Leveraging Geospatial Technologies and Data to Strengthen Immunisation Programmes

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Rapid guidance for investment planning

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Acknowledgments

Leveraging geospatial technologies and data to strengthen immunisation programmes: rapid guidance for investment planning is the result of a team effort with collaborators and technical contributors, as listed below. The process was facilitated by HealthEnabled and co-led by Gavi, the Vaccine Alliance and UNICEF, driven by their joint dedication to support and promote the use of innovations to accelerate improvements in global immunisation coverage and equity.

After this guidance document is available and used by EPI and immunisation programme managers, the developers would like to hear your experiences and suggestions on how to improve the guide to better support planning and budgeting for the effective use of geospatial data and technologies in immunisation programmes. Periodic updates will be made based on user experiences.

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Glossary of Terms

Bottleneck	A specific gap or problem in the process of delivering health services in any health programme. In the context of immunisation systems, a bottleneck is a challenge with the supply of vaccines, provision of services or demand for vaccinations that makes it difficult to achieve the desired immunisation coverage.
Geospatial data	Information about the location and shape of objects, geographic features and the relationships between them.
Geospatial technologies	A set of equipment, computer applications and systems to visualise, measure, and analyse Earth's features, typically involving such systems as Global Navigation Satellite System (GNSS), Geographical Information Systems (GIS), and remote sensing (RS).
Enabling environment	The knowledge, attitudes, practices and policies that stimulate and support effective and efficient functioning of organisations, individuals and programmes. These factors include, but are not limited to, infrastructure, workforce, governance mechanisms, legislation and policies in the country.
Equity	Immunisation equity is the absence of avoidable differences in vaccination coverage among groups of people, whether those groups are defined socially, economically, demographically or geographically.
Zero-dose	Zero-dose children are those who have not received any of the vaccines in the routine immunisation schedule. For operational purposes, zero-dose children are identified as those missing the first dose of the diphtheria-tetanus-pertussis vaccine (DTP-containing vaccine)

1 Background

Recent experiences and evidence have demonstrated the potential benefits of using geospatial data and technologies to support immunisation programmes [1, 2, 3]. However, the countries that would benefit the most from the use of geospatial health information for improving immunisation coverage and equity often lack the guidance they need to plan for and access resources for geospatial data and technology applications.

This rapid guidance document identifies the steps and key considerations for Ministries of Health (MOH) and national Expanded Programme of Immunisation (EPI) managers and their partners when planning and developing funding applications for effective and sustainable use of geospatial data and technologies.

Any data that includes information on the location and shape of objects is geospatial data. The equipment, tools and computer systems used to collect, store, visualise and measure geospatial data are collectively called geospatial technologies. The application of geospatial data and technologies can support immunisation programme managers distribute resources and plan for service delivery, assess gaps and inequities in access to services, improve planning for equitable service delivery and monitor programme performance as well as population health. These improvements are achieved through better understanding of the spatial distribution of immunisation services, the target population, communities and settlements in need of those services and the infrastructure and environment between them.

The 2018 UNICEF resource, Guidance on the Use of Geospatial Data and Technologies in Immunization Programs [1] and the report Improving Immunisation Coverage and Equity through the Effective Use of Geospatial Technologies and Data: A Landscape Analysis & Theory of Change [2] identify eight applications or use cases of geospatial data and technologies to support immunisation programmes. This guide builds on the background of those eight applications by providing operational guidance on creating plans and budgets for their implementation. The first two applications, **health system mapping** and **population estimation and spatial distribution**, are the essential foundations that use geospatial technologies to generate primary information on the health infrastructure and population distribution that apply to immunisation programming. Four applications, **microplanning**, **disease surveillance**, **vaccination session tracking** and **campaign monitoring**, use geospatial data and technologies to support planning and monitoring of immunisation service delivery. The last two applications, **geographic accessibility modelling** and **vaccination coverage modelling**, use advanced spatial analysis to derive additional geospatial information that can help managers understand the underlying factors that impact the equitable distribution of immunisation services.

While this rapid guidance is focused on immunisation, geospatial data and technologies are more beneficial if they are developed with cooperation across health systems. They have broad application across health systems and can benefit from integration and coordination between immunisation delivery services and other health areas.

The applications of geospatial data and technologies described here contribute to the achievement of immunisation outcomes in the Theory of Change for a reduction in childhood disability and mortality due to vaccine-preventable diseases (see the Theory of Change in Annex 1). It is expected that the effective management and use of geospatial data and technologies can improve:

- Identification of zero-dose and under-immunised children
- Planning and allocation of immunisation resources
- Service delivery through better planning, monitoring and tracking of immunisation activities

The effective use of geospatial data and technologies described in this guide can help close the performance gap to reach universal health coverage by aligning relevant immunisation programme application to address health system challenges (Figure 1).

Linkage between applications of geospatial data and technologies and contributors to Universal Health Coverage

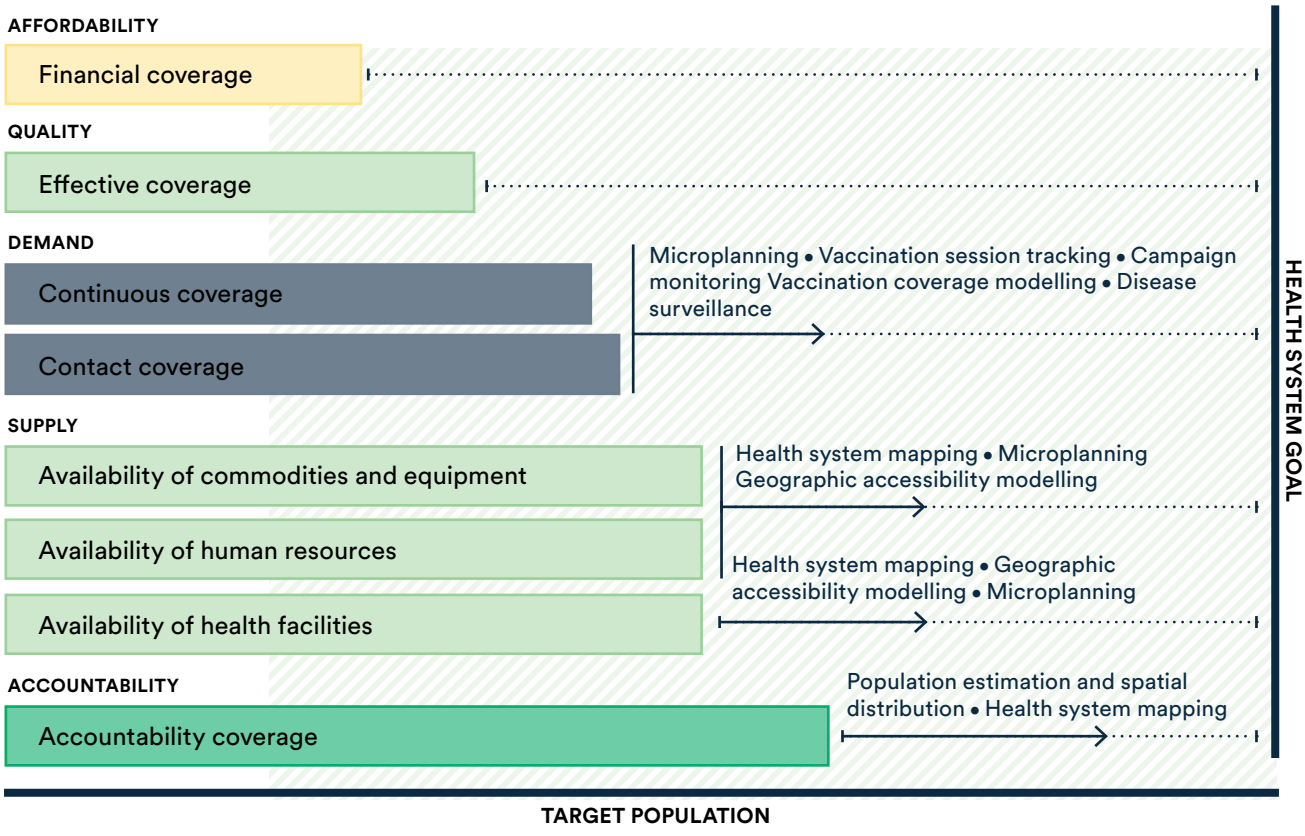

FIG. 1 Model illustrating the link between applications of geospatial data and technologies for immunisation and their contribution to Universal Health Coverage (adapted from [4])

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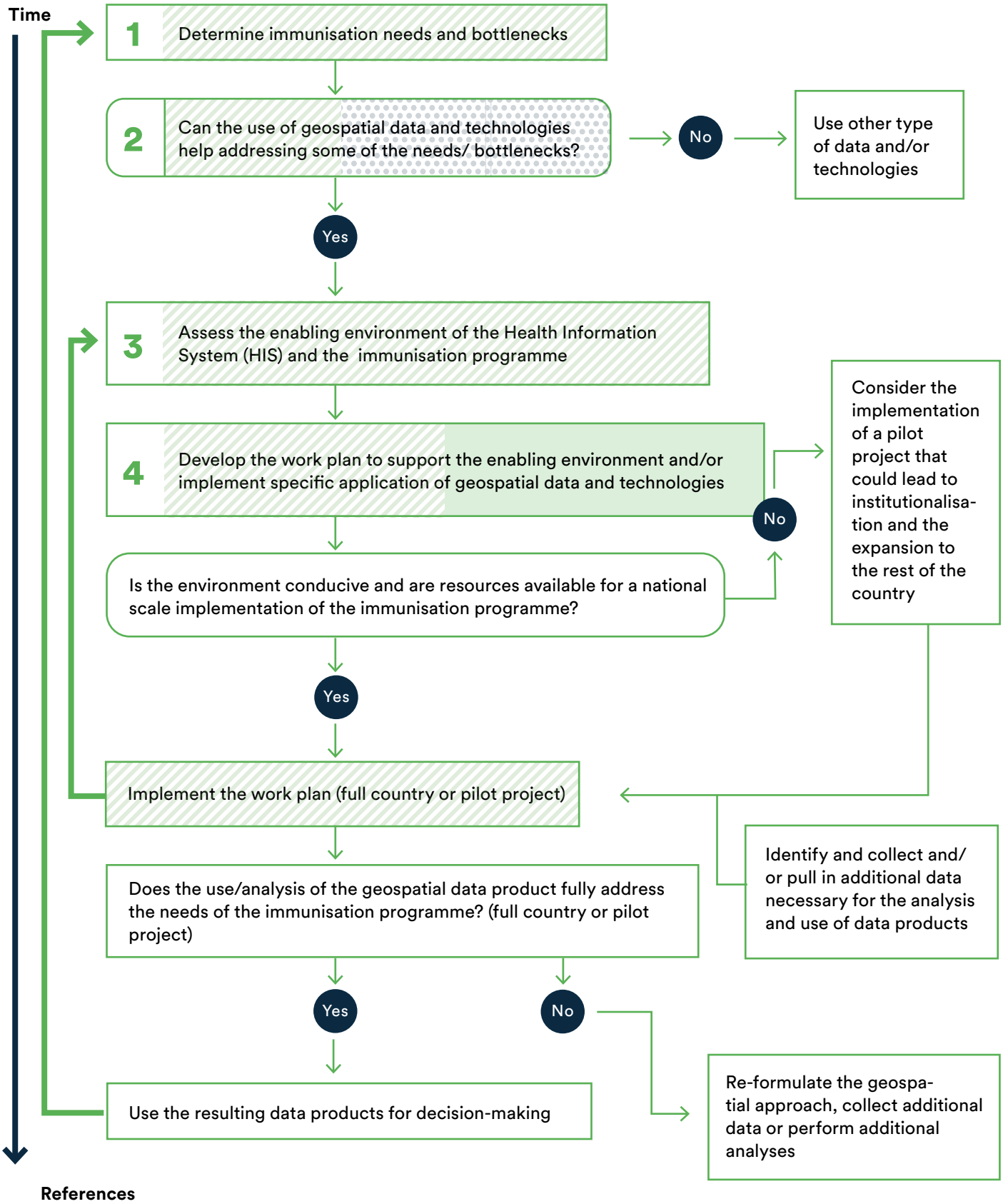
How to use this guide

This guidance document provides information, steps and important considerations for the process of selecting, planning and budgeting geospatial data and technology applications for immunisation. It serves as a complement to the information provided in the 2018 UNICEF Guidance [1] and the 2020 Landscape Analysis [2]. The steps outlined below help guide immunisation programme managers to integrate geospatial data and technologies into immunisation programming and to request the resources they need based on immunisation programme needs and the current enabling environment.



References

See UNICEF 2018 Guidance for an introduction

See 2020 Landscape Analysis for background

Covered by this Guide for specific applications of geospatial data and technologies with complementary planning guide on the enabling environment

FIG. 2 Implementation roadmap for immunisation programme application of geospatial data and technologies including the geo-enabling environment. Adapted from [1].

An immunisation programme bottleneck is any gap or problem in the process of delivering immunisation programme services.

Step 1
The process begins with an assessment of the current gaps and priority bottlenecks within the immunisation programme. Investments in geospatial data and technologies are most effective when they address clear needs in the system and make progress towards the underlying mechanisms of change in immunisation programming as illustrated in the Theory of Change (Annex 1).

Step 2
Once the current needs and bottlenecks are understood, Figures 3 and 4 can be used to identify if and how an application of geospatial data and technology can address some, if not all, of these needs and bottlenecks.

Figure 3 shows how the eight applications described in this guide can help address common health system challenges which are listed according to the WHO classification [5]. Figure 4 provides an example linking bottlenecks experienced by an immunisation programme to specific geospatial data and technologies for immunisation.

It should be noted that not all immunisation programme needs and bottlenecks can be addressed with geospatial data and technologies. The process of identifying existing bottlenecks helps to ensure that any areas that can be improved with geospatial data and technologies are identified. It also guides investments to address existing needs in the underlying systems and programme priorities.

Step 3
When one or more relevant applications of geospatial data and technologies have been identified, an assessment of the enabling environment related to geospatial data and technologies (the "geo-enabling environment") will show if the foundation for successful implementation and sustainability are in place.

An assessment of the geo-enabling environment involves the identification and review of governance structures, policies, human capacity, procedures and protocols that will support sustainable integration of geospatial data and technologies into the immunisation programme. The 2018 UNICEF Guidance [1] provides practical information and tools to assess the geo-enabling environment and identify actions to make improvements.

This step is important to ensure that existing resources are being leveraged effectively to support the application of geospatial data and technologies and that a supportive enabling environment exists to sustain these applications for the long-term. It is important to recognise that not all elements of the geo-enabling environment will be fully developed before applying geospatial data and technologies to immunisation programming. Experience shows in many cases that early implementation experience with geospatial data and technologies are important to build the awareness and political support needed for strengthening the geo-enabling environment. In practical terms, this means that the process of improving the geo-enabling environment often happens in parallel with the implementation of geospatial data and technologies in sub-sectors of the health system. The results of this assessment will provide a starting point to guide investment and improvements in the geo-enabling environment and the integration of geospatial data and technologies.

Step 4
After completing Steps 1, 2 and 3, this guide can be used to support the development of a plan and budget. This guide is organised into three parts, all of which should be considered for a comprehensive planning and budgeting exercise:

Section 3: Considerations for planning each of the eight applications of geospatial data and technologies.

Section 4: Cross-cutting considerations that apply to all of the geospatial applications for immunisation programming.

Section 5: Considerations to improve the geo-enabling environment.

FIG. 3 Links between health system challenges and applications of geospatial data and technologies

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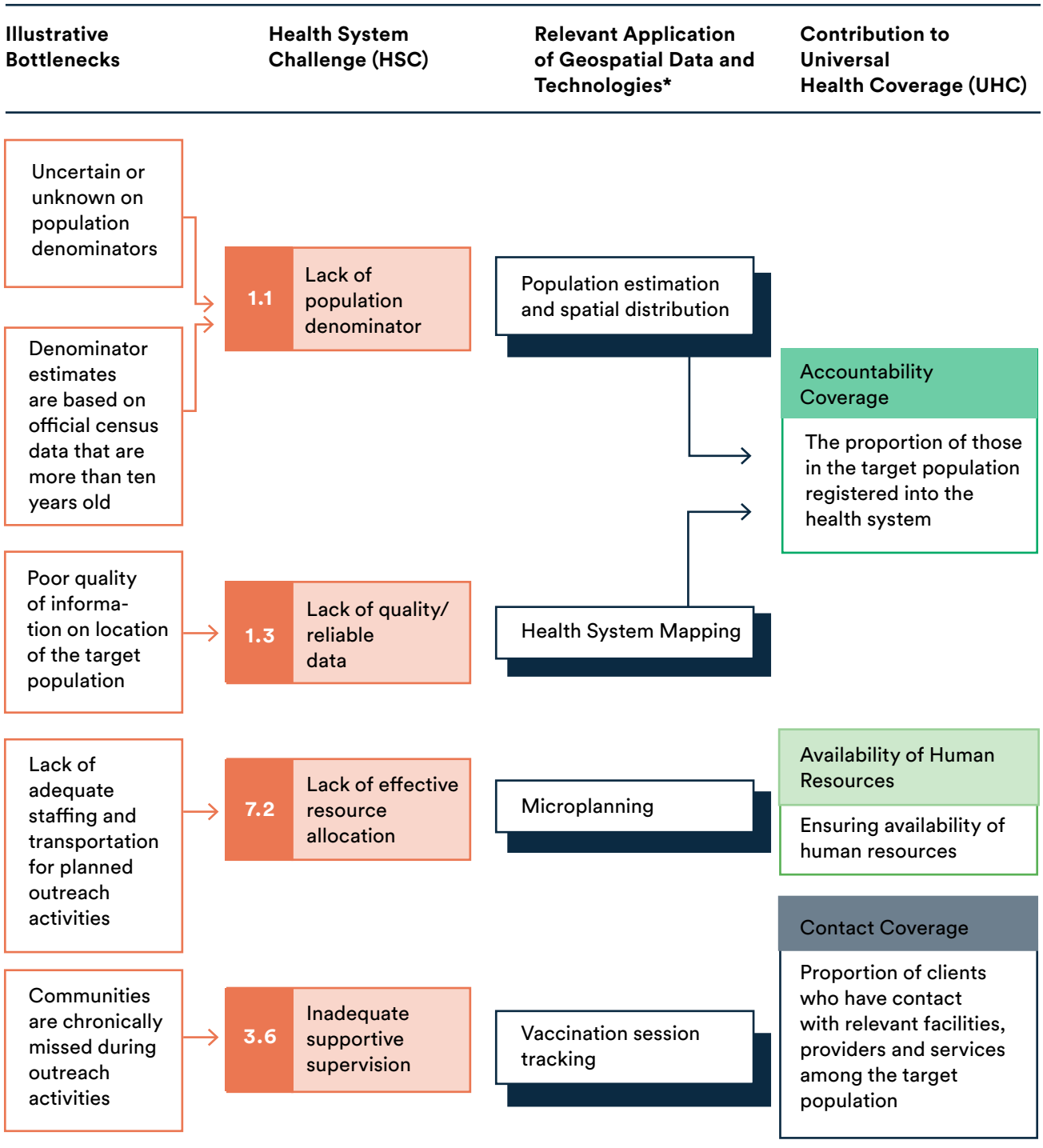

*These are not included in WHO guidelines or classification but provide appropriate functionality

FIG. 4 Example of the process of identifying bottlenecks, linking them to health system challenges, relevant immunisation applications of geospatial data and technology and universal health coverage (adapted from [6] fig 4.1.3)

Where to start?
Immunisation programmes that are just starting to consider geospatial data and technologies should begin with these foundations:

ONE

Conduct an **assessment of the geo-enabling environment** to understand the current state of supportive elements in the health system and the immunisation programme. Use the tools and assessment surveys in UNICEF's 2018 *Guidance on the Use of Geospatial Data and Technologies in Immunization Programs* to create a plan for improving the enabling environment. More information on creating a plan to strengthen the enabling environment is in Section 5 of this document.

TWO

If it has not been done or is out of date, begin with Health system mapping—the data, systems, partnerships and procedures established during **Health system mapping** will form the foundation for all other immunisation programme applications of geospatial data and technologies.

THREE

Assess the available population data - accurate and reliable population estimates for sub-national areas provide a foundation that will support other applications of geospatial data and technologies. If the available population data is not useful for immunisation planning purposes, begin planning for **Population estimation and spatial distribution** activities as described in this guide.

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Specific investment and planning considerations

This section aims to provide the person in charge of planning and fundraising with considerations specific to each of the applications of geospatial data and technologies identified to improve immunisation programme service delivery.

These applications can be powerful tools to address existing immunisation programme bottlenecks but should not be viewed as a quick-fix or a stand-alone technology project. They should be implemented in the context of a vision for strengthening the geo-enabling environment and cross-programme vision with a focus on local capacity building to strengthen in-country technical expertise and building systems for long-term impact (Section 5).

This section describes the objective of each prioritised immunisation use case, how each contributes to immunisation outcomes in Theory of Change, and specific considerations to guide the user in developing a plan for the specific application of geospatial data and technologies. Section 4 provides cross-cutting guidance on planning and budgeting for all of the geospatial data and technology use cases. A list of additional resources for each topic and general resources on geospatial data and technologies can be found in Annex 2 of this guide.

HEALTH SYSTEM MAPPING

Objective

Establish a process to support the standardisation and continuous collection, analysis and dissemination of information on the spatial distribution of geographic features pertaining to essential health resources and services, including health facilities, administrative and reporting boundaries, catchment areas and all health service delivery access points. Initial data collection is followed by the sustained monitoring of information related to all aspects of health services delivery access points.

Link to theory of change

Outputs: Improved identification of zero-dose and under-immunised children; Improved planning and allocation of immunisation resources; Improved service delivery. Health system mapping provides the foundation necessary to implement all of the other applications of geospatial data and technologies across all three pillars in the Theory of Change.

Specific considerations to plan health system mapping

This application of geospatial data and technology describes the geography of the health system by collecting information on the geographic location of features core to the immunisation and health programmes. These features include, but are not limited to, health-related infrastructure (health facilities, permanent and temporary vaccination sites, warehouses, pharmacies, cold chain and distribution centres) and health boundaries (health districts, catchment areas).

Additional data such as administrative boundaries and the geographic locations of inhabited settlements can be included. All of this information is stored and maintained in a Master List, the complete, up-to-date and uniquely coded list of all active and previously active records for a given type of feature (e.g. health facilities, villages, boundaries) that are officially curated by the appropriate agency.

The core geographic information collected in health system mapping activities, stored and maintained in Master Lists is an essential foundation necessary to implement the other applications of geospatial data and technologies discussed in this guide. The collection and management of these data are considered a key element of the enabling environment that will contribute to the sustainable and effective use of geospatial data and technologies for immunisation.

In addition to the general considerations detailed in Section 4 of this guide, health system mapping activities should consider the following:

- Health system maps and the resulting datasets are relevant across health sectors and other government agencies. Efforts should focus on gathering, coordinating and validating any existing data, followed by the coordination of new data collection efforts with partners and other agencies to complement and fill any gaps.
- Development of a consensus strategy to guide reporting structures and processes among partners will encourage and promote collaboration.
- Health system mapping requires strong collaboration, data sharing agreements and compatibility with cross-sector platforms to promote data sharing. Some data such as boundaries and public infrastructure may fall under agencies outside of the health sector.
- The platform or customised interface for managing and sharing data should be designed to fit the needs of key partners and incorporate built-in maintenance guidelines, procedures and systems for reporting and updating information.
- Mechanisms and procedures for end users and stakeholders responsible for data management and verification to report new data and update information should be established. These responsibilities can be incentivised or integrated as part of regular activities.
- Stakeholder workshops should include training and support for how to interpret and use data and reporting outputs in daily activities and decision-making processes.
- The number of district or health areas involved in the reporting and data collection process and their willingness to share and collaborate will have a strong impact on cost and timelines; local-level stakeholders should be involved in the analysis, interpretation and consolidation training workshops for best results and sustainability.
- If using geospatial data that are available in the open domain instead of from a government institution, consider exactly how the data will be used. Some data may be useful for operational purposes only (e.g. catchment area boundaries that are used for microplanning purposes) and may not be appropriate for reporting in official documents.

POPULATION ESTIMATION & SPATIAL DISTRIBUTION

Objective

The application of geostatistical models and Artificial Intelligence (AI) to estimate population count and distribution at high spatial resolution using data from remote sensing, household surveys or sampled census datasets. High-resolution population estimates support the measurement of programme targets, coverage and improved programme planning.

Link to theory of change

Output: Improved planning and allocation of immunisation resources. Optimised immunisation resources and location of services, reduced waste, and improved planning.

Specific considerations to plan population estimation and spatial distribution with geospatial data and technologies

An accurate count or reliable estimate of the total target population and distribution at sub-district levels will support the planning and monitoring of immunisation programme activities. If recent census data based on a complete enumeration of the country are available these are often the best choice for population estimates and denominators. If census data in the country are out-of-date or do not provide estimates at a sub-national or sub-district level, high-resolution population estimates can provide an alternate source of reliable denominators with distribution by operational units for immunisation programme planning and monitoring.

High-resolution population estimates are created with statistical modelling techniques using available population data. If the available population data are incomplete or outdated, additional data collection should be considered if financial resources are available and time allows. If no population data are available to support statistical modelling, existing population estimates or rapid modelling tools can be used to generate population estimates.

A reliable estimate of the target population at operational levels of immunisation programme planning (e.g. sub-district, health catchment areas) is an essential component to reaching effective vaccination coverage for all children by providing reliable denominators for planning, resource allocation and monitoring. The collection, creation, management and use of population estimates will support the sustainable and effective use of other geospatial data and technologies applications for immunisation described in this guide.

In addition to the general considerations detailed in Section 4 of this guide, population estimation and spatial distribution activities should consider the following:

- Advocacy efforts with stakeholders and partners are important to gain commitment on the use of population estimates for programme planning, service delivery and monitoring activities and to stress the value of generating population estimates for priority immunisation goals. Advocacy efforts should ensure that immunisation programme priorities are not sacrificed to other priorities.
- Establishing good relationships with agencies responsible for population statistics (e.g. National Statistical Office or other agency) are essential and should involve formal coordination mechanisms and strategies to share responsibilities, datasets and work towards common goals. Relationship building can be time consuming but cannot be avoided or rushed without putting the entire effort at risk.
- Any existing national population datasets, census or household survey datasets should be gathered, and a determination made if they are still representative and reliable. Data managers will need to assess several sources of data to decide which are the most appropriate for modelling based on available time and resources.
- After high-resolution population estimates have been created, work with other partners to identify future household surveys and other data collection activities (e.g. Demographic and Health Surveys (DHS), Multiple Indicator Cluster Surveys (MICS), census and other household surveys) to plan future model updates. Partners should develop a plan for coordinating activities to harmonise sampling design for data collection, share household survey and ancillary data as well as consult on quality assurance and monitoring procedures.
- Coordination agreements will ensure that the needs of all relevant stakeholders are met during sustained operations to update the high-resolution population estimates. Strong leadership and intelligent design choices will avoid fragmentation and competing updating mechanisms.

MICROPLANNING WITH GEOSPATIAL DATA AND TECHNOLOGIES

Objective

Using spatially accurate maps of the layout of health facility catchment areas, including the location of settlements, immunisation resources and other relevant geographic features to create geo-enabled operational plans for health facility and district-level immunisation service delivery planning and monitoring.

Link to theory of change

Output: Improved identification of zero-dose and under-immunised children. Contributes to increasing the number of children immunised by identifying all settlements in a given catchment area, optimizing catchment areas to avoid gaps or overlaps of services, identifying missed settlements, and optimizing service areas, workload and resources required for fixed, mobile, and outreach sessions based on realistic population estimates and locations of service delivery points and settlements. The availability of geographically accurate information has also proven to increase accountability and transparency of the microplanning process.

Specific considerations to plan microplanning with geospatial data and technologies

The application and use of spatially accurate maps for local level operational plans builds on a foundation of complete, up-to-date and geo-referenced Master Lists of immunisation service delivery locations, health and administrative boundaries and settlements as well as reliable population estimates for the areas of implementation. Refer to the Sections on Health system mapping and Population estimation and spatial distribution in Section 3 of this guide for more information on these foundational activities.

In addition to the general considerations detailed in Section 4 of this guide, microplanning with geospatial data and technologies should consider the following:

- Conduct a situational assessment to determine which microplanning tools will be most useful and appropriate at different levels of decision-making. These may be large-scale printed maps, digital platforms, mobile devices or a combination depending on capacity and infrastructure. The final map products need to be presented in a format that is easy to use and meets the local staff's needs and capacities. This could be a map indicating the location of the health facilities and settlements with suggestions of priority locations for outreach vaccination strategies in order to maximise the number of children covered or a computer dashboard that can generate multiple scenarios based on the desired outcome.
- Identify the approach, procedures and roles for the microplanning implementation process in cooperation with all stakeholders from the community to the district and central level and identify how the geospatial data management chain will align with current roles and capacity in the EPI.
- Any data that already exists should be gathered, including primary information from Health system mapping such as geolocated health facilities and vaccine storage facilities, vaccination outposts, population settlements, boundaries of health catchment areas, administrative and reporting divisions. Ancillary datasets not specifically under the mandate of the Ministry of Health can also support microplanning (road network, hydrography, areas with security/access issues, environmental or seasonal hazards such as flood zones and places of interest such as markets and mosques).
- Any use of existing data will require documentation of data usage rights. If usage rights are not clear, authorisation should be obtained and may require signing partnership and data-sharing agreements.
- If available, high-resolution geo-referenced and standardized satellite imagery can be used to derive building footprints and settlement layers to complement the information on the location of population settlements from Health system mapping and also provide better characterisation of the geographic spread of households within and between communities for more targeted microplanning. Develop partnerships with other programmes that may already have access to these images or negotiate directly with satellite data providers.
- Existing data on immunisation coverage in the area of interest can be incorporated into the process to help identify zero-dose populations or areas where efforts need to be intensified.

- Cooperate with community leaders, key informants and additional sources at the village level to obtain local-level population and settlement information. Local EPI staff should be included early in the process to provide authority, local knowledge and validate the collection of any additional geospatial data to fill any gaps or missing information on the geographic features in the catchment area.
- The microplanning team should work with local EPI and MOH staff to agree on the health catchment area boundaries in a participatory meeting. Local resources from the EPI (past microplans with lists of villages and hand-drawn sketches) can be used alongside high resolution images or derived products such as building footprints or aggregated settlement layers to make sure every village and hamlet is accounted for. The drawing of health area catchment boundaries can benefit from the use of automated spatial analysis techniques, such as using geographic accessibility modelling to identify geographic areas within a given travel time to health facilities (see the Section on Geographic accessibility modelling for more information). The extent of these areas can then inform participatory delineation and validation of the health area catchment boundaries with local EPI and MOH staff.
- New data collection must assign a unique identifier (code) for all health facilities, vaccination delivery sites, cold chain facilities and settlements during data collection and these should ideally match the official codes used in the Master Lists. Relying on names is difficult as there are often different spellings or disagreement on official names of health centres or settlements.

DISEASE SURVEILLANCE WITH GEOSPATIAL DATA AND TECHNOLOGIES

Objective

To establish a system for the collection and analysis of geolocated data on disease incidence to identify and respond to real-time reports of vaccine-preventable disease (VPD) or adverse events following immunisation (AEFI).

Link to theory of change

Output: Improved service delivery. Improves immunisation programme rapid problem identification and the ability to respond to outbreaks of VPD or AEFI; facilitates information sharing and coordination for targeted action; contributes to optimised distribution of immunisation programme resources and services.

Specific considerations for planning disease surveillance with geospatial data and technologies

The timely collection of geolocated reports on suspected vaccine-preventable diseases or AEFI linked to a geographically coded health facility or community can support high-risk countries in outbreak preparedness and response. Disease surveillance systems enhanced with geospatial data builds on the foundation of Master Lists with geospatial data on immunisation service delivery units and settlements (see Health system mapping for more information).

In addition to the general considerations detailed in Section 4 of this guide, disease surveillance with geospatial data and technologies should consider the following:

- Collaboration and sharing should be supported across all stakeholder groups with governance structures, advocacy and coordination agreements on the collection, management and use of disease surveillance data.
- Common geographic datasets (population estimates and distribution, microcensus data and satellite imagery) can enhance disease surveillance by providing information on missed communities that need enhanced polio-related acute flaccid paralysis (AFP) surveillance and other VPD surveillance, especially in inaccessible or security compromised high risk areas.
- Disease surveillance reporting should feed into an established reporting structure with data sharing capabilities for decision-makers to coordinate response, provide supportive supervision, and predict potential hotspots.
- Disease surveillance systems may integrate data from individual case investigations such as the patient's place of residence and place of work in order to identify and notify new areas of possible disease spread.
- Disease surveillance systems can feed into cross-border and international reporting bodies (e.g., POLIS for polio reporting) for coordination and response.

VACCINATION SESSION TRACKING

Objective

To provide highly accurate geographic coverage data or evidence on the areas visited by vaccination teams during house-to-house campaigns or planned routine immunisation outreach visits as part of a facility-level microplan. Vaccination session tracking uses mobile phones or tablets with global position tracking to improve reporting of vaccination session completeness and performance.

Link to theory of change

Output: Improved service delivery. Helps programme managers identify missed settlements and provide rapid corrective action to improve immunisation coverage and increase quality and timeliness of services.

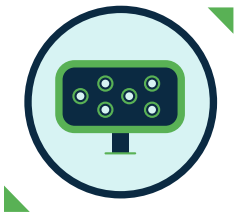
Specific considerations to plan vaccination session tracking

The tracking of supplemental immunisation activities and routine outreach visits should be considered in situations where house-to-house campaigns require highly accurate coverage data or evidence of areas covered as part of a health facility vaccination microplan. A system to track vaccination sessions can help managers make certain that vaccinator teams visit all neighborhoods, settlements and hard-to-reach areas.

A key foundation that is required to implement a vaccination session tracking system is an accurate and validated microplan with geospatial data and technologies for the health area of interest (see the Microplanning section of this document for more information). The combination of operational microplans and the ability to track vaccination outreach sessions can help programme managers identify missed settlements and provide rapid corrective action to improve coverage.

In addition to the general considerations detailed in Section 4 of this guide, vaccination session tracking activities should consider the following:

- Vaccination session tracking and monitoring requires specialised equipment (e.g. global positioning-enabled smartphones, solar chargers for areas where phone batteries cannot be recharged daily) and a data plan for automated data uploads and transmission. These can be significant cost drivers if resources are not locally available. If vaccination team members can use their own smartphone project costs can be reduced. A volume discount from local telecommunications providers may be negotiated to help control costs.
- Open-source applications or platforms can host the session tracking data, or a local server can be used if available. Packaged data management applications may be available at no cost with relevant training materials.
- Since session tracking is normally part of a scheduled vaccination campaign or activity, implementation must be aligned and co-planned with these activities.



CAMPAIGN MONITORING

Objective

To provide near real-time data during vaccination campaigns using geospatial technology to assess daily coverage, vaccine supplies and stockouts, and monitor team performance.

Link to theory of change

Output: Improved service delivery. Near real-time monitoring of immunisation campaign activities can improve timeliness, completeness and efficiency of campaigns and enables supervisors to respond with rapid corrective action during campaign activities, contributing to overall improved immunisation service delivery.

Specific considerations to plan campaign monitoring with geospatial data and technologies

Monitoring of vaccination campaigns using geospatial technology uses a customised data collection form for the immunisation campaign staff to record their location and vaccine stock at the beginning and end of each day. They also enable tracking of AEFI reports and the daily tally for each antigen delivered. The information is then consolidated into a data management system or platform for data visualisation and sharing.

In addition to the general considerations detailed in Section 4 of this guide, campaign monitoring activities using geospatial data and technologies should consider the following:

- A smartphone and a data plan for automated data uploads and transmission for each vaccination post are the main cost drivers. In some situations, EPI managers or supervisors can use their own smartphone which greatly reduces the project cost. A volume discount for data plans from local telecommunications providers may be negotiated. Solar chargers may be needed for areas where phone batteries cannot be recharged daily.
- Vaccination teams will need training on using the digital data collection forms for appropriate and timely reporting.
- Local technical capacity to create digital forms and a local server to host the data are ideal. These can be outsourced if needed.
- The resulting data should be made available and presented in a format that is useful for managers to monitor daily activities, take action and for post-campaign analysis.

GEOGRAPHIC ACCESSIBILITY MODELLING

Objective

Modelling the physical accessibility of health care services to quantify the movement opportunity for people to reach existing health services and help identify areas and populations with limited geographic access to immunisation services. This informs locally-appropriate solutions to improve coverage, expand service outreach and improve planning and resource allocation.

Link to theory of change

Output: Improved planning and allocation of immunisation resources. Contributes to optimised planning and distribution of resources based on more accurate identification of gaps in coverage and immunisation service accessibility.

Specific considerations to plan geographic accessibility modelling

The travel time or distance between target populations and immunisation services is an important factor in access and uptake of services. Country programs may choose to follow global guidelines or establish locally-appropriate parameters on the maximum time it should take a caregiver to reach the nearest immunisation service delivery unit. These parameters can help determine the need for additional posts, outreach sessions or mobile immunisation service delivery to optimise accessibility.

Some datasets are needed to start geographic accessibility modelling activities. These include information from Health system mapping such as geolocated health facilities, vaccination outposts, settlements, boundaries of health catchment area, administrative and reporting divisions, as well as additional datasets to characterise accessibility such as digital elevation models, land cover data, road networks, river networks, barriers to movement (such as seasonal flooding, difficult terrain and public transit networks, for example). It also requires Population estimation and spatial distribution data.

In addition to the general considerations detailed in Section 4 of this guide, geographic accessibility modelling activities should consider the following:

- The availability, quality and sharing agreements to access existing datasets will have a significant impact on the timeline during development and set-up. The task of gathering existing data can be time consuming (1 to 6 months) and should begin as soon as possible so that data gaps can be identified to plan for any new data collection activities. Some data may be incomplete and will require dedicated field work to fill the gaps.
- Delineation and validation of health area boundaries may come up during the process of gathering datasets and can have an impact on timelines if a complete Health system mapping is not available for the area of interest.
- Extraction, cleaning and validation steps will always be needed before existing datasets can be used for geographic accessibility modelling.
- Sub-national participatory workshops can help gather information from participants on local factors such as care-seeking behaviours, modes and speed of transportation, seasonal or permanent barriers to movement and the quality of roads in the area of interest. These workshops can also provide an opportunity for capacity building and practical knowledge on geographic accessibility modelling and geospatial data and technologies.
- A dedicated capacity building workshop on accessibility modelling (using AccessMod or other free, open-source software) can inform a review of all existing geospatial data for the implementation area and address errors and gaps. The workshop can make use of any existing literature on accessibility and modes of transport in the area and add additional participant input on travel scenarios.
- A national working group in charge of managing accessibility modelling can help the programme. It should prioritise cross-agency and cross-ministry representation as well as participation from academic groups.

VACCINATION COVERAGE MODELLING

Objective

To support the availability of information on subnational disparities in immunisation coverage and the number of unvaccinated children in different geographic areas, population groups and socio-economic status. This is obtained by geostatistical modelling of nationally representative survey data and triangulation with routine immunisation data, and ancillary information on population distribution and socio-economic characteristics.

Link to theory of change

Output: Improved planning and allocation of immunisation resources. Contributes to optimised distribution of immunisation resources by identifying geographic areas with poor coverage to target services to those areas. When combined with socioeconomic indicators, equity mapping can help identify underlying reasons for non-vaccination and suggest solutions to increase equity and contribute to overall improved planning and resource allocation.

Specific considerations for planning vaccination coverage modelling

Modelled estimates of immunisation coverage should be presented at the level of district, sub-district or health catchment area in order to be used for programme planning. Up-to-date and validated health area boundaries such as those created during Health system mapping are required.

In addition to the general considerations detailed in Section 4 of this guide, Vaccination coverage modelling using geospatial data and technologies should consider the following:

- Form partnerships with local service providers, technical universities or national agencies with experience and capacity in geostatistical modelling activities.
- Existing data sources for the area of interest need to be gathered. These include national immunisation coverage data with geographic coordinates from relatively recent surveys (e.g. DHS, MICS or EPI surveys). Modelled estimates of immunisation coverage may already be available from other sources.
- Modelled estimates generated from surveys can be triangulated with routine administrative data of immunisation coverage. This requires careful matching between the health reporting areas used by the routine administrative system and the health area boundary datasets, so that modelled and routine data can be matched and their similarities assessed.
- The number of unvaccinated (or under-vaccinated children) can be mapped by combining the modelled estimates of immunisation coverage with population distribution estimates (either from census information or from Population estimation and spatial distribution activities described in this guide).
- Modelled estimates of immunisation coverage can be combined with available socio-economic status information (from censuses, DHS or other surveys) for equity mapping to help identify possible underlying barriers to immunisation and suggest solutions to increase equity.
- Develop capacity training programmes for EPI managers and other stakeholders to understand the utility of modelled coverage estimates and how they can support decision-making. The datasets and modelled estimates should be incorporated into the existing HIS to improve uptake by EPI managers for use in planning exercises. Whenever possible, invite local stakeholders to participate in and inform the modelling process.

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General planning, budgeting and timeline considerations

The following general planning, budgeting and timeline considerations should be used to prepare a multi-year project plan, budget, and funding request for the sustainable integration of the identified applications of geospatial data and technologies into the immunisation programme. In order to plan effective and sustainable interventions or applications, it is recommended that the costs across all phases and supporting activities in the project cycle are considered, not just the cost of new equipment or a budget for pilot project implementation.

Phases and planning and budgeting activities

PHASE 1	**Development and set-up** Prepare and assess, design the intervention or associated application, make plans for data quality, interoperability and sharing, establish partnerships, advocacy efforts and team building activities, identify equipment and software needs, initiate purchasing process, plan for monitoring and evaluation
PHASE 2	**Deployment** Implementation begins (pilot project or full-scale), conduct end user testing, document and make refinements and improvements based on implementation experiences
PHASE 3	**Integration and interoperability** Continuous review and updating for interoperability of geospatial data with national spatial data infrastructure and governance, integration of health content or geospatial technology with the Health Information System (HIS)
PHASE 4	**Scale** Expand the reach of the intervention or associated application based on pilot project experiences, consider future end users and invest in long-term assets, including human resources
PHASE 5	**Sustained operations** Recurring costs, monitoring and evaluation activities, ongoing data management procedures, sharing lessons and experiences (documentation), periodic update of geospatial data, maintenance and replacement of equipment and software, refresher training for end users, collection or acquisition of additional geospatial data

The phases align with the WHO's Digital Implementation Investment Guide (DIIG) recommendations for developing a plan and budget for sustainable implementation of digital health interventions [6]. The table highlights the common activities that project managers should consider when preparing and planning for any of the applications of geospatial data and technologies discussed in Section 3 of this guidance. The headings and titles within each phase of implementation are not meant to indicate a sequence or order of operations—within each phase the activities and processes may occur at the same time or in a different order. However, it is recommended that all of the activities in each phase should be considered and completed before moving on to the next phase. Some of these may be done concurrently or may not be necessary depending on the context.

GENERAL PLANNING CONSIDERATIONS	GENERAL BUDGET CONSIDERATIONS	GENERAL TIMELINE CONSIDERATIONS
Phase 1: Development and set-up		
• **Needs assessment:** understand the needs of the programme and inform planning of activities to implement the application within the immunisation programme. • **Establish standard operating procedures (SOPs) for data collection and management:** a set of guidelines and specifications to describe the requirements and standards for data collection. These include resolution, accuracy, format, parameters, etc. • Establish principles and procedures for data updates and management. • **Workflow assessment:** Understand how the application of geospatial data and technologies will address specific bottlenecks in the day-to-day progression of activities and how it will fit into existing decision-making mechanisms and decision points for managers and end users. A better understanding of the end user's needs and data-use culture will help design the process and improve the usability of the final data products.	**Up-front costs** • Consultant(s) or Full-time equivalent(s) to support the assessment process and the development of principles and procedures • Travel costs and per-diem for assessments	Main timeline drivers in this phase will be the level of local political support and awareness and consequently the time required to mobilise in-country actors.

GENERAL PLANNING CONSIDERATIONS	GENERAL BUDGET CONSIDERATIONS	GENERAL TIMELINE CONSIDERATIONS
Gather data • **Gather existing data sets:** Depending on the application of geospatial data and technologies, it is important to identify any data that may already exist. Strong relationships with partnering organisations, other sectors, Ministries, and data collection units within the government will help identify and gain access to these data. • **Validate data and identity data and programme needs and gaps:** If available data are not adequate, identify specific needs for data completion (e.g. new data collection or data improvement) and opportunities to collaborate on new data collection. • **Develop data sharing agreements and ensure interoperability** of data sharing platforms between health and other sectors.	**Up-front costs** • Consultant(s) or Full-time equivalent(s) to support the assessments • Travel/per-diem as applicable	• Gathering existing data, obtaining authorisation to use and share it, as well as making it usable for the desired intervention can be time consuming. Gaps are likely to exist so the data assessment should be completed early to plan for the level of new data collection that will be required in later phases. • Although some household survey data can be accessed through dedicated user portals (e.g., DHS, MICs), access to other household survey data can be complicated by restrictive confidentiality protection measures or insufficiently clear confidentiality protection requirements. Start assessing those measures early and make improvements where appropriate. Obtain ethics board approval and start discussing data sharing agreements as early as possible. • Local bodies/agencies may not always be open to data sharing; establishing these relationships and agreements can take time. • Data compatibility should be considered and tested carefully to avoid incompatibility roadblocks later that may negatively impact cost and timelines.

GENERAL PLANNING CONSIDERATIONS	GENERAL BUDGET CONSIDERATIONS	GENERAL TIMELINE CONSIDERATIONS
• Select and set-up the appropriate geospatial technologies and equipment • Identify and, if necessary, customise digital technology/platforms for data collection, data analysis, data sharing, and data use. • Purchase necessary hardware and software: based on identified needs and gaps identified during assessments. • Ensure that data collection tools, procedures and format are compatible with national HIS or other data-sharing platforms. • Ensure necessary connectivity: field data collection, data entry at immunisation delivery points will need a data plan to send information, power or solar chargers for handheld data collection devices. • Obtain necessary authorisation for data collection, storage and use: local regulations may limit or restrict collection, access and use of household-level, demographic, microcensus data. Obtain ethics board approval from relevant agencies and be sure to understand the privacy regulations and permission to proceed.	**Up-front costs** • Consultant(s) or Full-time equivalent(s) to support the identification and customization of technology platforms, data collection forms, SOPs, ensure interoperability and manage data sharing agreements • Equipment (number and type of hardware required). If field data collection activities are planned, determine if data collectors/vaccinators can use their own personal global positioning system (GPS)-enabled mobile phones. Allocate resources for periodic updates, maintenance and replacement. **Recurring costs** • Software licensing and updates—explore open source options (e.g. ODK, QGIS) • Data plan to be negotiated with local providers • Power to be negotiated with local providers	• Procurement of necessary equipment and hardware can be a lengthy process given the potentially large size of the investment, so start the procurement process as soon as needs are well defined. • Procedures, forms and training materials for data collection need to be translated into the local language —allow time for translation and testing of data collection and training tools.

GENERAL PLANNING CONSIDERATIONS	GENERAL BUDGET CONSIDERATIONS	GENERAL TIMELINE CONSIDERATIONS
Project planning and organisation • **Stakeholder coordination and advocacy workshops:** Bring together all stakeholders at appropriate levels to co-develop the workplan for pilot phase implementation with clear timelines, accountability mechanisms, equipment and infrastructure needs and establish partnership mechanisms and ensure that the benefits of geospatial applications to the achievement of immunisation goals and other health goals are well understood and supported at the highest possible level. • **Capacity building** Develop a plan and conduct capacity building depending on needs identified in the assessment. • **Develop Monitoring and Evaluation (M&E) plan** Create a plan and allocate necessary resources to monitor implementation and assess impact of effective use of the applications of geospatial data and technologies on the performance of immunisation programme throughout the life of the project.	**Up-front costs** • Consultant(s) or Full-time equivalent(s) to support stakeholder workshops, capacity building, workplan development and M&E planning • Training and workshop costs: workshop materials, per diem, venue, catering and local transportation costs	• The concerned stakeholders might not all be available at the same time. • The initial level of expertise in the management and use of geospatial data and technologies might vary among stakeholders and between levels, requiring time for more training sessions than initially planned.

GENERAL PLANNING CONSIDERATIONS	GENERAL BUDGET CONSIDERATIONS	GENERAL TIMELINE CONSIDERATIONS
Phase 2: Deployment and implementation		
• **Capacity building:** at the sub-national level for end users of final data/map products. Capacity building/training workshops should focus on the identified needs and workflow assessment of the immunisation programme managers and intended end users of the final data products to support daily activities and decision-making. • **Define data ecosystem and specification, extraction, cleaning validation of existing data.** • **Training of implementation teams** (e.g., field data collectors, vaccinators): for targeted data collection to fill identified gaps or tracking of immunisation activities and events with geospatial technologies. • **Data collection / implementation:** Depending on the application of geospatial data and technologies, data is collected through organised field activities or as part of routine daily activities at immunisation delivery locations. • **Validation of output information products** (such as thematic maps, dashboard visualisation, baseline datasets generated through implementation and data collection) with local stakeholders and users, in order to assess their suitability of format and content. Create maps in a format that is useful and accessible for the end users. This may require collaborative workshops with EPI managers and local leaders. • **Establish lines of communication and technical support:** Create troubleshooting and support mechanisms with internal staff champions such as the MOH geospatial data management unit which can provide expert support as needed • **M&E activities:** Carry out established M&E plan, collect evidence and data on the process, successes, lessons and areas for improvement and scale-up. • **Document lessons, challenges and necessary adjustments for future expansion/sustained operations:** Share pilot phase experiences with stakeholders, other sectors and partners	**Up-front costs** • Consultant(s) or Full-time equivalent(s) to support workshops, develop workshop and training materials, conduct staff training, capacity building, data extraction, data collection, data cleaning, technical oversight, M&E activities, documentation • Training and workshop costs: per diem, venue, catering and local transportation costs • Size, number and type of data collection activities will impact cost (number of people to train, Covid-19 personal protective equipment (PPE), per-diems, travel costs, equipment, data plan, power, etc) **Recurring costs** • Data plan • Data storage • Power • Software licensing renewal • Technology infrastructure/hardware maintenance/ replacement • Printing costs	• The final phase of integrating sub-national results/ data into a final national output can be technically challenging. Allow time to cross-check and gather input from experts in close collaboration with the core GIS team. • When additional field-based data collection is undertaken it is crucial that local-level health area managers participate in data validation and data updates. They need to have confidence in the data, and they are in the best position to make the necessary observations. Often such observations can be carried out with very little additional effort as part of routine operations. • Data collection activities should include risk assessment for insecure areas. SOPs for field travel and data collection should include measures to manage risk to data collectors. If fieldwork is not possible in some areas due to inaccessibility or risk, participatory mapping exercises using satellite imagery may be leveraged to fill in the gaps.

GENERAL PLANNING CONSIDERATIONS	GENERAL BUDGET CONSIDERATIONS	GENERAL TIMELINE CONSIDERATIONS
Phase 3: Integration and interoperability		
• Integrate datasets/maps into HIS or other digital health information system for data sharing. • Operationalise principles and procedures for data updates and management. • Establish principles, procedures and conduct training to integrate and promote the use of geospatial data into immunisation programme decision- making workflow: develop and promote a community of practice around data-driven decision-making. • In preparation for scaling, conduct a review and assessment of processes, procedures, management and activities involving all stakeholders: identify barriers, end user acceptability, usability, identify adjustments and strategies to address issues for expansion as well as a financial assessment of early project activities to inform scale-up plans. • Develop detailed plan, strategy and budget for scale-up/sustained operations.	**Up-front costs** • Consultant(s) or Full-time equivalent(s) to provide technical oversight, support training, integration, procedures and review processes • Training and workshop costs: per diem, venue, catering and local transportation costs **Recurring costs** • Data plan • Data storage • Power • Software licensing renewal • Technology infrastructure/hardware maintenance/ replacement	• Sorting out integration and interoperability can be difficult and time consuming. Devote sufficient effort to ensure it does not become a bottleneck. Make sure there is high-level support for making progress to add incentives to find practical solutions. • Integration and interoperability of workflows, SOPs, tracking, reporting, data collection and monitoring systems at the most local level is crucial to success and takes time. It requires careful coordination beginning at the earliest stages and continued throughout.

GENERAL PLANNING CONSIDERATIONS	GENERAL BUDGET CONSIDERATIONS	GENERAL TIMELINE CONSIDERATIONS
Phase 4: Scaling		
• **Implement scale-up plan:** based on experiences and adjustments in pilot phases and from broader experiences in other countries. • **Ongoing capacity building at national/central and sub-national levels:** to maintain and improve operations within a dedicated GIS team and immunisation programme managers involved in geospatial data management and use • **Data is regularly updated, verified, analysed, disseminated and shared to other relevant information systems.** • **Promote the use of data/maps to support and inform vaccination planning and decision-making at all levels (district, national, provincial).** • **Document and share experiences and new data/maps:** across sectors and with other partners. • **M&E activities:** to measure progress, identify problems, and strengthen scale up activities.	**Up-front costs** • Consultant(s) or Full-time equivalent(s) to support technical oversight of scale-up plan, training/capacity building, documentation and M&E activities. • Additional hardware/software for scaled-implementation plan • Training and capacity building workshop costs: per diem, venue, catering and local transportation costs **Recurring costs** • Data plan • Data storage • Power • Software licensing renewal • Technology infrastructure/hardware maintenance/replacement • M&E activities	• Scaling can quite easily run into time-consuming bottlenecks. Clear documentation of methods helps avoid delays in the scaling process. • Documentation of the benefits, evidence and impact that are widely shared can help avoid bottlenecks. The more the value of geospatial data and technologies is understood the greater the incentive to find practical solutions. • Phased regional scaling approach should be considered depending on the size of the country, to allow for ongoing development of local capacity and establishment of internal processes for data collection, management and use
Phase 5: Sustained operations		
• **Provide regular refresher training/ongoing capacity building.** • **Create and implement maintenance and updating plans for software, hardware, infrastructure.** • **Implement mechanisms and processes so data is regularly updated, verified, analysed, disseminated and shared with other relevant information systems.** • **M&E activities:** conduct a comprehensive evaluation to understand the effectiveness of the programme as designed and opportunities for making changes based on new technologies and insights.	**Recurring costs** • Consultant(s) or Full-time equivalent(s) to support technical oversight of sustained operations and M&E activities, including comprehensive evaluation • Ongoing capacity building/training • Data plan • Data storage • Power • Software licensing renewal Technology infrastructure/hardware maintenance/replacement • M&E activities	

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Considerations for the geo-enabling environment

This guide is intended to help managers plan for the implementation of specific applications of geospatial data and technologies in immunisation programmes. The use cases represent an opportunity to contribute to the long-term efficient and sustainable management and use of geospatial data and technologies not only for the immunisation programme but for other health programmes as well.

The long-term sustainability of these applications will depend on the availability of the necessary enabling environment. The elements that compose the enabling environment have been captured in the HIS geo-enabling framework developed by the Health GeoLab Collaborative [7] and used as reference by UNICEF when developing the geo-enabling framework for the immunisation programme as part of the 2018 UNICEF Guidance [2].

To complement the 2018 UNICEF Guidance that provides a structured way to identify, plan and improve missing or critical elements of the geo-enabled framework, the table below provides more details on the costs and timeline drivers to strengthen these elements when developing a plan and budget alongside any of the specific interventions described in Section 3. The order in which these elements are built and improved will depend on the local context, priorities and resources available. Many can be strengthened and built in parallel with the implementation of applications for immunisation programming.

COST AND TIMELINE DRIVERS FOR ACTIVITIES AIMED AT STRENGTHENING THE GEO-ENABLING ENVIRONMENT

Vision, strategy and plans

Main triggers that will be conducive of the activities in this area:
1.1 The importance of geospatial data and technologies is recognised across several programmes and there is a willingness to sustain related activities for the long term.
1.2 There is a need for the immunisation programme to sustain their geospatial data and technology related activities.
1.3 Same as 1.2 with a cross-programme vision, strategy and plans that have already been established.

Benchmarks (i.e. the situation to be ultimately achieved for the sustainable use of geospatial data and technologies in the immunisation programme):
1.1 The MOH has a vision, strategy, and plans regarding the management and use of geospatial data and technologies.
1.2 The immunisation programme has a vision, strategy and plan regarding the management and use of geospatial data and technologies.
1.3 The vision, strategy and plan of the immunisation programme is aligned to those in the MOH.

Anticipated potential activities to achieve benchmarks (Single cost/ Recurrent cost):
- Organisation of advocacy, coordination and dissemination activities (workshops and materials) to sensitise MOH stakeholders on the requirements for sustainable integration of geography in health information systems (recurrent)
- Advisor with expertise on implementation of geospatial data and technologies in health systems to support the development of the vision, strategy and plans (Single cost)
- Consultation meeting to develop, review and agree upon the vision, strategy and plans (Recurrent)

Main timeline drivers
- Level of commitment and support in existing management
- County specific health strategy/plan formulation cycle
- Current political and security context
- Current public health priorities
- Presence of a local champion in the health sector
- Amount of travel and meetings required for buy-in, coordination and approval

Main budget considerations
- Amount of travel and meetings required for buy-in, coordination and approval
- Translation to local language of training material and during workshops, if required
- Fee of advisor or consultant with expertise in implementation of geospatial data and technologies in health systems
- Existing strategies, plans and policies

COST AND TIMELINE DRIVERS FOR ACTIVITIES AIMED AT STRENGTHENING THE GEO-ENABLING ENVIRONMENT

Governance structure

Main triggers that will be conducive of the activities in this area:
2.1 There is a need to discuss and agree upon issues aimed at ensuring the quality of geospatial data and the cost-effective use of geospatial technologies within the health sector.
2.2 The issues that need to be addressed concern all the stakeholders from the public health sector.
2.3 A National Spatial Data Infrastructure (NSDI)-like forum does exist or is in the process of being established in the country.

Benchmarks (i.e. the situation to be ultimately achieved for the sustainable use of geospatial data and technologies in the immunisation programme):
2.1 The MOH has established a governance structure to handle issues pertaining to geography, geospatial data management and geospatial technologies.
2.2 All of the health programmes, including immunisation, as well as the MOH development partners using geospatial data and technologies are involved in this structure
2.3 The MOH is on the board of the NSDI.

- Anticipated potential activities to achieve benchmarks (Single cost/ Recurrent cost):
- Organisation of activities (meetings/workshops) to advocate for creation and participation in the governance structure (e.g. a technical working group, committee or similar) (Single cost)
- Consultancy to support the creation of the Terms of Reference (ToR) and workplan of the governance structure (e.g. a technical working group, committee or similar), and organise meeting agendas (Single cost)
- Convening regular meetings of the governance structure (Recurrent)
- Nominated MOH focal point to attend the NDSI meetings (Recurrent)

Main timeline drivers
- Level of commitment and support in existing management
- Presence of a local champion in the health sector
- Stakeholder availability
- Level of trust among stakeholders
- Urgency to address common issues
- Presence of an operational NSDI

Main budget considerations
- Number of stakeholders that need to be involved in the governance structure
- Amount of travel and meetings required
- Translation of advocacy and workshop materials to local language, as required
- Fee of advisor with expertise on implementation of geospatial data and technologies in health systems

COST AND TIMELINE DRIVERS FOR ACTIVITIES AIMED AT STRENGTHENING THE GEO-ENABLING ENVIRONMENT

Technical capacity

Main triggers that will be conducive of the activities in this area:
3.1 The use of geospatial data and technologies has reached a level within the health sector that would benefit from a central level geospatial data management unit.
3.2 The intervention that is being implemented by the immunisation programme requires a certain level of technical capacity and expertise within the MOH or accessible to the MOH (e.g. through external partnerships with technical institutes, Universities, NGOs, centres of excellence or other national agencies) related to the management and use of geospatial data management and technologies.

Benchmarks (i.e. the situation to be ultimately achieved for the sustainable use of geospatial data and technologies in the immunisation programme):
3.1 The MOH has a central level geospatial data management unit with enough technical capacity to: a) ensure guardianship over the defined guidelines, standards and protocols; b) support the development, maintenance, regular update and sharing of the Master Lists for the geographic objects core to public health and immunisation; c) support the implementation of the guidelines, standards, protocols and registries in all the health programmes and information systems; d) provide GIS services to HIS units and beyond, as needed.
3.2 The immunisation programme has access to enough technical capacity and expertise for immunisation specific geospatial data collection, extraction, management, analysis, and visualisation.

Anticipated potential activities to achieve benchmarks (Single cost/ Recurrent cost):

- Organisation of trainings on geospatial data collection, extraction, management, analysis, or visualisation for health staff involved in the application of geospatial data and technologies (as required by specific application) (Recurrent)
- Organisation of initial and refresher trainings for data manager/GIS technicians at central level geospatial data management units (if one is established, or else the personnel with a mandate over geospatial data management belongs to a relevant data management unit) (Recurrent)
- Participation of data manager/GIS technician to conference/events for continued training (Recurrent)
- Establishment of partnerships to source technical capacity or training support for the MOH (e.g., technical institutes, Universities, NGOs, Centres of Excellence or other national agencies) (recurrent)

Main timeline drivers

- Existing technical capacity and skills within the MOH
- Conducive MOH organisational structure (natural host for the central level geospatial data management units)
- Specific timeline of the application of geospatial data and technologies to be supported
- In-country presence of capacity building institutions (e.g. Universities)
- Availability of the staff to be trained

Main budget considerations

- Existing technical capacity gaps
- Amount of travel required for training
- Gaps in existing training materials and curriculum
- Scale and frequency of training needed
- Number of people to be trained
- Ongoing salary of data manager/ GIS technicians at central level geospatial data management units
- Cost of partnerships with technical institutes or other national agencies
- Training costs (venue, equipment, stationary)
- Equipment used during the training (Global Navigation Satellite System (GNSS)-enabled devices, laptops with the GIS software)
- Good internet access if web-based tools or data are being used
- Venues for trainings
- Training fee for
- facilitators/GIS expert
- Training facilitator
- Transportation and lodging cost

COST AND TIMELINE DRIVERS FOR ACTIVITIES AIMED AT STRENGTHENING THE GEO-ENABLING ENVIRONMENT	
Data specifications, standards and protocols	
Main triggers that will be conducive of the activities in this area: 4.1 The need to improve the quality of geospatial data and the cost-effective use of geospatial technologies has been recognised within the health sector, in particular with regards to the application of geospatial data and technologies to be costed. 4.2 A NSDI-like forum does exist or is in the process of being established in the country.	**Main budget considerations** • Number of stakeholders needed to be involved during the consultation • Amount of travel and meetings required • Translation if required • Fee of consultant with expertise on the identification or adaptation of health-related geospatial data and technologies specification, standards and protocols to support the application of geospatial data and technologies
Benchmarks (i.e. the situation to be ultimately achieved for the sustainable use of geospatial data and technologies in the immunisation programme): 4.1 Data specification, standards and protocols have been defined by the MOH and are being used across all the programmes, including immunisation, and relevant partners. 4.2 The specifications and standards followed by the MOH are aligned with those promoted by the National Spatial Data Infrastructure (NSDI).	
Anticipated potential activities to achieve benchmarks (Single cost/ Recurrent cost): • Organisation of activities for identification and agreements on data specification, standards and protocols (workshops) (Single cost) • Provide technical support to programmes to implement the defined specifications, standard and protocols (recurrent)	
Main timeline drivers • Level of commitment and support of the managerial level • County specific health strategy/plan formulation cycle • Current political and security context • Current public health priorities • Presence of a local champion in the health sector • Amount of travel and meetings required for buy-in, coordination and approval	

Master lists and common geo-registry

Main triggers that will be conducive of the activities in this area:
5.1-5.2 The immunisation programme plans to use geospatial data and technologies as part of the intervention.
5.3-5.4 There is a need to maintain and regularly update the Master Lists of specific geographic objects to sustain specific applications of geospatial data and technologies.
5.5 There is a willingness to ensure consistency across all the information systems used by the health sector.

Benchmarks (i.e. the situation to be ultimately achieved for a sustainable use of geospatial data and technologies in the immunisation programme):
5.1 The types of geographic objects (e.g. health facilities, administrative divisions, health areas, villages) needed by the immunisation programme for the implementation of its interventions have been identified.
5.2 The immunisation programme has access to a Master List[2] for each geographic object they need to cover.
5.3 These Master Lists are accessible to all the programmes and their partners through a common geo-registry.
5.4 An updating mechanism is in place and the Master Lists are regularly updated.
5.5 All the above Master Lists, and especially their officially recognised codes, are being integrated into all the information systems and used during data collection, reporting and monitoring across all programmes including immunisation (in the immunisation registry, for example).

Anticipated potential activities to achieve benchmarks (Single cost/ Recurrent cost):
- Identification of the type of geographic objects needed by the immunisation programme and for which Master Lists would be required to support the application of geospatial data and technologies (single cost)
- Development and agreement on standards for Master List content and structure (single cost)
- Assessment of the currently availability of data for the required Master Lists and according to the identified standards and identification of gaps, including gathering of existing datasets and stakeholder consultation (Single cost)
- Data collection, including digitisation for completion of Master Lists (Single cost)
- Establishment of the updating mechanism and regular update of Master Lists (recurrent)
- Deployment of a Master List management platform compliant with recognised standards for hosting, management and sharing of Master Lists (recurrent)

Main timeline drivers
- Extended identification of gaps in data quality and availability for the Master Lists that need to be filled
- Availability of an operational platform to host, maintain and regularly update the Master Lists
- Level of collaboration and coordination between the MOH and organisations in charge of maintenance of the datasets of geographic objects that might not be under the mandate of the MOH (e.g. administrative divisions, villages)
- Delays in field data collection due to weather, social or political instability

Main budget considerations
- Scale of implementation (staff, equipment, training)
- Data quality of existing datasets[1]
- Amount of travel and meetings required
- Consultancy (field work training, supervision, technical oversight of data collection, management and analysis) for data collection for completion of Master Lists. Consider costs such as visits for field work, planning and monitoring,
- purchase of field data collection equipment
- Salary/per-diems for field data collectors
- Workshops and materials for training in field data collection

For establishment of the updating mechanism, platform and regular update of Master Lists consider costs:
- field visits for data collection
- maintenance of field data collection equipment
- situational assessment for feasibility of implementing a Master List management platform
- consultancy to guide implementation activities of Master List management platform
- cost of hosting and maintenance of the Master List management platform (staff, equipment including platform server hosting cost)

COST AND TIMELINE DRIVERS FOR ACTIVITIES AIMED AT STRENGTHENING THE GEO-ENABLING ENVIRONMENT

Availability of geospatial technologies

Main triggers that will be conducive of the activities in this area:
6.1 The central level geospatial data management and technologies unit has been established and need to be properly equipped.
6.2 The immunisation programme is implementing interventions requiring the use of geospatial technologies (GNSS enabled devices, GIS software).

Benchmarks (i.e. the situation to be ultimately achieved for the sustainable use of geospatial data and technologies in the immunisation programme):
6.1 The central level geospatial data management and technologies unit has access to the necessary geospatial technologies (GNSS enabled devices, GIS software) to support its mandate.
6.2 The immunisation programme has access to the necessary geospatial technology to support its activities.

Anticipated potential activities to achieve benchmarks (Single cost/ Recurrent cost):
- Purchase and maintenance of GNSS enabled devices (recurrent)
- purchase of laptops for staff involved in geospatial data management, analysis and visualisation (recurrent)
- Purchase of separated large screen and external keyboard to facilitate the work of technician purchase of shared drive or enterprise geospatial server solution for data and product storage when having several GIS technicians (recurrent)
- When it applies, purchase of GIS software license (desktop or cloud-based) for data management, analysis and visualisation (recurrent)
- Establishment of Internet connection with a good bandwidth for staff involved in geospatial data gathering management, analysis and visualisation (recurrent)
- purchase and maintenance of printers for map printing (Single cost)

Main timeline drivers
- Current level of technical capacities and skills to handle the technologies that are needed
- Efficiency of procurement and distribution processes in MOH related to large numbers of equipment

Main budget considerations
- When it applies, GIS Software licensing fees
- cost of solution for data storage
- Hardware equipment
- Number of field data collectors requiring
- GNSS enabled devices
- Number of technicians in central level geospatial data management unit
- Sophistication of the equipment

COST AND TIMELINE DRIVERS FOR ACTIVITIES AIMED AT STRENGTHENING THE GEO-ENABLING ENVIRONMENT	
Policy	
Main triggers that will be conducive of the activities in this area: 8.1 A central level geospatial data management unit has been established, with specification, standards and protocols released and Master Lists have been created. 8.2 The immunisation programme is not yet complying to the policy that has been released.	**Main budget considerations** Number of stakeholders needed to be involved Amount of travel and meetings required Translation required A consultant with expertise in developing policy pertaining to the management and use of geospatial data and technologies in health system
Benchmarks (i.e. the situation to be ultimately achieved for the sustainable use of geospatial data and technologies in the immunisation programme): 8.1 A policy enforcing the following has been released: a) the mandate over the guardianship on geospatial data specifications, standards and protocols as well as over the development, maintenance, update and sharing of Master Lists for the geographic objects core to public health through the use of a common geo-registry; b) the use of the developed guidelines, standards, protocols and Master Lists by all the stakeholders in the health sector. 8.2 The immunisation programme is complying with this policy.	
Anticipated potential activities to achieve benchmarks (Single cost/ Recurrent cost): • Advocacy with the MOH for the development of the policy (single cost) • Development and regular review of the policy (recurrent) • Implementation of the policy including the alignment of the immunisation programmes strategic and planning documents to the defined policy (single cost) • Implementation of the policy • Evaluation of the level of implementation of the policy (recurrent)	
Main timeline drivers • Level of commitment and support of the managerial level • Presence of a local champion in the health sector • Level of collaboration and coordination in the health sector • Existence of cross-sector policies	

Planning & budgeting checklist

PHASE 1: DEVELOPMENT AND SET-UP

- ◯ Do all elements of the geo-enabling environment exist to support the use of geospatial data and technologies in the immunisation programme?
- ◯ Does the chosen application of geospatial data and technologies address a known bottleneck in the immunisation programme?
- ◯ Will the intended application of geospatial data and technologies address specific end user needs and how is the end user expected to use the resulting data products in their day-to-day work?
- ◯ Do all stakeholders, end users and decision-makers share a common vision and understanding for the integration of geospatial data and technologies into the immunisation programme?
- ◯ Are there standard guidelines and agreements on the collection, storage, management, sharing and use of geospatial data in the health system?
- ◯ Are there appropriate data privacy and security measures in place to protect sensitive and personal information?
- ◯ What capacity exists in the immunisation programme, health system and partner government agencies to guide and manage the use of geospatial data and technologies for improvements in service delivery? What training, skills and competencies need to be included as part of the implementation plan and at what level?
- ◯ Is there a plan in place to monitor, evaluation, document and share experiences and lessons learned?

PHASE 2: DEPLOYMENT

- ◯ Are end users and local level health area managers involved in the training, data collection and implementation to ensure locally appropriate activities and validation?
- ◯ Is there meaningful involvement and cooperation with relevant partners in other health sectors and in government agencies responsible for statistics and geospatial data?
- ◯ Is there a process for understanding and documenting lessons learned during implementation to inform future scale-up or phased roll-out of the application of geospatial data and technologies?
- ◯ Are the resulting data products and analyses shared with local level health area managers? Do they have confidence and a shared understanding of the value of the data?

PHASE 3: INTEGRATION AND INTEROPERABILITY

- ◯ Are there procedures in place and being used to update geospatial data periodically?
- ◯ Are the data products and analyses available to stakeholders at all levels and integrated into the HIS?
- ◯ How can the implementation, data collection and data sharing procedures be improved to make the intervention more useful for decision-making?
- ◯ What parts of the implementation or operation need to be adjusted for scale-up? What needs to be in place in the immunisation programme, enabling environment or local infrastructure before roll-out to new areas?

PHASE 4: SCALING

- ◯ What elements or characteristics in the new implementation areas create challenges or opportunities for use of the application of geospatial data and technologies?
- ◯ Are the data products and analyses being used effectively by decision-makers? Why or why not?
- ◯ Are local managers and key partners continuing to develop their skills and capacity for the management and use of the application of geospatial data and technologies? What is needed to improve local capacity?
- ◯ Has anything changed in the geo-enabling environment since beginning the intervention? What elements still need improvement?

PHASE 5: SUSTAINED OPERATIONS

- ◯ Is there a plan and resources for regular replacement and maintenance of technology equipment and software licenses?
- ◯ Are there continued efforts to improve local capacity, skills and competencies in geospatial data use and management?
- ◯ How has the application of geospatial data and technologies improved the coverage and equity of immunisation service delivery in implementation areas? How are these results documented, shared and used to improve sustained operations?

Conclusion

There is great potential for the use of geospatial data and technologies to increase coverage and equity in national immunisation programmes and contribute to achieving universal health coverage. With careful planning during the initial stages, including an understanding and assessment of the enabling environment for integrating geospatial data and technologies in health systems, these interventions can have a sustainable and long- term impact on immunisation outcomes.

With the help of this guidance document, national EPI managers can identify appropriate geospatial tools to address country-level priorities and create a comprehensive workplan and budget to incorporate these applications into the national immunisation program. In order to improve the delivery of life-saving vaccines to all children, immunisation programmes can invest in appropriate geospatial tools and technologies as outlined here to contribute to equitable health and immunisation systems with the support of strong leadership and the necessary capacity to use the data effectively.

References

[1] UNICEF. 2018. Guidance on the use of geospatial data and technologies in immunization programs: overview and managerial considerations for in-country strengthening. October 2018. [link]

[2] Chaney, S.C., & Mechael, P. 2020. Improving Immunisation Coverage and Equity through the Effective Use of Geospatial Technologies and Data: A Landscape Analysis & Theory of Change. September 2020. [link]

[3] UNICEF. 2017. Improving Vaccination Coverage and Reducing Inequities: Use of GIS in Immunisation Programmes FINAL REPORT 6 February 2017. [link]

[4] Mehl, G. & Labrique, A. 2014. Prioritizing integrated mHealth strategies for universal health coverage. Science. 345(6202): 1284-1287. [link]

[5] WHO. 2018. Classification of Digital Health Interventions v1.0: A shared language to describe the uses of digital technology for health. [link]

[6] WHO. 2020. Digital Implementation Investment Guide (DIIG): Integrating Digital Interventions into Health Programmes. September 2020. [link]

[7] Health GeoLab Collaborative. 2018. HIS Geo-Enabling Toolkit [link]

Annex 1

Theory of change

Use of Geospatial Technologies for Immunisation Programming

Health Impact	**Reduction in Childhood Disability and Mortality Due to Vaccine-Preventable Diseases**		
Immunisation Impact	≥80% of children fully immunised in all districts and equitable coverage across population subgroups based on geographic, socio-economic and cultural differences		
	Improved immunisation campaigns and routine immunisation programmes		
Immunisation Outcomes	Increased number of children immunised through improved target setting	Optimised immunisation resource distribution and location of services	Improved quality, timeliness and perception of immunisation services with equity in coverage between communities
Geospatial Data and Technologies Outputs	Improved **identification of zero dose and under-immunised children** through more accurate microplanning and identification of missed settlements to implement appropriate vaccination strategy	Improved **planning and allocation** of immunisation resources through strengthened use of geospatial data, analysis and visualisation	Improved **service delivery** through better planning, monitoring and tracking of immunisation activities for rapid problem identification and corrective action
Geospatial Data and Technologies Inputs	Produce and regularly update digital maps for health area planning based on health resources mapping through a participatory process involving local health staff to map immunisation resources	Optimize distribution of resources (workforce, funding, vaccines and supplies) based on more accurate target population distribution and identification of gaps in coverage and immunisation service accessibility based on geospatial accessibility analysis and coverage modelling	Track by location vaccinator activities, immunisation sessions, supervision and allocation of financial resources
Geospatial Data & Immunisation Foundations	**Health System Mapping (essential):** Develop and maintain master lists and data standards for health facilities, vaccination delivery sites and cold chain, settlements, infrastructure, health area boundaries and other core geographic objects **Population Estimation (essential):** Generate and use accurate population estimates (human density and distribution) to establish targets (denominators) in immunisation programme planning **Analytics & Modeling for Accessibility, Coverage, and Surveillance Planning and Monitoring (when possible):** Use modeling to understand geographic accessibility to services, vaccine distribution, and immunisation coverage with links to data (through HIS, IHRIS, and eLMIS) on vaccine-preventable diseases and AEFI		
Enablers	Clearly defined vision, strategy and plan for a geo-enabled HIS/immunisation programme Information system governance structure covering geospatial data and technologies Policies supporting and enforcing the strategy and governance, including data accessibility Necessary human and financial resources to ensure effective use and sustainability of geospatial data over the long-term		

Annex 2

Additional resources

General Publications and reports

Chaney, S.C., & P. Mechael. 2020. Improving Immunisation Coverage and Equity through the Effective Use of Geospatial Technologies and Data: A Landscape Analysis & Theory of Change. September. https://www.gavi.org/our-impact/evaluation-studies/using-geospatial-technologies-improve-immunisation-coverage-equity

UNICEF. 2018. Guidance on the use of geospatial data and technologies in immunization programs: overview and managerial considerations for in-country strengthening. October 2018. https://www.unicef.org/media/58181/file

WHO. 2020. Digital Implementation Investment Guide (DIIG): Integrating Digital Interventions into Health Programmes. September. https://www.who.int/publications/i/item/9789240010567

The Geography of Universal Health Coverage. ADB Brief. Roth et al., 2016. https://www.adb.org/publications/geography-universal-health-coverage

Building Capacity for Geo-Enabling Health Information Systems: Supporting Equitable Health Services and Well-Being for All. ADB Brief. Ebener et al., 2018. https://www.adb.org/publications/building-capacity-geo-enabling-health-information-systems

Report of the SAGE Working Group on Quality and Use of Immunization and Surveillance Data. WHO September, 2019. https://www.who.int/immunization/sage/meetings/2019/october/5_SAGE_report-revSept2019.pdf

Meeting reports

UNICEF. 2017. Improving Vaccination Coverage and Reducing Inequities: Use of GIS in Immunization Programs Final Meeting report. https://www.unicef.org/media/58031/file

Geospatial Modelling for Immunization Equity: Technical Meeting Executive Summary, August 2019 – Washington DC. https://drive.google.com/file/d/1ely2aDWxLXA6yM-iy1nNqTp7dddJ1zBP/view

Guidance and other reference material

Geospatial Analysis in Global Health M&E: A Process Guide to Monitoring and Evaluation for Informed Decision Making. MEASURE Evaluation 2015. https://www.measureevaluation.org/resources/publications/ms-14-98

A Guide for Preparing, Mapping, and Linking Logistics Data to a Geographic Information System. DELIVER Project 2012. https://publications.jsi.com/JSIInternet/Inc/Common/_download_pub.cfm?id=12241&lid=3

Health GeoLab Collaborative HIS geo-enabling toolkit, guidance and starter kits https://healthgeolab.net/resources/reference-materials/

Health GeoLab Collaborative Knowledge Repository https://healthgeolab.net/resources/knowledge-repository/

Using Geospatial Analysis to Inform Decision Making in Targeting Health Facility-Based Programs: A Guidance Document. MEASURE Evaluation, 2014. https://www.measureevaluation.org/resources/publications/ms-14-88

Esri/ArcGIS COVID-19 Vaccine distribution resources and tools https://coronavirus-resources.esri.com/pages/vaccine

Esri/ArcGIS Health and Human Services Grant Program https://www.esri.com/en-us/industries/health/segments/public-health/modernization-overview

QGIS: A Free and Open Source Geographic Information System https://www.qgis.org/en/site/

Annex 2

Additional resources

Training materials

Measure Evaluation GIS Training Materials
https://www.measureevaluation.org/resources/training/capacity-building-resources/geographic-information-systems-mapping-and-analysis-of-spatial-data

Geographic Approaches to Global Health, Global Health Learning Center https://www.globalhealthlearning.org/course/geographic-approaches-global-health

US Centers for Disease Control and Prevention (CDC) GIS Training Curriculum
https://www.cdc.gov/dhdsp/maps/gisx/training/index.html

DHS Training Curriculum and Video Tutorials
http://spatialdata.dhsprogram.com/resources/

Health GeoLab Collaborative
- HIS Geo-Enabling Course

https://healthgeolab.net/resources/his-geo-enabling-course/
- Workshops and training materials https://healthgeolab.net/resources/workshops_trainings/

ArcGIS Enterprise GIS Training Plan for Staff of Ministries of Health https://healthgeolab.net/KNOW_REP/Esri_Training_Recommendations_WHO_Dec2019_Generic.pdf

Resources for Health system mapping

Health Resources and Services Availability Monitoring System (HeRAMS), upcoming normative and technical supporting material, https://www.who.int/initiatives/herams

Common Geo-Registry (CGR), A single source of reference information for the standardization, management and use of geographic data over time.
https://dsme.community/common-geo-registry/

HIS geo-enabling: Guidance on the establishment of a common geo-registry for the simultaneous hosting, maintenance, update and sharing of Master Lists core to public health. Health GeoLab, August 2017
https://healthgeolab.net/DOCUMENTS/Guidance_Common_Geo-registry_Ve1.pdf

Mapping Community-Based Global Health Programs: A Reference Guide for Community-Based Practitioners, MEASURE Evaluation, 2014 https://www.measureevaluation.org/resources/publications/ms-13-76

Guidelines for creating framework data for GIS analysis in low- and middle- income countries. Makanga et al., 2016. *The Canadian Geographer/Le Géographe canadien. 60*(3): 320-332. https://onlinelibrary.wiley.com/doi/full/10.1111/cag.12295

Master Facility List Resource Package: Guidance for countries wanting to strengthen their MFL. WHO 2018.
https://www.who.int/healthinfo/MFL_Resource_Package_Jan2018.pdf?ua=1

Toolkit for Implementing the Health Facility Registry in Nigeria. MEASURE Evaluation
https://www.measureevaluation.org/countries/nigeria/toolkit-for-implementing-the-health-facility-registry-in-nigeria/

Annex 2

Additional resources

Part 2 of the Health GeoLab guidance to improve the management and use of geospatial data and technologies:

- 2.1 Documenting the process and defining the data needs https://www.healthgeolab.net/DOCUMENTS/Guide_HGLC_Part2_1.pdf
- 2.2 Defining the vocabulary, the data set specifications and the ground reference https://www.healthgeolab.net/DOCUMENTS/Guide_HGLC_Part2_2.pdf
- 2.3 Compiling existing data and identifying gaps https://www.healthgeolab.net/DOCUMENTS/Guide_HGLC_Part2_3.pdf

Resources for Population estimation and spatial distribution

Leaving No One Off The Map: A Guide For Gridded Population Data For Sustainable Development. 2020 report by the Thematic Research Network on Data and Statistics (TReNDS) of the UN Sustainable Development Solutions Network (SDSN) in Support of the POPGRID Data Collaborative https://www.sdsntrends.org/leaving-no-one-off-the-map

New Methodology: a hybrid census to generate spatially disaggregated population estimates UNFPA Technical Brief, December 2017
https://www.unfpa.org/sites/default/files/resource-pdf/Hybrid_Census_Brief_v9.pdf

The Value of Modelled Population Estimates for Census Planning and Preparation, UNFPA Technical Guidance Note, 2020
https://www.unfpa.org/sites/default/files/resource-pdf/V2_Technical-Guidance-Note_Value_of_Modeled_Pop_Estimates_in_Census.pdf

Resources for Microplanning with geospatial technologies

The Use of Geospatial Data and Technologies in Support of Immunization Microplanning in Myanmar Implementation Report (2017 - 2018) Gavi, UNICEF & Health GeoLab https://www.unicef.org/media/58036/file

Best Practices in Innovations in Microplanning for Polio Eradication: A Supplement to “Best Practices in Microplanning for Polio Eradication” WHO Global Polio Eradication Initiative https://www.who.int/polio-transition/documents-resources/best-practices-microplanning-innovations.pdf?ua=1

The Common Geo-Registry: A single source of truth for managing geographic data over time across multiple information systems, TerraFrame technical brief https://terraframe.com/images/Common_Geo-Registry_Brief_190806.pdf

Resources for Vaccination session tracking

Summary of the Novel-T partnership tracking system in Nigeria
http://www.novel-t.ch/project/vaccination-tracking-system

Improving Polio Vaccination Coverage in Nigeria Through the Use of Geographic Information System Technology. Barau et al., 2014. *The Journal of infectious diseases. 210*(suppl_1): S102-S110. https://academic.oup.com/jid/article/210/suppl_1/S102/2194326

Annex 2

Additional resources

Resources for Geographic accessibility modelling

AccessMod: Supporting Universal Health Coverage by modelling physical accessibility to health care, open source tools and projects https://www.accessmod.org/

Improving Emergency Obstetric and Newborn Care (EmONC) - Implementation manual for developing a national network of referral maternity facilities, UNFPA 2020 https://www.unfpa.org/publications/implementation-manual-developing-national-network-maternity-units

Using Geospatial Analysis to Inform Decision Making in Targeting Health Facility-Based Programs: A Guidance Document. MEASURE Evaluation, 2014. https://www.measureevaluation.org/resources/publications/ms-14-88

Resources for Vaccination coverage modelling

Use of geospatial data and technologies for improved immunization coverage and equity, Kenya. UNICEF, Gavi, Kenya MOH project and workshop website, 2018 https://sites.google.com/view/giskenya/home

Geospatial Modeling for Immunization Equity: Technical Meeting summary, August 2019 https://drive.google.com/file/d/1ely2aDWxLXA6yM-iy1nNqTp7dddJ1zBP/view

Guidance for Use of The DHS Program Modeled Map Surfaces, DHS Spatial analysis report 14, 2016 https://dhsprogram.com/publications/publication-SAR14-Spatial-Analysis-Reports.cfm

Equity Reference Group Geospatial Modelling for Immunisation Equity - Meeting Summary and Consensus Statement, July 2020 https://sites.google.com/view/erg4immunisation/products#h.p_hCetdMXXJAOA

Guidelines on the use of DHS GPS Data. Spatial Analysis Reports No. 8. MEASURE DHS 2013 https://dhsprogram.com/pubs/pdf/SAR8/SAR8.pdf

Creating Spatial Interpolation Surfaces with DHS Data. Spatial Analysis Reports No. 11. MEASURE DHS 2015. https://dhsprogram.com/pubs/pdf/SAR11/SAR11.pdf

Gavi
The Vaccine Alliance

unicef
for every child

health.enabled