entire immunization program cycle in a manner sustainable with the country capacity, including all stakeholders involved in immunization programs (Ministry of Health, donors, NGOs, etc.);

Day 1, Tuesday, October 25

Time	Session	Speaker/Chair
8:30 – 9:00	*Arrival & Breakfast*	

9:00 – 10:10	• Director's opening (5min)
	• Intro and Background of meeting (5min)
	• Round of introductions participants (10min)
	• Setting the stage
	  ○ Immunization (10min)
	  ○ Immunization and GIS (10min)
	  ○ Literature review on GIS applications for Immunization (10min)
	• Meeting agenda, objectives and outcomes (5min)
		Dr Stefan Peterson, Chief Health Section, UNICEF
		Maria Muñiz, UNICEF
		All
		
		Maya Van den Ent, UNICEF
		Rocco Panciera, UNICEF
		Rocco Panciera, UNICEF
		Rocco Panciera, UNICEF

10.10 – 10.30	*Morning Break*	
10.30 – 12.40	Thematic Session 1: ***Mapping immunization resources and key features***	
	Format Two sets of presentation (10min each) followed by small group discussions (7-8 people) to summarize main opportunities and challenges around predefined questions, followed by group reporting to the plenary. Introduction of session objectives (5 min) *Part I - Mapping health service availability (10 min each):* 1. Establishing Master Facility Lists and Registries 2. Putting CHWs on the map: Toward a Geography of Community Health Workers Table group discussions (15 min) *Part II - Mapping other key features (10 min each):* 1. Using Community Health Workers (CHW) in low resource settings to map village level data 2. Use of satellite images and GPS for boundaries/facility mapping 3. Cameroon GIS Project : Implementation, Use and Perspectives Table group discussions (15 min) Groups report to plenary (20 min)	*Chair:* Rocco Panciera, UNICEF *Speakers* Scott Teesdale, InSTEDD Nicholas Oliphant, UNICEF *Speakers:* Fabien Munyaneza, University of Rwanda Narottam Pradhan, Project Concern International Gérald Sume Etapelong, World Health Organization

12.40 – 13.20	*Lunch*	
13.20 - 14.45	Thematic Session 2: ***Improving mapping of target populations and immunization coverage***	
	Format 10 min presentations followed by small group discussion (<8 people) to summarize main opportunities and challenges around predefined questions followed by group reporting to the plenary Introduction of session objectives (5 min) *Presentations:* 1. Mapping the denominator: WorldPop population datasets 2. DHS Spatially Modeled Surfaces 3. Improving estimates of coverage and burden at sub-national level Table group discussions (15 min) Groups report to plenary (20 min)	*Chair:* Maria Muñiz, UNICEF *Speakers:* Andrew Tatem, University of Southampton Clara Burgert, ICF International Matthew Ferrari, Penn State University
14.45 – 15.05	*Afternoon Break*	
15.05 – 16.15	Thematic Session 3: ***Identifying determinants of immunization coverage and inequities***	
	Format 10 min presentations followed by small group discussion (<8 people) to summarize main opportunities and challenges around predefined questions followed by group reporting to the plenary Introduction of session objectives (5 min) *Presentations:* 1. Assessing physical accessibility and geographic coverage using GIS 2. Using GIS to assess the vaccine supply chain distribution network and its impact on vaccine availability Table group discussions (15 min) Groups report to plenary (20 min)	*Chair:* Nicholas Oliphant, UNICEF *Speakers:* Steeve Ebener, AeHIN GIS Lab Andrew Inglis, MCSP/USAID(JSI)
16.15– 17.40	Thematic Session 4: ***Monitoring implementation and measuring impact on health outcomes***	
	Format 10min presentations followed by small group discussion to summarize main opportunities and challenges around predefined questions followed by group reporting to the plenary Introduction of session objectives (5min) *Presentations:* 1. Near-real time tracking of Polio Vaccination teams, Nigeria 2. High-spatial resolution estimates of changing child mortality in Africa. 3. Importance of the use of GIS in a vaccination program Table group discussions (15 min) Groups report to plenary (20 min)	*Chair:* Clara Burgert, ICF International *Speakers:* Vincent Seaman, Bill & Melinda Gates Foundation Roy Burnstein, IHME Ali Mohammad, Johns Hopkins University

17.40 - 17.50	Afternoon break 2	
17.50 – 18.30	*Showcase session:* ***Software, tools and platforms for geospatial data acquisition, management, visualization and analysis***	
	Format Demonstrations + Q&A 1 min lightning pitch in plenary, then 2 x 15min showcase demos, in separate stations presenting 1-2 case studies, with audience/participants rotating to their choice of demo station Introduction of session format (5 min) *Demonstrations:* 1. AccessMod for geographic accessibility 2. PlanWise for resources allocation optimization 3. EPISample (for Android): a software for field data collection, sampling, and navigation 4. Open, collaborative health facility mapping with Healthsites. 5. Resource Map 6. Carto builder	*Chair:* Rocco Panciera,UNICEF *Speakers:* Nicolas Ray, Uni. of Geneva & UNEP/GRID-Geneva Katie Waller, CONCERN Worldwide & Scott Teesdale, InSTEDD Jodi Van den Eng , CDC Nate Smith, healthsites.io Eduardo Jezierski, InSTEDD Tyler Bird & Santiago Giraldo, Carto
18.30 – 18.40	*Day 1 Wrap up*	Rocco Panciera & Maria Muñiz, UNICEF
18.40 – 20.00	*Reception*	

Day 2, Wednesday, October 26		
8.30-9.00	*Arrival & Breakfast*	
9.00-9.10	Welcome back, Day 2	Rocco Panciera & Maria Muñiz, UNICEF
9.10 – 10.00	Thematic session 5 – part I: ***Effective strategies for institutionalizing capacity for acquisition, maintenance, analysis and use of geospatial data to inform immunization programs***	
	Format 2 sets of 10min presentations (Part I and Part II), followed by panel discussion around specific questions for panelists Introduction of session objectives (5 min) *Presentations* 1. Geo-enabling the Health information System (HIS) as a way to strengthen in countries GIS capacity 2. Microplanning and integration with DHIS2 in Cameroon 3. Polio Eradication efforts as well as enhancing Routine immunization coverage	*Chair:* Nicolas Ray, Uni. of Geneva & UNEP/GRID-Geneva *Speakers:* Steeve Ebener, AeHIN GIS Lab Gérald Sume Etapelong, WHO Narottam Pradhan, Project Concern International
10.00 - 10.20	*Morning Break*	

10.20 – 11.25	Thematic session 5 – part II: ***Effective strategies for institutionalizing capacity for acquisition, maintenance, analysis and use of geospatial data to inform immunization programs***	
	Presentations 1. The central role of MFL in enhancing routine data capabilities - The Kenya Case 2. Integrating GIS in National health Information systems in Papa New Guinea Table buzz to define questions (5min) Panel discussion (30 min)	*Speakers* Martin Osumba, Kenya Ministry of Health Alex Rosewell, University of New South Wales
11.25 – 13.10	***Way forward discussion on enhancing integration of geospatial data and tools into immunization programs***	
	Format Small groups discussions (2 rounds), followed by plenary discussion Intro, objectives and topics (5min) Round 1 (review country-specific programmatic challenges) Working groups (20 min) Small break (10min) Round 2 (develop country-specific strategies) Working groups (20 min) Groups report to plenary (20 min) Cross-cutting plenary discussion (20 min)	*Chair:* Jan Gravendonk, WHO
13.10 – 14.00	*Lunch Break*	
14.00 – 15.30	***Guidance Document Review Session***	
	Format 10min presentations followed by small group discussion around guidance structure and content followed by a group reporting to the plenary Introduction of session objectives (5 min) *Presentations* Draft guidance GIS for immunization AeHIN GIS Lab guidance for the collection and use of geospatial data in health ICF Master Facility List Collecting, Assessing, and Using Immunization Data Reference guide Table group discussions (15min) Group discussion (15min)	*Chair:* Rocco Panciera, UNICEF *Speakers:* Rocco Panciera, UNICEF Steeve Ebener, AeHIN GIS Lab Clara Burgert, ICF International Jan Gravendonk, WHO
15.30 – 15.50	*Afternoon Break*	
15.50 – 17.15	***Next Steps***	
	Format Plenary/Open Discussion around 3 main topics For each topic: 5min table discussion 20min plenary	*Chair:* Maria Muñiz, UNICEF
17.15 – 17.30	*Concluding Remarks*	Rocco Panciera & Maria Muñiz, UNICEF