AfricaCDC
Centres for Disease Control and Prevention

Safeguarding Africa's Health

LABORATORY SYSTEMS AND NETWORK CAPACITIES IN AFRICA

FRAMEWORK FOR GIS-MAPPING

An entity of the African Union

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Africa CDC is a continental autonomous health agency of the African Union established to support public health initiatives of Member States and strengthen the capacity of their public health institutions to detect, prevent, control and respond quickly and effectively to disease threats.

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CONTENTS

ABBREVIATIONS AND ACRONYMS	**ii**
FOREWORD	**iii**
ACKNOWLEDGMENTS	**iv**
EXECUTIVE SUMMARY	**1**
1.0 INTRODUCTION	**2**
1.1 Background and rationale	2
2.0 GOAL AND OBJECTIVES	**4**
2. 1 Objectives and Activities	4
2.2 Phases in LabMap program	4
3.0 ESTABLISHING A COUNTRY LEVEL GIS LABMAP PROGRAM	**5**
3.1. Stakeholders Engagement	5
3.3 Review of existing collection tools, data systems and technical skills	5
3.4 . Establishment of Governance Structures at Country Level	5
3.5. Review and selection of laboratories for GIS mapping	6
3.6 Developing a field data collection activity plan and required resources	7
4.0 DATA COLLECTORS TRAINING AND DATA COLLECTION	**8**
4.1 Data collector's profile	8
4.2 Data collection training	8
4.3 Evaluating the data collectors skills:	9
4.5 Data systems, access and security	9
4.5. 1.Data quality control	9
5.0 DATA VALIDATION, ANALYSIS AND UTILIZATION	**11**
5.1 Validation:	11
5.2 Use cases and data utilization:	11
5.3 Data analysis to inform use cases:	11
5.4 Capacity strengthening workplans and resource requirements	11
5.5 Publication of report	12
5.6 Updating of LabMap data, and monitoring implementation	12
5.7 Advocacy and communication	12
6.0 USE CASES	**13**
6.1 Data translation into policy and practice	13
6.2 Laboratory based surveillance of notifiable diseases	14
6.3 Hub and spoke network optimization	16
7.0 GOVERNANCE AND COORDINATION AT CONTINENTAL LEVEL	**19**
8.0 RESOURCE MOBILIZATION AND SUSTAINABILITY	**22**
7.1 Strategies for resource mobilisation for lab mapping activities	22
7.2 Strategies for sustainability	22
7.3 Estimate cost for LabMap per country	22
9.0 MONITORING AND EVALUATION	**24**
9.1 Key Performance Indicators	24
9.2 Data collection	25
ANNEXES	**26**
REFERENCES	**34**

ABBREVIATIONS AND ACRONYMS

Africa CDC	Africa Centers for Disease Control and Prevention
AI	Artificial Intelligence
ASLM	African Society for Laboratory Medicine
AU	African Union
DHIS	District Health Information System
DNO	Diagnostic Networks Optimization
EMR	Electronic Medical Records
FeIPA	Federation of Lab Professional in Africa
GIS	Geographical Information System
IDSR	Intergrated Disease Surveillaice and Response
KPI	Key Performance Indicators
LabMap	Laboratory Mapping Program
LabDF	Lab Director Forum
LIS	Laboratory Information System
OHTWG	One Health Technical Working Group
MLL	Master Laboratory List
M&E	Monitoring and Evaluation
MOH	Ministry of Health
NPHL	National Public Health Laboratory
NPHI	National Public Health Institute
RISLNET	Reginal Integrated Surveillance and Laboratory Network
RCCs	Regional Coordinating Centers
ToC	Theory of Change
WHO AFRO	World Health Organization Regional Office for Africa
IHR	International Health Regulations
SO	Strategic Objectives
SWOT	Strength, Weakness, Opportunities, and Threats

FOREWORD

The world is facing unprecedented, interconnected threats to the health of people, animals, and the environment. Addressing these threats requires cross-sectoral and systems-wide approaches and strengthening early warning surveillance, laboratory and emergency response capabilities. To prepare laboratory systems to effectively support response to emerging and re-emerging disease outbreaks, Geographic Information System (GIS)-based Laboratory Mapping (LabMap) will provide critical insights into laboratory systems' capacity, capabilities and the data will be used to develop appropriate capacity strengthening strategies and policies. Digital mapping of geospatial function of laboratories and their networks in Member States becomes an indispensable tool to improve functionality of national and regional laboratory networks. It will also help to increase diagnostic testing capacity and surveillance coverage of laboratory networks and prepare for and respond to disease outbreaks.

LabMap should follow the One Health approach to build laboratory capacities for responding to health threats that arise in complex interconnection among people, animals, plants, and their shared environment. One Health is a collaborative, multidisciplinary, and multisectoral approach that can address urgent, ongoing, or potential health threats at the human-animal-environment interface at subnational, national, regional and global levels. This approach ensures balance and equity among all the relevant sectors and disciplines. In today's highly connected world, a disease can be transported from an isolated village to any major city in as little as 24 hours. Zoonotic – diseases and other health threats within the human-animal-ecosystem interface pose ongoing and increasing risks to public health and global health security and therefore must be considered.

Approximately 73 percent of emerging pathogens originate from animal hosts, the majority being wild animals. The COVID-19 pandemic in December 2019 and its origin as a zoonotic pathogen is a significant example of this interconnectedness that requires one health approach to address global health security challenges effectively. The African continent has not been spared of emerging and re-emerging infectious disease threats arising from international travel. Over the last decade, different regions have experienced animal-originating outbreaks of Ebola, Marburg Virus Disease, Rift valley fever, Crimean Congo hemorrhagic fever, anthrax, rabies, and yellow fever[2].

The International Health Regulations (IHR-2005) has identified mapping and using priority health risks and resources as one of the core capacities in Public Health Emergency Preparedness and Response (PHEPR)[3]. Effective preparedness and swift response to epidemics is the goal of Africa Centres for Disease Control and Prevention (Africa CDC). In this regard, Africa CDC in collaboration with European Centre for Disease Prevention and Control (ECDC) undertook ranking of diseases and public health events requiring a rapid and efficient response under a multidisciplinary consultative forum. The purpose of prioritization of epidemic-prone disease is to inform Africa CDC strategic planning and help effective resource allocation to manage prevention and response actions to health emergencies[4]. This is a critical step for effective response to limit the spread of diseases, prevent minimize morbidity and mortality, lower social-and economic disruptions as well enabling early socio-economic recovery and returning to normal. The laboratory system capacity development should address these priority diseases. The LabMap initiative is critical to generate data that will be used to ensure that laboratory capabilities are available and that laboratory networks are optimal to serve all populations in addressing public health threats. This LabMap Strategic Framework was jointly developed by Africa CDC, African Society for Laboratory Medicine (ASLM) and African Union (AU) Member States.

The strategic framework addresses critical gaps observed in the past 5 years of implementing LabMap and reflects shared commitment of multisectoral collaborations in addressing laboratory systems and networks capacity challenges. This strategic framework on the mapping of laboratory functions will be used by all partners and Member States engaged in and supporting geospatial mapping of laboratory functions for better preparation of laboratory systems for early detection of health threats.

Dr. Jean Kaseya
Director General
Africa CDC

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The following individuals from Africa CDC and ASLM provided technical leadership, made technical inputs, coordinated the finalization of the framework for laboratory mapping

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EXECUTIVE SUMMARY

Today, the demand for testing services is increasing and becoming more diverse across various countries' networks of public and private laboratories. These laboratories are expected to offer expanded and novel testing services. However, the extent of their capacity and coverage is only known in basic terms. The laboratory capacity for epidemic-prone diseases, as well as communicable and non-communicable diseases, drug resistance testing, pathogen genome sequencing, diagnostic capacity for disease surveillance, and surge capacity for outbreak-related diseases, remains poorly understood. This lack of information hampers both small and large-scale efforts to address the existing gaps. Mapping laboratory functions across Africa is crucial for several reasons: providing evidence and data contributing to the overall goal of enhancing healthcare systems, improving functionality of national and regional laboratory networks, optimizing resource allocation, facilitating cross-border transportation of specimens for diagnostic testing, increasing diagnostic testing capacity and surveillance coverage of laboratory networks, preparing for and responding to disease outbreaks and ensuring compliance to with IHR requirements pertaining to laboratory capacities and capabilities. Africa CDC, in partnership with ASLM and other partners, have been expanding laboratory capacity mapping across Africa regions since 2018.

The implementation of this framework will leverage existing regional and national institutions and structures for better coordination and collaboration. Africa CDC, in partnership with ASLM and other partners will facilitate the updating of the existing GIS LabMap survey tool and data systems in collaboration with Member states. The Continental Laboratory Technical Working Group (AfLTWG) will play a critical role in coordinating and providing guidance for GIS Lab Mapping activities. The Systems & Networks Steering Group, a new structure, will be dedicated continental level to monitor and review implementation on regular basis and feed into the AfLTWG). At country level, national One Health laboratory TWGs are expected to take a similar role and where these do not existing, the NPHI can assume this role. The Africa CDC's five regional Coordinating Centres (RCCs) will act as key hubs in supporting countries in GIS LabMap and work directly with National Public Health Institutes (NPHIs) and/or similar government structure structures across One Health sectors.

This Framework provides guidance on how Member States, Africa CDC, ASLM and other partners and stakeholders can expand the geospatial mapping of laboratories and usage of the subsequent data for decision making in the African Union (AU) Member States. Specifically, this framework addresses two strategic objectives:

- To expand geospatial mapping of laboratory capacity in AU member states
- To increase the utilization of laboratory capacity mapping data to inform improvement and scale-up of diagnostic capacity.

To achieve these two strategic objectives, Africa CDC, ASLM, Member States, implementing partners and donors commit to:

- Using standardised data collection, storage and data management systems
- Sharing the data and insights to optimise access to diagnostic services and cross boarder disease surveillance.
- Translating data into policy by integrating data into the policy-making process to create more effective, adaptive, and evidence-based public policies.
- Engaging all One health sector stakeholders to enhance collaboration in addressing diagnostic capacity gaps of public health disease threats across the sectors.
- Mobilising resources for the implementation of the data collection, use cases and capacity strengthening workplans including priority disease surveillance.
- Updating GIS mapping data and evaluating the progress in laboratory capacity system strengthening including laboratory-based surveillance.

1.0 INTRODUCTION

1.1 Background and rationale

GIS Laboratory Mapping is a system for the collection, storage and analysis of Geographic Information Systems (GIS)-linked data on laboratory capacity, systems and networks. In 2018, Africa CDC in collaboration with ASLM launched GIS Laboratory Mapping (LabMap) program to conduct GIS mapping of laboratory capacities and capabilities across the African continent[5]. LabMap is designed to strengthen the Regional Integrated Surveillance and Laboratory Network (RISLNET) of Africa CDC and is aligned with Africa CDC's strategic priority to support laboratory networks to be resilient and responsive to health threats. LabMap is also aligned to the Africa Strategic plan (2023-2027) and WHO AFRO Regional strategy for health security and emergencies (2022-2030) recommending evidence-based planning of capacity building interventions of the health system.

GIS mapping of public health and private laboratory capacities has proven to be a very useful tool for analyzing critical gaps to increase diagnostic testing capacity and surveillance coverage of laboratory networks, as well as preparing for and responding to disease outbreaks. LabMap has been implemented on the continent with the aim of improving functionality of national and regional laboratory networks. A review of GIS mapping initiatives and experiences within laboratory programs was conducted in 24 countries in Africa. The multi-country assessment of GIS mapping of public health laboratory capacity in support of better laboratory programming for epidemic response revealed the need for a continental LabMap strategic framework that will allow member states to standardize, and advance GIS laboratory mapping for better planning and programming including improvement and harmonization of laboratory mapping programs.

To achieve this, a strategic framework for GIS mapping, inclusion of GIS mapping in national laboratory strategic plans, and the utilization of a central GIS mapping data repository with defined indicators are necessary. The ongoing endeavor strives to enhance and promote harmonization and standardization of laboratory mapping exercises. These measures will guide the completion of laboratory capacity mapping in the continent, enabling a more effective response to public health epidemics.

Figure 1 shows Member States involved in laboratory GIS mapping program

GIS LabMap
N = 27

Note: *The extent of the laboratories mapped vary across countries and the map captures the 27 countries that are engaged in GIS laboratory mapping program starting with a minimum of one laboratory mapped to measure capacity.*

Milestones of LabMap Program

2018

The Africa CDC in partnership with ASLM launched GIS Laboratory mapping with funding from the Bill and Melinda Gates Foundation (BMGF) to support data collection in Niger and Ethiopia as pilot countries with 461 laboratories covered. The data collection was based on standardised data collection tool and web-based data collection platform and storage. These web-based systems are interoperable with the national Laboratory Informational Management System or DHIS 2.

2019

- Public portal and resource map was developed to increase handling and utilisation of GIS LabMap data. The portal, open to the public, displays the laboratories mapped and their assigned tier levels.

2023

- Africa CDC in partnership with ASLM, expanded mapping of national public health laboratories/tertiary tier laboratories to ten countries assessing their capacities towards detection of Africa CDC priority diseases and pathogens. This is critical to inform Africa CDC disease detection, surveillance and response strategies against public health emergencies.

2024

- Three regional GIS laboratory mapping implementation review worskops were held in Tunisia, Ghana and Zambia to document countries experiences, challenges and opportunities in laboratory mapping.
- Development of the standard operational procedures to guide stakeholder engagements, data management(collection, quality assurance, handling, analysis and utilisation).
- The GIS mapping cumulatively covered 27 countries and 5202 laboratories that include human, animal and environmental health laboratories across the continent.
- Development of the web-based training materials to support remote trainings and self-assessment in country. This was initiated as part of cost minimization for GIS LabMap to ensure that it is more sustainable for countries and it can be conducted regularly to monitor improvements. The web-based materials are supported by video tutorials and training manuals to build the capacity of countries to conduct laboratory mapping by themselves.
- Development of a dashboard with key priority information as a strategy to increase analysis and data utilisation at continental and member states level. The process is continuous to ensure Member states dashboard is designed according to their context and data needs.
- Increase utilisation of LabMap data in eleven countries namely Malawi, Zambia, Mozambique, Sierra Leone, Mali, Guinea, Zimbabwe, Sao Tome, Burkina Faso, Gabon and Cameroon. The Member states have identified capacity gaps and developed capacity strengthening workplans. The program has further defined different use cases for LabMap to add value to laboratory systems and networks. A number of countries including Malawi, Zimbabwe, Mozambique, Zambia have shared their insights through ECHO session and conferences.

2.0 GOAL AND OBJECTIVES

The goal of the laboratory mapping strategic framework is to sustain and optimize laboratory and information sharing systems using GIS-Laboratory mapping for effective and efficient clinical and public health laboratory services for early disease detection and surveillance of public health threats in Africa.

This goal can be addressed through several interlinked strategic objectives focusing on specific processes and actions required to design and implement the program.

2. 1 Objectives and Activities

Objective 1: To expand geospatial mapping of laboratory capacity in AU member states
Objective 2: To increase the utilization of laboratory capacity mapping data to inform improvement and scale-up of diagnostic capacity.

2.2 Phases in LabMap program

The Labmap program must be effectively implemented, monitored and evaluated to achieve its desired long-term outcomes of strengthening laboratory capacities and optimizing services. Member states must plan for the implementation of the different phases of the process, which include data collection, quality assurance, data cleaning, data validation and analysis, and the integration of strategies into the laboratory strategic and operational planning frameworks (See Annex 1, Figure 2). Data collection and utilization manuals have been developed to guide countries in navigating the different phases. Each Member state can adapt or adopt these guides based on local context.

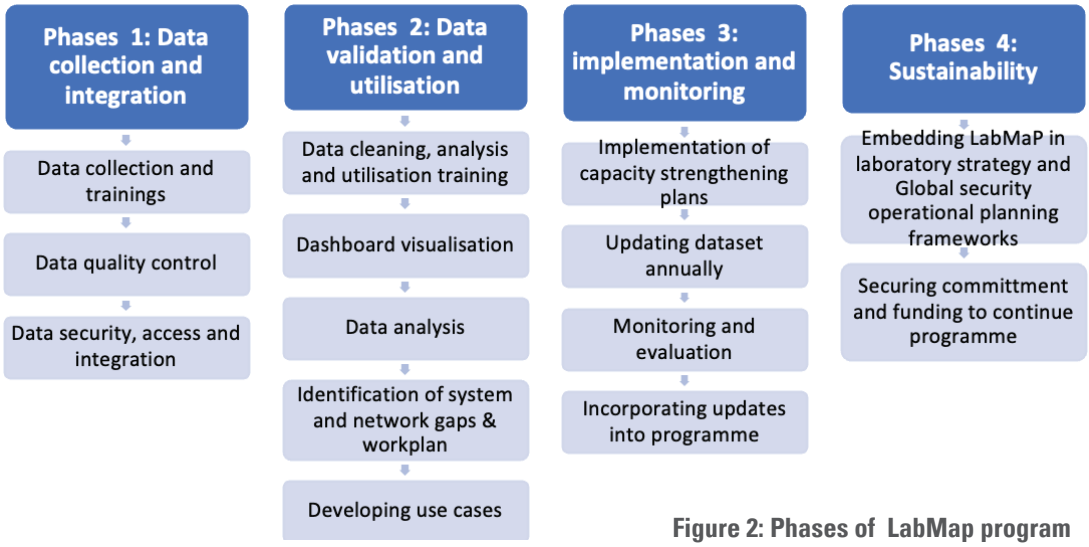


Figure 2: Phases of LabMap program

3.0 ESTABLISHING A COUNTRY LEVEL GIS LABMAP PROGRAM

Member states should adapt the phases described below to design and implement a partial or nationwide program. Member states may be at different phases of GIS LabMap program implementation and as such, may not need to adopt all the phases. Establishing such a program should at a minimum include:

- Engagement of key stakeholders, ideally using a One Health approach
- Signing the data sharing agreement between Member states and Africa CDC, ASLM or partners.
- Review of existing collection tools, data systems and technical skills
- Establishment or expansion of GIS LabMap governance structures with clear roles and responsibilities.
- Review and selection of laboratories for capacity mapping
- Development of an activity plan with required resources

3.1. Stakeholders Engagement

As a starting point, it is critical to have high level commitment and leadership when establishing the program from all one health sectors through well-defined stakeholders' engagement process throughout the program cycle. The national MOH/NPHI to officially request Africa CDC (directly or through partners) for LabMap implementation(See annex 2) . One Health sectors governance and coordination structures can create enabling environment to implement an efficient program by synergistically collaborating across stakeholders. The process of initiating GIS Laboratory Mapping for the Member States should ensure wide consultation with one health sector stakeholders and engagement with Africa CDC on their plans to conduct national laboratory mapping. This ensures that a good partnerships framework between the national MOH including the National Public Health Institutes (NPHI) and Africa CDC, ASLM or implementing partners is established. The emphasis is on the multi-disciplinary team within the country coordinating team in the context of the one health approach. The steps required includes;

- Stakeholders mapping of One Health sector stakeholders and implementing partners (See Annex 2).
- Assign roles and responsibilities including respective obligations for its success and identification of focal persons(See Annex 7)
- Define the channels of communication between Africa CDC/partners and Member State
- Define the frequency to monitor and review progress.

3.2 Data sharing agreement

It is critical that prior to data collection and during stakeholders' engagement data sharing agreement should be discussed and signed off between the Member State and Africa CDC including implementing partners. The sharing agreement should define the terms and conditions of data sharing, including the specific data being shared, the purpose of the sharing, how the data will be used, and the responsibilities of each party to ensure data protection, preventing misuse, and promoting accountability in data handling practices(See Annex 3).

3.3 Review of existing collection tools, data systems and technical skills

A review of collection tools and data systems with stakeholder should involve evaluating LabMap data collection, existing Member State similar tools and data systems, availability of personnel and capacities to coordinate, analyze data, generate capacity strengthening plans and translate data into policy and practice throughout the program Cyle. A summary report should be compiled to demonstrate the status of laboratory mapping in the country and supplementary role of the Africa CDC led GIS LabMap.

3.4 . Establishment of Governance Structures at Country Level

Member States should establish a governance and coordinating structures to ensure good partnerships among the critical stakeholders. This will ensure that all partners understand their roles including their respective obliga-

tions for its success, channels of communication and frequency to monitor and review progress. Having a defined structure will also ensure that stakeholders share strategic laboratory documents and other available resources, facilitate communication, administrative and logistic arrangements and commitment to mobilize necessary resources to ensure successful implementation. The key structures include;

- **Multi-Sectoral Coordinating Committee**: Where One Health national laboratory TWG exists, the framework will leverage on existing structures. In case they are no One Health structure, Member State should be encouraged to form one inclusive of all One Health sectors to ensure comprehensive coverage of mapping in all sectors. A group of 5-10 members should be drawn from One Health TWG members such as National Public Health Institutes, Animal health, Environmental Health, Food Safety and the private sector in a One Health approach with the Ministry of Health as the parent sector. During the design and planning phase, the committees should ensure the participation of all key laboratory sector stakeholders in country. The Multi-sectoral Coordinating Committee should serve the role of:
    - Providing technical guidance as needed
    - Overseeing data collection, utilisation, report writing and publication.
    - Establishing a national roster of data collectors.
    - Estimating resource requirements
    - Engaging and obtaining consensus during planning and implementation
    - Meeting regularly to discuss and review the implementation of the program
- **Core Team**: Member states should designate a team of at least three officers (GIS LabMap focal person, data administrator and Health Informatics personnel) with a documented scope of work(See Annex 5). The GIS LabMap focal person is a liaison officer for the LabMap program and regularly reports to the multi sectoral Coordinating Committee. Given the likelihood that human health laboratories will constitute the bulk of the mapped laboratories, at least one of the core members should be from MoH.
- **National One Health Laboratory Technical Working Group**: The TWG should be updated and regularly review the progress of the GIS LabMap activities. The TWG should also review the GIS LabMap generated insights and strategies for improvements. The membership of the One Health TWG should be based on national guideline if it exists. In case there is no guideline, it's important that all one health sectors have membership that includes MOH.

3.5. Review and selection of laboratories for GIS mapping

The purpose of this review is to establish the expected number of laboratories to be mapped by each national tier system and across the one health sectors. The expected number to be reached is further reviewed against the available resources. The key output is recommendation of the different mapping models with different mix in the context of the available resources. This is a country led mapping process(see table 2)

The national multi-sectoral coordinating committee should assess the existing inventory of each sector's laboratories across all the administrative units, taking into consideration the tier system to inform and prioritize laboratories to be mapped and ensure nationally or sub-nationally representative data. The findings should inform the development of a master list of laboratories to be mapped with clear tier system.

For data to qualify for robust analysis and insights , the committee must ensure the selected sites meet certain pre-defined mapping criteria

Selection Criteria for Laboratories to be Mapped
Using the Master List of Laboratories (MLL)in the national laboratory network, the multi-sectoral coordination committee should select a representative number of laboratories to be mapped in each tier and across One Health sectors including private laboratories, taking into consideration the availability of resources(See

annex 5). Determination of laboratory tiers should be based on the standard three-tiered WHO levels of health care system classification (https://tbksp.who.int/en/node/754) or its equivalent. According to WHO there are at least three levels: Primary, Secondary, and Tertiary care.

- **Tertiary Level:** This is the highest level of care and provides highly specialized services for complex or rare conditions. It can include national or reference laboratories.
- **Secondary level**: This involves specialists and is accessed when primary care needs additional expertise. It can include provincial or regional laboratories.
- **Primary level**: This is the first point of contact for most health services and can include district and community laboratories such as health centres and health posts.

Based on this classification, the following minimum number of laboratories should be selected for GIS mapping from **each tier** to adequately determine the capacity of the laboratory network for the country.
Table 1: Selection criteria for sites to be mapped

No	Sampling Models
Tertiary Level	Include all the tertiary level laboratories in country
Secondary level	For Countries with: i) Less than 100 Secondary level laboratories- Map all laboratories in this level ii) >100-200 Secondary level laboratories: Map 75% of laboratories in this level iii) >200-500 Secondary level laboratories, map 60% of laboratories in this level iv) Above 500 secondary level laboratories, map 40% of laboratories in this level
Primary Level	For countries with: i) Less than 100 Primary level laboratories- Map all laboratories in this level ii) >100-200 Primary level laboratories: Map 75% of laboratories in this level iii) >200-500 Primary level laboratories, map 60% of these laboratories iv) Above 500 Primary level laboratories, map 40 % of laboratories in this level

3.6 Developing a field data collection activity plan and required resources

Upon completing training, Member State should develop a field data collection activity plan by pairing name of site with a specific data collector, key date for data collection, and vehicle allocations especially for in person data collections with the objective to reduce the potential for nonresponse bias as much as possible(See Annex 8). The laboratories staff being interviewed are sometimes working alone but also have to provide services to patients. Key considerations;

- Creating awarness to the sites: Send pre-notification letters 2 weeks before the survey explaining purpose of the survey, (2) establish the legitimacy of the survey and the interviewer, (3) assure confidentiality of answers, and (4) provide contact information for verifications.
- Aligning collectors by parent sector: Assign the data collectors who belong to the same One Health sector for easy acceptability by the host. This also helps in interpreting the context and enhances quality.
- Teams composition: Group data collectors in teams by geographical areas and skills levels. It is critical to ensure that data collectors are in pairs based on strength especially the first week to support each other. The pair can also support testing at site as the staff is being interviewed. Each team should have a team leader to coordinate the data collection exercise.
- Prioritise tertiary laboratories in descending order: The tertiary laboratories are expected to have several test menu hence likely to take more time and this reduces for secondary and primary laboratories. This is also critical in the context of budget constraints and the impact of tertiary laboratories on priority diseases.

4.0 DATA COLLECTORS TRAINING AND DATA COLLECTION

This phase includes data collectors' trainings, field data collection, data accessibility, security, quality, data systems and repository. Credibility of the process is very important in the data collection stage; the data must be collected in a way that yields accurate information about the actual situation through a standardised data collection tools in a country official language. Africa CDC in collaborations with ASLM and Member states have developed a tool and will periodically review the tool to ensure emerging needs are captured(https://aslm.org/wp-content/uploads/2019/11/Survey-on-laboratory-capacity-English.pdf). The tool should be in translated into Member State official language. The tool is supported by the data collection manual and online data collection platform to minimise data quality errors. . The key steps include;

4.1 Data collector's profile

Data collectors selected should be from the same member state, have at least 3 years' hands-on experience in a biomedical laboratory and preferably with prior experience in conducting laboratory network audits/assessments.

4.2 Data collection training

Training is both theoretical and practical and should be organized in person; in case in person cannot be delivered, remote training may be considered provided some requirements such as defining learning objectives, course outline, selecting appropriate instructional strategies, and identifying the necessary technology tools are met. Training team will include one lead facilitator with laboratory background for program aspect and one facilitator for technical Information technology or data analysis.

The GIS LabMap training course covers critical areas such as (i) Rationale for Laboratory mapping, (ii) data collection systems (iii) survey tool covering human resources, infrastructure, test menu, quality management system, biosafety and biosecurity, network and surveillance, equipment, supply chain, and equipment maintenance.

There are two models of trainings;

Physical Trainings

- Training will last three days with 2 days theoretical and 1-day mock data collection in the field.
- The recommended number of trainees should be 10-20 to maintain quality of training.
- There has to be clear training agenda with power point presentations.
- There will be both plenary and breakout sessions to make training more interactive and facilitate group discussion.

Remote trainings

There are several steps needed for successful remote training for LabMap data collection. First step is to identify training platform such as Lab Map Academy(https://academy.aslm.org/)or virtual platforms. The second step is selection of data collectors with considerations of how data will be collected after training. The training can be accessed at the data collectors work station with internet connectivity on smartphones or computers. Depending on the data collection method of either physical collection or self-collection (described in 4.4 below), the selection of data collectors for self-collection should always be the laboratory personnel(site level focal person) at the work station where data will be collected. Third step, is to ensure data collection training last at least 5 days with 3 hours sessions each day followed by trainees' self-assessment by practicing at their workstation.

The Member State should ensure that the selected sites are aware of the data collection program so that the data collector sets aside time for training and collection. The face-to-face interaction is replaced by screen recordings of the platforms and simulations. The evaluation consists of interactive quizzes

to enhance engagement and understanding, establishing a support system, monitoring trainee progress and providing feedback: implement tools and practices for tracking participant progress and offering personalized feedback, designing pre and post tests using the online exam and compilation of training feedback and assessment results.

4.3 Evaluating the data collectors skills:

The data collectors' skills are to be evaluated using standard evaluation criteria before deployment into the field. The criteria for evaluation should include both technical and practical with passing mark threshold. It is expected that before taking the training, the data collectors should have pre-testing and this will be followed by post-test after training. The pre-and post-test results will be used as one of the criteria to assess the competences of the collectors. After practical's, data should be audited and compared against the sources documents or person to ascertain accuracy as part of the evaluation of competences.

4.4 Data Collection approaches

The collection of LabMap data can either be external or self-assessment through web-based data systems. The external assessment involves deploying external assessors that do not work at the laboratory being assessed while in self-assessment the data collection is done and submitted by the person working at the target laboratory. The selection of assessors either for external or self-assessment is done by the Member State using criterial provided through the Member State focal person. The assessors can either be trained physical or through remote training.

4.5 Data systems, access and security

Once the data collector completes recording data, the data is transmitted online in real time to the Africa CDC or Member State repository server. It is at this point that data can be integrated with the other data systems in real time such as the DHIS 2 or the Laboratory Information System(LIS) (See figure 2). Data is queried and cleaned. However, in depth cleaning is done during validation by the country stakeholders. Member States will extract and validate the data and once validated, the data can be visualised using dashboards or further analysed to generate evidence to improve the laboratory systems and network.

4.5. 1.Data quality control

External quality assessment of laboratory mapping data should be undertaken with clear indicators(***See table 2***) and protocol using dual approach strategy;

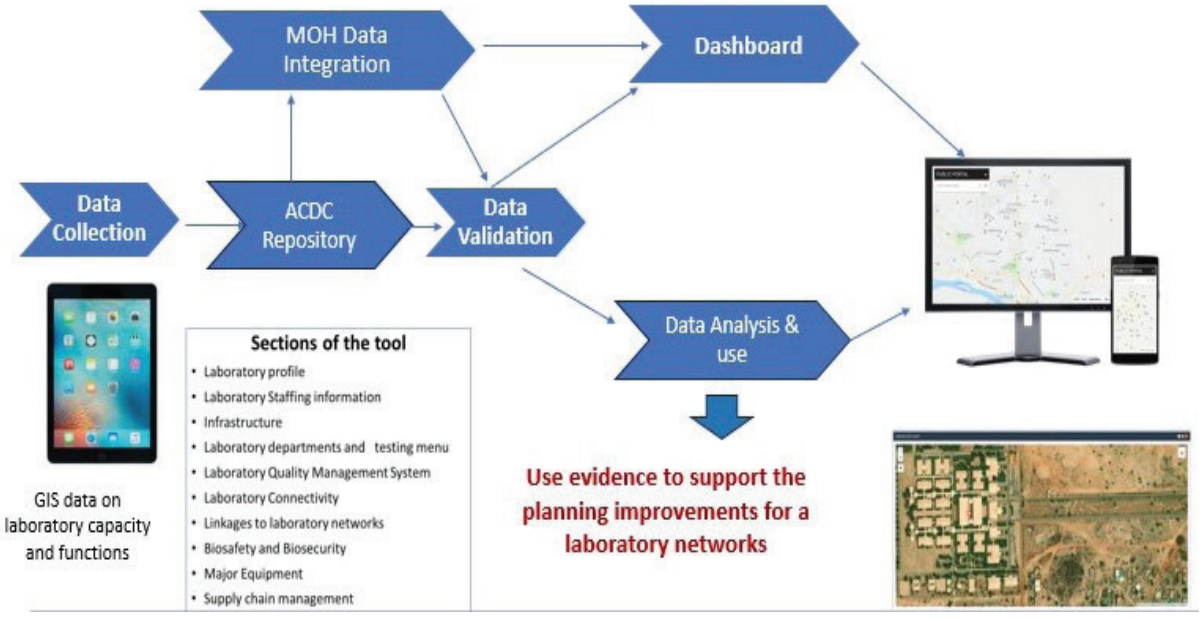


Figure 3: Data Systems

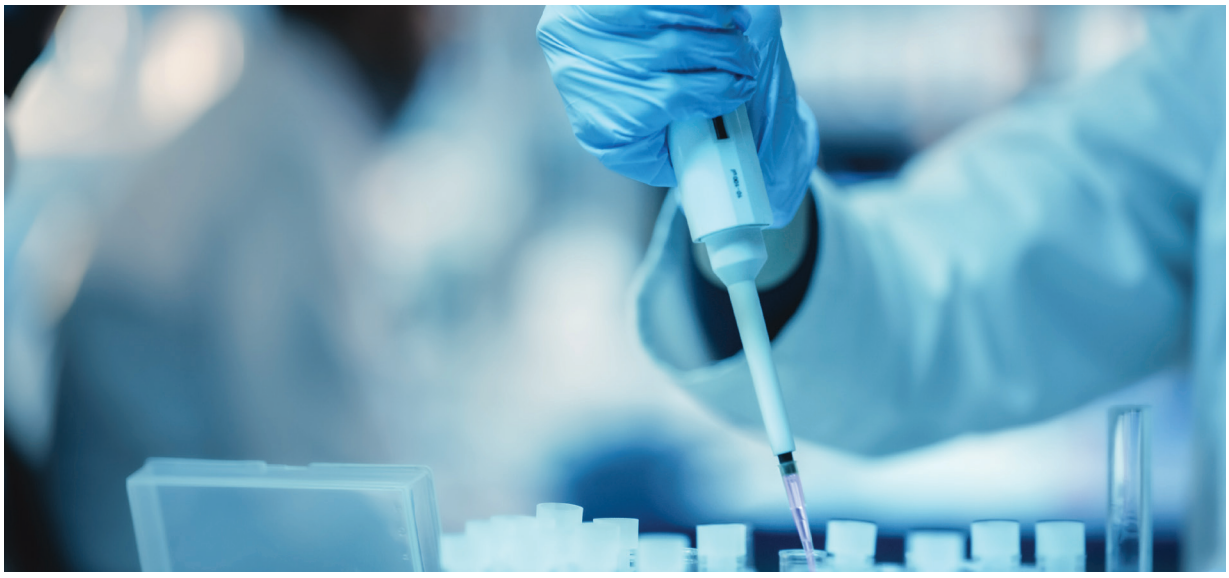
i. Conduct a review of the initial database housed on the repository server and available on the tablets for a theoretical assessment of data from the selected laboratories one by one;

ii. Carry out a field trip to at least 10 percent randomly selected sites, if possible, in order to actively collect data to compare with previous data for updating.

The elements (indicators) that should be verified and their method of calculation are contained in the table below:

Table 2 : Indicators for data quality assessment

Indicators	Definition	Calculation method	Target
Data completeness	Fully filled fields in a form	(Number of fields completely filled in/Total number of fields to be filled in) *100	100%
Data synchronization	Process which allows data transfer from an Android device (phone, tablet) to a server . It is therefore the sending and automatic updating of collected data transferred to a platform	(Number of forms received/Total number of forms transmitted) *100 Or (Number of forms finalized/Number of forms initiated) *100 Or (Number of forms sent/Number of forms finalized) *100 Or (Number of forms received/Number of forms sent) *100	100%
Data integrity	Assurance that digital information has not been corrupted	(Number of corrupted data/Total number of saved data) *100	0%
Data accuracy	% of data corresponding to reality (on site)	(Number of data entered/Total number of data recorded) *100	100%
Data uniqueness	Unique identity, unique opening authorization (license). Should not be repeated	(Number of duplicated data/Total number of saved data) *100	100%



5.0 DATA VALIDATION, ANALYSIS AND UTILIZATION

Following data collection, the in-country team engages in the analysis and use of the data to optimise laboratory systems and networks. This process is critical in transforming data into useful insights based on the use cases. This involves inspecting, cleansing, transforming, and aggregating data with the goal of discovering useful insights and informing conclusions, and supporting decision-making and network optimizations.

5.1 Validation:

Stakeholders' collaborations and involvement from One Health sectors is critical during validation, analysis and utilization process. A workshop is encouraged either remotely or physical depending on availability of financial resources. Key stakeholders from One Health sectors should be equitably represented to review the data and insights and take corrective measures based on existing policy documents.

5.2 Use cases and data utilization:

Utilization of LabMap data is a desired outcome of the program. LabMap data has several use cases including: i) translating evidence into policies and practices such as laboratory strategic plans, annual workplan and National Essential Diagnostic Lists; ii) informing grant proposal requests, iii) supporting advocacy for resource allocation, iv) determining existing disease detection capacity and integration with public health, disease surveillance and response; v) providing insights for further diagnostic network optimization(DNO) exercises to ascertain diagnostic services accessibility; vi) inputting data into route optimization for sample transportation. These have been expanded in the Use case section 6.0 to define what is expected and guide Member States in operationalizing them.

5.3 Data analysis to inform use cases:

Data analysis supported by the data analysis plan to inform the use cases is conducted at different levels as below;

Descriptive Analysis:
This is first phase of analysis to describe the distributions by national tier system of different capacities of the laboratory network with respect to availability and type of testing services, equipment availability, types and placement, numbers, types and competencies of human resources among other key parameters measured during mapping. The analysis can be done using any analytical software (such as R, SPSS, Excel) focusing on key indicators agreed upon by national One Health stakeholders outlined in the data analysis plan. For mapping location any open-source GIS software can be used to visualize locations. Use of data visualization techniques is encouraged as a strategy to make data easily available for program managers. In this case, a LabMap dashboard with KPIs will be integrated within the national data systems.

Capacity gap analysis, insights, and prioritisation:
The analysis focuses on assessing capacity gaps between current availability of laboratory services, and the national or international requirements on those specific areas. In order to identify requirements against which to measure progress, the country teams should review existing published documents such as the national tier system, Africa CDC and national priority diseases list, National Laboratory Strategic Plans, HIV Sstrategic plans, TB strategic plan, National Health Strategic Plans, National Essential Diagnostic List (NEDL), Staffing norms, and One Health sectors strategic documents The countries may consider prioritizing the laboratory sites or thematic issues that require addressing. Key considerations for addressing the issues include use of laboratory tiers, population density, disease burden, geographical locations, security, and other relevant criteria.

5.4 Capacity strengthening workplans and resource requirements

Once Member States have identified insights and prioritised the key laboratory sites or key issues, they can now proceed to develop a capacity strengthening plan to operationalise

the relevant use case identified. In order to implement a project use case, Member States would need to describe the capacity gap being addressed, identify actors, define goals, resources and timelines. It is at this stage that Member State will mobilise resources to implement the utility case selected in collaboration with Africa CDC and partners(See annex 6)

5.5 Publication of report

A final report should be compiled describing the key laboratory system and network capacity gaps, strategies for improvement, and policy implications. The Member State should consider disseminating findings to the national structures including One Health stakeholders. The report should at least include introduction, methodology, key findings, policy implications, recommendations and capacity strengthening plans. For purpose of publication, a standard non-research protocol will be made available to the Member States for ethical clearance.

5.6 Updating of LabMap data, and monitoring implementation

Comprehensive data on laboratory capacity can be collected and updated easily through local, country-owned systems. As implementation of capacity strengthening plans roll out, there is need to pause and reflect on progress made. For successful review, evidence is needed. Therefore, it is expected that Member States will collect and update GIS LabMap every year using two types of data collection methods namely self-assessment and external assessments. Newly enrolled Member State in to GIS LabMap program will start with external assessments and update the dataset using self-assessment method annually for 2 years. In the third year, the Member States will undertake external assessment subject to funding availability. The data generated during subsequent years will be used to monitor changes (based on key performance indicators) introduced as result of implementing the capacity strengthening plans and National laboratory strategic plans.

Using data gathered from the GIS LabMap, the monitoring can happen at two levels i) continental level through Steering committee and ii) national level through the Laboratory TWG. At continental level the monitoring focuses on reviewing progress on workplan and M&E plan. At national level, the focus will be on reviewing the implementation of utility cases identified by Member State using existing information collected at national level.

5.7 Advocacy and communication

Africa CDC can use continental laboratory technical working group (AfLTWG), regional forums, Laboratory mapping workshops and continental and global fora to amplify the role of GIS laboratory mapping in advancing laboratory services. The Member States also can use existing national platforms such as Laboratory TWGs and other national platforms to advocate for technical and financial support.

6.0 USE CASES

GIS laboratory mapping evidence can be used in diverse applications as described under this section. It outlines critical steps that Member States should follow to operationalise the use cases and transition from LabMap evidence into policy and practice. The starting point is the Member State publishing the insights generated from LabMap program to enable application for relevant use case.

6.1 Data translation into policy and practice

Once the Member State has published LabMap evidence and approved, the next steps is to the applications of the evidence to inform decisions, improve practices, or advocate for policy change. The laboratory strategies or policies based on evidence are likely to be better informed, more effective and less expensive than those formulated through ordinary time-constrained and politically constrained processes without evidence input. This evidence can be complimented and triangulated with additional sources of information to ensure this is validated and strategies or policies are formulated on solid technical evidence and open up a range of policy options to consider during policy agenda setting, formulation and implementation. The critical steps to be followed at national or continental have been described below;

Table 3 Evidence translation to policy and practice

No	Step	Action	Purpose
1	Leverage the Africa Laboratory Technical Working Group or National One Health TWG	Form a diverse group to oversee and drive the initiative.	To bring together stakeholders and guide the Strategy and policy development process.
2	Disseminated the GIS LabMap insights including from DNO and other sources to AfLTWG, One Health TWGs and other program and policy makers	Publication of report with insights to evaluate the components of a laboratory system.	To understand the existing laboratory system's strengths, weaknesses, opportunities, and threats. Assess laboratories across different tiers of the healthcare system for a comprehensive overview.
3	Collect relevant documents and data	Gather Africa CDC or national health policies, laws, strategic frameworks and plans, ministerial orders, and data on laboratories (number, location, staffing, uses, finances).	Gap analysis to identify strategic or policy issues and forming the evidence base.
4	Conduct strategy and policy workshops to review or develop strategies and policies that strengthen laboratory systems and networks	Workshop 1: Identifying Issues • Develop a clear vision for the laboratory system. • Perform an overall SWOT analysis. • Identify specific policy topics for development. • Conduct a SWOT analysis for each identified policy topic.	Setting agenda through policy briefs and white papers. Compare the evidence to strategy or policy gap

No	Step	Action	Purpose
		Workshop 2: Providing the Evidence • Finalize all SWOT statements. • Group SWOT statements to identify key elements. • Begin the process of verifying and validating these key elements. Subsequent Workshops • Finalize the verification of SWOT statements. • Formulate outcomes based on the verified SWOT analyses. • Define specific strategy or policy statements for each key element to achieve the desired outcomes	
5	Incorporate laboratory systems and network experts to review the polices or strategies	Leverage experts to provide critical technical and analytical feedback on results from interlaboratory comparisons and other relevant activities.	Use workshops with participants and experts to discuss potential sources of error and methods for quality assurance and control to improve laboratory performance.
6	Draft and implement strategies or policies	Prepare the draft policy based on the finalized outcomes and policy statements from the workshops.	Create a tailored laboratory policy that aligns with the continental or country's specific needs and development goals.

6.2 Laboratory based surveillance of notifiable diseases

The GIS LabMap information on network design and connectivity, referral and sample transportation, and conventional and point of care devices combined with test volumes per device can be transformed to optimise real time bio-surveillance across the country or region. Real-time bio-surveillance through a robust national laboratory system, and effective modern point-of-care and laboratory-based diagnostics is vital to the timely addressing of global health security issues.

Link to Joint External Evaluation
The WHO Joint External Evaluation (JEE) tool was designed to assess country-level progress made to prevent, detect, and respond to emerging public health threats in meeting the requirements outlined in the IHR . The JEE target for surveillance is a country that has surveillance with a national laboratory system, including all relevant sectors, particularly human and animal health, and effective modern point-of-care and laboratory-based diagnostics. The national laboratory system should include:

- ability to conduct diagnostic tests on priority diseases;
- ability to transport specimens safely and quickly from 80% or more of intermediate levels/districts to national laboratory facilities for advanced diagnostics;
- ability to conduct high-level diagnostic testing at national laboratories or have

agreements with regional networks to ensure testing is available

- ability to test for antimicrobial susceptibility for priority pathogens in human health and in animal food production.

Steps in establishing disease surveillance
The 1998 Integrated Disease Surveillance and Response (IDSR) is a comprehensive public health strategy developed to strengthen the early detection, reporting, laboratory confirmation, and response to public health events and priority diseases at all levels of the health system. It requires countries to strengthen capacity for disease surveillance and response, application of electronic tools to enhance real-time surveillance to improve timeliness of outbreak detection. Potential data systems that exit across Africa to support real time bio-surveillance. To achieve this, LabMap data should be integrated with the existing country data systems to operationalise the real time disease surveillance on test volumes It is important to note that the sources differ on frequency and preference should be the data systems that achieves reporting within 48 hours of outbreak detection.

The key considerations include data integration, data privacy and use of a unique identifier (ID number), data security and user-agreement policies, information system maintenance and sustainability. Depending on the country, more considerations may need to be made. Countries need also to ensure that they are ready to embark on electronic Integrated Disease Surveillance and Response system from laboratory perspective(aids), by weighing the costs and benefits and also assessing eIDSR feasibility options in their county.

Table 3 Steps in linking LabMap and laboratory based surveillance

No	Steps	Lead
1	Engage National One Health Laboratory stakeholders, National Surveillance and Response Team, and leverage existing technical working groups	Africa Laboratory Technical Working Group Laboratory Systems & Networks Steering Group National One Heath TWG
2	Evaluate the country capabilities and need for functional eIDSR and dashboard. WHO has developed a standardized eSurveillance assessment tool, which may also be used as a resource tool: network coverage, power supply option, equipment, central repository, hardware, software for surveillance or similar function, devices, technical capacity. The ministry of health needs to make electronic disease surveillance a priority, and establish an epidemics and infectious diseases (EID) division to follow up on implementation of disease surveillance activities. Appointing a disease surveillance focal point at district level is a key point in the success of IDSR implementation.	National One Heath TWG
3	Determining appropriate scope surveillance for priority diseases and visualizations' to be implementations. Countries should consider as starting point WHO JEE, and Africa CDC test types for surveillance. Countries should determine the scope (real time alert notification, case-based reporting, routine weekly reporting, routine monthly reporting, and outbreak/emergency management). Countries may start with any approach that fits their needs and capacity at the time, and later add on other functions. Obtain estimates for initial investments and current costs. Countries should determine potential investors.	Laboratory Systems & Networks Steering Group National One Heath TWG

3	Evaluate Master Laboratory Facility list equipment list, test type, network, connectivity and referral data to identify strength and gaps in the network.	Laboratory Systems & Networks Steering Group National One Heath TWG
8	Standard operating procedures for One Health laboratory-based surveillance.	National One Heath TWG
9	Develop a roll out plan • Develop and launch country-specific implementation plan. • Consider a disease specific step-wise incremental process in implementing plan and training. • Incorporate routine monitoring and regular evaluations.	National One Heath TWG

6.3 Hub and spoke network optimization

While GIS LabMap can provide useful insights on capacity gaps in the systems and network, it has limitations. The hubs and spokes network optimization can be adopted to enhance networking, optimize sample referrals and improve accessibility of diagnostic services by patients. Access to diagnostics is essential for ensuring health for all. How a diagnostic network is designed is key to delivering patient-centered and equitable diagnostic services(https://aslm.org/resource/diagnostic-network-optimization-dno-objectives-definition-and-key-principles-and-approach/).

Using data from GIS LabMap ,Member States can further undertake an in-depth analysis of their diagnostic network through the Diagnostic Network Optimization(DNO). In this context, DNO is described as a geospatial network analytics approach to plan diagnostic networks consistent with national health goals and strategies, including universal health coverage(https://www.finddx.org/what-we-do/cross-cutting-workstreams/diagnostic-network-design-and-optimization/). LabMap data can provide which sites are testing which pathogen and type of equipment available in the country to inform further network optimization. Depending on the research questions, additional data may be gathered. Geospatially-powered visualization, analysis and optimization should be done to analyze a country's diagnostic network and inform changes to the type, number and location of diagnostics and associated sample referral system to achieve national health goals. It enables decision-makers to utilize data and build evidence to identify the most impactful interventions for:

- **better network visualization** facilitating enhanced coordination among programmes and partners and enabling better decision-making;
- **improving access to diagnosis** leading to reduced diagnostic delay and loss, resulting in more people diagnosed and treated; and
- **increasing network efficiency** resulting in reduced procurement and operating costs, enabling better prioritization of available resources.

There are various forms of DNO that can be implemented depending on research questions. The types of DNOs range from simple to complex depending on the research questions. Member States should be guided by the research questions that in turn can lead to appropriate data to be gathered , analysis software and timelines to use as described below;

Table 4 Diagnostic Network Optimization guiding Research questions

Focus	What questions can be answered?	Tools
Population accessibility Analysis	• How accessible are current services to the population (travel time/distance)? • Could coverage be improved with service expansion or introduction of new Diagnostics?	DxGeoMap, AccessMod, ArcGIS, Planwise
Laboratory capacity mapping	• Are Diagnostic services equitably distributed? • To what extent is capacity utilized? • Could the current network support higher testing volumes?	Tableau, PowerBI, Excel, ArcGIS, LabMap, OptiDx
Basic optimization	• What is the optimal location of Diagnostic capacity to meet current & future needs? • How can integration work best?	ArcGIS, AccessMod, OptiDx
Advanced optimization	• What is the optimal mix and placement of devices? • What is the best balance between adding more devices & sample transport?	OptiDx, SC design Software
Digitally-powered DNO, automated data flows	• How does the Diagnostic network perform in real time • Track progress for continuous improvement	

Considerations for hub and spoke network optimizations

i. **Country ownership** of the DNO and capacity to conduct and utilize the DNO analysis is critical to ensure its use is aligned with country goals and strategies, and that recommendations inform action.

ii. **Engagement with DNO within a multi-stakeholder framework:** DNO works best in a multi-stakeholder framework coordinated and led by Ministries of Health. As DNO can help bring planning and system efficient help bring planning and system efficiencies across siloes of disease programmes, agencies and departments, and the public and private sector, it is important to ensure that all programmes, sectors and partners are engaged, contribute relevant inputs and participate in implementing the recommendations.

iii. **Disease integration:** DNO can help analyse where diagnostic network capacity for one disease could be integrated with testing for other diseases to increase access and efficiency. However, when considering changes to testing services for one disease, experts and representatives from all related disease programmes should be involved in the analysis to ensure all priorities are adequately addressed.

iv. **Existing skill sets and the need for capacity building:** A multi-disciplinary team including strategic decision- Akers, a data analyst/ statistician and disease area experts is essential to conduct DNO. The extent of capacity building or external technical assistance required is influenced by multiple factors such as existing skill set, staff time available for training and conducting DNO, and overall timeline. While in-country capacity building might make DNO more sustainable and reduce long-term costs, DNO can typically be conducted more quickly when supported by an external technical assistance partner.

v. **Iterative updates:** DNO is most effective

when conducted in an iterative manner, embedded in planning/funding cycles, with models being updated as significant developments occur or with any changes in forecasted testing demand. Networks should be assessed or monitored annually, and repeat DNO analysis should be performed when significant gaps are identified. However, DNO is not intended for day-to-day operational planning, routine monitoring of activities, reporting of laboratory results or detailed budgeting.

vi. **Consideration of immediate and longer-term goals and budgetary requirements:** DNO is most effective when keeping in mind both immediate programmatic and budgetary constraints, as well as longer-term aspirational targets.

vii. **Alignment with national strategy:** As DNO is only one element of data-driven planning, investments in diagnostic systems need to be conducted at an appropriate time point, compared with other programme interventions and fully aligned with national disease and laboratory system strategies to achieve overall healthcare goals.

viii. **Development of operational plan:** Each DNO should be accompanied by the development and agreement of an operational plan that outlines how the recommendations will be implemented.

7.0 GOVERNANCE AND COORDINATION AT CONTINENTAL LEVEL

To effectively deliver the strategic objectives in this framework, it's crucial to leverage existing regional and national institutions and structures for better coordination and collaboration. Africa CDC, in partnership with ASLM and other partners through the LabMap Program, will establish a system that enables Member States to collect, store and analyze GIS-linked data on laboratory capacity, systems and networks functionality.

The Africa CDC's five regional Coordinating Centres (RCCs), across the Northern, Central, Eastern, Western and Southern Africa regions, will act as key hubs in supporting countries in GIS LabMap. The RCCs work directly with National Public Health Institutes (NPHIs) and/or similar government structures across One Health sectors. The NPHIs are national-level institutions that lead and coordinate public health functions, including disease surveillance, laboratory systems and networks, emergency preparedness, response and public health research.

Existing structures, for example, the Continental Laboratory Technical Working Group (AfLTWG) will play a critical role in coordinating and providing guidance for GIS Lab Mapping activities. The laboratory systems and network steering group, a new structure, will operationalize and steer LabMap activities at continental level, report its progress to the AfLTWG quarterly and work closely with countries. The Africa CDC RCCs and National One Health TWGs shall have representatives in steering group.

At country level, national One Health laboratory TWGs are expected to take a similar role and where these do not existing, the NPHI can assume this role with close collaborations with the Africa CDC regional bodies the RCCs. This approach will ensure coordination and enhance the ability to detect and respond swiftly to health threats and disease outbreaks, guided by scientific evidence and data-driven strategies.

Table 5: Governance structure with defined roles and responsibilities;

Institution	Roles and Responsibilities
Africa CDC	• Facilitate the standardisation of LabMap survey tool • Coordinate GIS LabMap activities with regional health priorities and strategic frameworks to ensure alignment with public health goals, enhance laboratory capacity, and support disease surveillance, outbreak response, and health system strengthening. • Support Member States to address capacity gaps identified by mapping exercise. • Translate evidence into policy and practice. • Resource mobilisation for laboratory mapping activities
ASLM and other development or implementing partners	Provide Technical Assistance in • Supporting GIS Laboratory Mapping program design and implementation • Develop and deliver training programs to strengthen laboratory capabilities, focusing on standardized procedures and quality management systems. • Oversee the collection, analysis, and reporting of laboratory data, ensuring it is used to inform decision-making and policy. • Prepare regular progress reports, case studies, and documentation of best practices for stakeholders and partners.

Institution	Roles and Responsibilities
Africa Laboratory Technical Working Group	• Provide technical guidance in the development, implementation, and sustainability of LabMap initiatives across Member States. • Review LabMap generated insights, and identify appropriate policies or strategies to strengthen the lab systems and networks across the continent. • Facilitate the sharing of information, knowledge, and best practices related to LabMap with countries, policymakers, and stakeholders through strategic partnerships. • Support Member States National TWG in establishing or enhancing their national multi-sectoral LabMap technical working groups, promoting cohesive coordination at the national level. • Support countries to mobilise funding to address the capacity gaps identified for priority pathogens.
Laboratory Systems and Laboratory Networks Steering Group	• Provide updates on the laboratory systems and network insights based on capacity gaps, prioritisation, and resource requirements from GIS LabMap to the Africa Laboratory Technical Working Group • Provide guidelines in designating focal point teams responsible for coordinating LabMap activities within the country, serving as the primary liaison with Africa CDC, ASLM, and other partners. • Build capacity of the national focal team human Resources in data collection, analysis and utilisation. • Support the integration of LabMap data products and surveillance dashboard with country data systems . • Facilitate the identification of LabMap use cases • Facilitate the development of manuscripts and publications • Coordinate the integrated south to south learning platforms related to LabMap with one health sectors, countries, policymakers, and stakeholders through strategic partnerships. • Monitor the implementation and compliance of countries in implementation the program.
Ministry of Health/NPHI of the member states	• Designate a dedicated national GIS LabMap focal point team of technical, Data Analyst and IT officers drawn across the one health sector responsible for coordinating LabMap activities within the country, serving as the primary liaison with Africa CDC, ASLM, and other partners. • Allocate personnel to participate in training programs, enhancing national capacity in laboratory mapping, data collection, and analysis at national and site level. • Oversee the systematic collection of laboratory data, ensuring accuracy, completeness, and timely reporting as per LabMap standards. • Contribute resources to support the expansion and long-term sustainability of the GIS LabMap program, that may include transport, training venues, personnel, bundles, and operational costs. • Actively analyse the data gathered through LabMap to inform policy, improve laboratory services, and enhance response capabilities to health threats. • Ensure that LabMap activities and insights are incorporated into the Laboratory Strategic Plans. • Maintain full ownership and custody of all data collected within the country. • Share and disseminate the LabMap data to the Lab TWG and all One Health stakeholders in country.

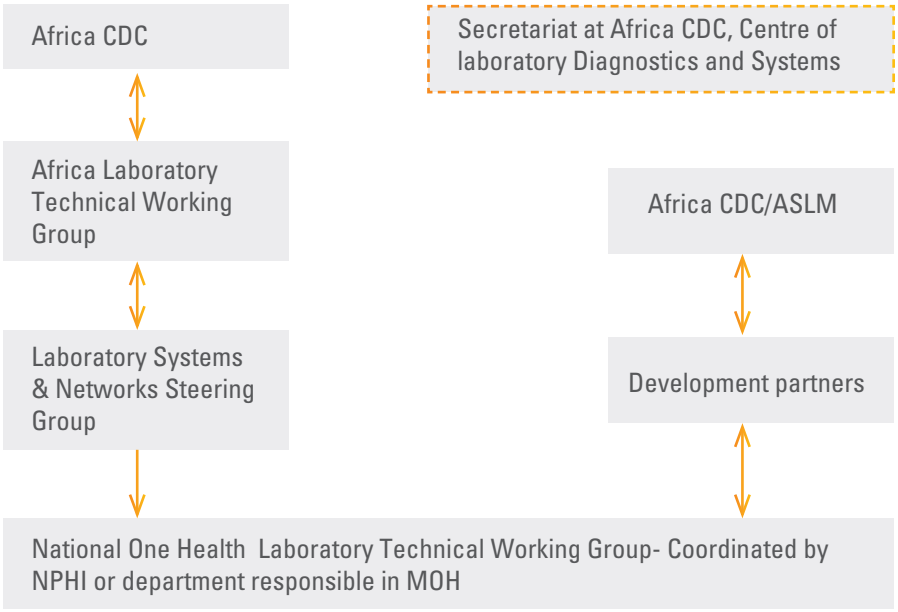


Figure -4 Implementation framework

8.0 RESOURCE MOBILIZATION AND SUSTAINABILITY

Resource mobilization and sustainability are critical aspects for the success of a laboratory capacity mapping program. Africa CDC assesses and determines the necessary resources of human, financial, and technical to perform a comprehensive evaluation of laboratory capabilities, infrastructure necessities, and staffing needs. In terms of funding strategy, Africa CDC and ASLM collaborate with partners to connect with global health organizations and development agencies, crafting persuasive proposals that emphasize the significance and impact of the mapping initiative. They also seek support from technology companies for software, equipment, and technical assistance, while partnering with universities for research expertise and additional resources.

The Africa CDC in collaboration with ASLM and Member states will use multiple strategies to mobilise funds to ensure the expansions and sustainability of laboratory mapping, updating of datasets, utilisation and implementation of activities delivered from mapping insights. Some of the resource mobilisations and sustainability strategies are outlined below;

7.1 Strategies for resource mobilisation for lab mapping activities

- Africa CDC and ASLM should advocate to Member State to prioritise and allocate funds for laboratory mapping activities
- Ensure GIS laboratory mapping activities are included into the national laboratory strategic plan as it makes it easier to mobilise resources. Ensure laboratory mapping activities are included in the annual operational plan
- Develop systems and network capacity strengthening plans based on use cases and integrate into laboratory strategic plans to address capacity gaps identified during data analysis and utilisation phase. This can be used to mobilise resources from various stakeholders.
- Member States should map out potential funders to solicit support for implementation of activities.
- Develop a standard concept note or proposal and send to partners to maximise resources for activities

7.2 Strategies for sustainability

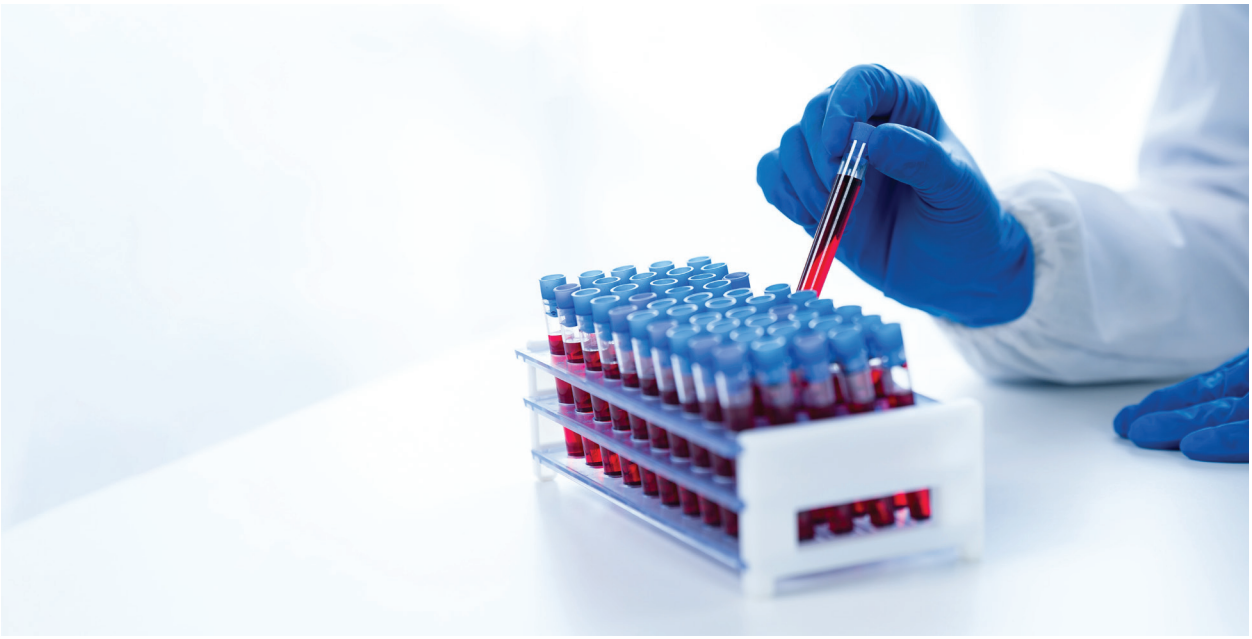
- Continual support from virtual learning platforms (e.g. ASLM academy, FIND academy) to enhance capacity and expertise
- Develop scope of work (TOR) for the GIS LabMap core team of Focal person, and data administrator and HIS personnel
- The member state Laboratory TWG should include GIS LabMap insights on their agenda to promote advocacy.
- Support establishment of infrastructure required for data collection, storage, analysis and reporting.
- Institutionalisation of GIS LabMap into existing government structures.

7.3 Estimate cost for LabMap per country

The costs below are indicative and are based on previous LabMap experiences and are influenced by Member State geographical size and number of laboratories to be mapped and cost of living.

Table-6 Costs of LabMap per country

Cost Element	External Assessment	Remote Self-Assessment
Data Collection Costs Data collection training Tablets Data bundles Vehicle rentals Fuel for data collection Upkeep for data collectors	$ 55000-$75,000 for 25 data collectors depending on country size	USD 15 per laboratory. The cost is for bundles only
IT Costs ONA subscriptions	$5,000/year	$5,000/year
Integration with national data systems (DHIS2/ LIMS)	$5,000/country	$5,000/country
Data validation, Analysis and Utilization work-shop	$20,000 per country	$20,000/country
Report publication	ASLM Journal, ACDC Journal of Public Health	ASLM Journal, ACDC Journal of Public Health
Report dissemination meetings	Integrate with other meetings for sustainability	Integrate with other meetings for sustainability
Capacity Strenghening plans implementation	$300,000 per country	$300,000 per country



9.0 MONITORING AND EVALUATION

The GIS LabMap framework includes a Key Performance Indicator (KPI) that measures progress towards achieving the Strategy's overall objectives and targets. The objective of this framework is to facilitate performance management, continuous learning and improved decision-making. The inclusion of KPIs and regular evaluation processes ensures that progress is measurable and transparent. This is done by providing relevant, comprehensive and timely information to decision makers to support them in improving GIS LabMap program quality, efficiency, effectiveness, and the impact of investments. The M&E framework will help to measure the progress in the implementation of activities, as well as progress in achieving the intended objectives and targets.

The laboratory systems and network steering committee will coordinate all stakeholders at continental, regional and national levels, to ensure optimum utilization of available M&E resources for enhanced monitoring and evaluation. Routine data collation, aggregation, and/ or analysis involved in generating key insights related to high-level Strategy implementation and performance towards achieving the goals and objectives will be achieved through Strategic Performance Reports to steering committee. By identifying areas of strong and poor performance, Strategic Performance Reports flag where progress against targets is off track which requires response and action by the Secretariat but also, depending on the issue, the wider partnership.

This section's emphasis on continuous improvement through feedback mechanisms and demonstrates commitment to adaptability and responsiveness. Progress in implementation of the LabMap Strategic framework will be routinely monitored on a quarterly, and annual basis whilst the evaluation of the strategic framework will be done through midterm review and end-term evaluation. The mid and end term reviews will provide the opportunity to gather additional information, assess progress, as well as to make appropriate mid-course corrections. The M&E will include reviews of; i) Objectives ii) Coverage of interventions in comparison to targets, iii) Status of indicators in line with strategic objectives iv) Major activities and how well they are implemented.

The M&E framework below gives the Strategic objectives, Outputs and activities, indicators for monitoring implementation.

9.1 Key Performance Indicators

The Africa CDC, ASLM, and Member States (MOH, NPHIs) will produce GIS LabMap Performance reports, dashboards and other materials to analyze data from the M&E framework. These materials are integral to assessing the effectiveness of programs, advocating for change where needed and encouraging course correction to achieve the goals of the Strategy, and to drive learning across the continent. As an organization committed to continuous learning and improvement, the Africa CDC in collaboration with ASLM will continue to update and refine frameworks, systems and tools within the overarching M&E Framework in response to the learning and accountability needs of Strategy delivery.

The Key Overarching Question for Measuring Performance of the Strategy: ***How can the GIS Laboratory Mapping data be effectively used to improve Laboratory Systems and Networks?***
In order to address the key question, interrelated specific questions have been outlined as below;

1. What is the status of the laboratory system and network capacity in the member states?
2. What are the laboratory systems and network capacity gaps?
3. What strategies and policies can be implemented to address the existing capacity gaps in the laboratory systems and network?

4. How does GIS LabMap data enhance the preparedness for disease outbreaks?
5. What are the required resources for laboratory systems and network?

9.2 Data collection

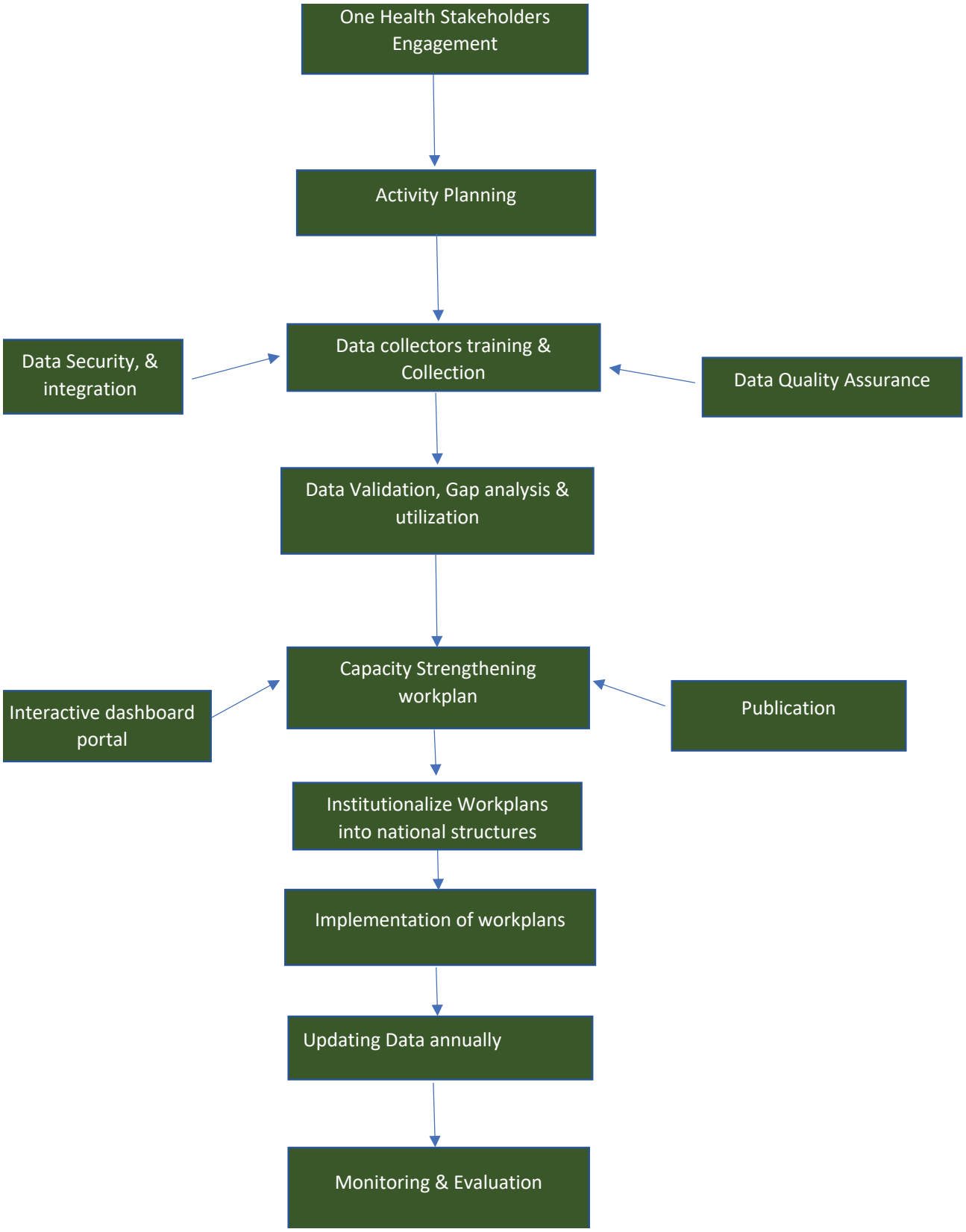
Routine and periodic data collection and in-country evidence generation reported to the Africa CDC, which leverage (where possible) existing routine national monitoring systems and reported to through regional meetings. In instances where routine data systems cannot provide required data to monitor and assess progress towards all areas of the Strategy, supplemental monitoring may be undertaken by Africa CDC and partners to provide more targeted, granular, and/or frequent data. This may involve online surveys, assessments, and program reviews.

Table 7: Monitoring and Evaluation Indicators

Objective/Outputs	Indicator	Numerator	Denominator
Objective 1: To expand geospatial mapping of laboratory capacity in AU member states	Percentage of AU member states with geospatially mapped laboratory capacity.	Number of AU member states with geospatially mapped laboratories	Number of AU member states
Output 1.1 Approved GIS strategic framework	Number of AU member states that have adopted the GIS strategic framework	Number of AU member states that have adopted the GIS strategic framework	Number of AU Member States
Output 1.2 Member states GIS lab mapping capacity developed	Number of AU member states with trained GIS laboratory mapping Experts	Number of AU member states with trained GIS lab mapping experts	Number of AU Member States
Output 1.3 Geo-mapping infrastructure and technology improved	Number of AU Member States supported and integrated LabMap data into national HMIS	Number of AU member states that have integrated LabMap data into HMIS/ DHIS2	Number of AU Member States
Objective 2: To increase the utilization of laboratory capacity mapping data to inform improvement and scale-up of diagnostic capacity.	Percentage of AU member states enrolled in LabMap and utilizing Lab mapping data for decision-making	Number of AU member states enrolled in LabMap program and utilizing LabMap data	Number of AU member states that have mapped the laboratory functions
Output 2.1 GIS lab mapping analytics	Number of AU member states with an integrated dashboard visualization portal for key laboratory monitoring indicators	Number of AU member states with unintegrated dashboard visualization portal	Number of AU Member States involved in laboratory mapping program
Output 2.2 Operationalise the LabMap use cases	Number of AU member states implementing at least one-use cases	Number of AU Member States using laboratory mapping to address laboratory capacity gaps (use cases)	Number of AU Member States involved in laboratory mapping program

Annexes

Annex 1: LabMaP Process Flowchart



Annex 2: One Health Stakeholders mapping

One Health sector	Department	Role	Impact (High/ Low)	Contact Person	Phone	Email

Annex 3: Data Sharing Agreement

DATA SHARING AGREEMENT BETWEEN
AFRICA CDC/ASLM/PARTNER
AND
PROVIDER: Member State

I. Definitions

1. AFRICA CDC/ASLM/PARTNER: (...)
2. Provider: Institution or party such as MOH, MOH department, NGO, etc that is agreeing to provide data to AFRICA CDC/ASLM/PARTNER.
3. Primary datasets: the main data records being shared to allow AFRICA CDC/ASLM/PARTNER to fulfill the Purpose. Primary datasets may be accompanied by accessory data, such as metadata and ancillary information for correct interpretation or display in Derivatives.
4. Derivatives: Original work developed by AFRICA CDC/ASLM/PARTNER or 3rd parties that is materially based on the primary datasets shared by Provider. Derivative works will be considered "Adapted Material" under the CC BY-NC-SA 4.0 terms.
5. CC BY-NC-SA 4.0: Creative Commons, Attribution-Noncommercial-Share Alike 4.0 International License.

It is described in this human-readable text: **https://creativecommons.org/licenses/by-nc-sa/4.0/ (https://creativecommons.org/licenses/by-nc-sa/4.0/)**
And this complete legal code: **https://creativecommons.org/licenses/by-nc-sa/4.0/legalcode (https://creativecommons.org/licenses/by-nc-sa/4.0/legalcode)**

6. The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 which can be found at: **https://www.ietf.org/rfc/rfc2119.txt (https://www.ietf.org/rfc/rfc2119.txt)** .

II. Purpose
The purpose of this agreement is to specify the terms and conditions under which Provider will share data with AFRICA CDC/ASLM/PARTNER. It describes the rights and obligations of the Provider and AFRICA CDC/ASLM/PARTNER with regards to data custody, and with regards to data intellectual property.
In the terms there are descriptions of specific pieces of information that AFRICA CDC/ASLM/PARTNER and Provider must exchange and acknowledge. These are captured in Addendum A:

Data Sharing Worksheet to simplify collecting the required information.

III. Data Custody

1. Provider must give primary datasets to AFRICA CDC/ASLM/PARTNER.
    1. With an agreed definition and completeness.
        1. Agreeing it contains certain 'columns' or data fields.
        2. Agreeing it contains certain events or rows.
2. In an agreed timeframe.
        1. Automatically from the Provider shortly after the data gets generated or collected by Provider, or within a fixed period from AFRICA CDC/ASLM/PARTNER's request.
3. In an agreed method.
        1. AFRICA CDC/ASLM/PARTNER and Provider must collaborate in order to establish a secure and reliable method (e.g file exchange, API query, uploads to online workspace, etc.)
4. Provider should collaborate with AFRICA CDC/ASLM/PARTNER to assist with correct interpretation of the data by providing a data model, or commentary on the fields, to AFRICA CDC/ASLM/PARTNER's satisfaction.
5. Provider should include supporting datasets (e.g. a list of district names) in addition to the primary datasets.
6. If Provider can't share data as specified due to a technical or non-technical issue Provider should notify AFRICA CDC/ASLM/PARTNER proactively, and should work with AFRICA CDC/ASLM/PARTNER to resolve the issue
    2. AFRICA CDC/ASLM/PARTNER must follow Data Storage practices:
        1. AFRICA CDC/ASLM/PARTNER Should store data as appropriate for their goals of creating useful derivatives:
            1. In appropriate formats determined by AFRICA CDC/ASLM/PARTNER,
            2. Using appropriate storage means determined by AFRICA CDC/ASLM/PARTNER,
            3. Under exclusive custody of AFRICA CDC/ASLM/PARTNER or by 3rd parties that must be beholden to AFRICA CDC/ASLM/PARTNER and terms of this agreement.
        2. AFRICA CDC/ASLM/PARTNER may discard or delete parts of the data if not necessary for their goals.
        3. Provider should ensure the AFRICA CDC/ASLM/PARTNER copy of data is not the only copy in existence. Under this agreement AFRICA CDC/ASLM/PARTNER is a custody of a copy the data for the purpose of development of useful derivatives, not as a hosting service for the primary storage of Provider data.
        4. AFRICA CDC/ASLM/PARTNER must implement professional-level data custody practices, including access control, access audit, and communications with Provider about custody risks.
    3. Creation of Derivatives
        1. AFRICA CDC/ASLM/PARTNER may create derivatives by querying, filtering, processing and crosslinking the data supplied by Provider:
            1. Derivatives may be static (eg a PDF report, a powerpoint presentation) or may be dynamic and interactive (e.g. a dashboard website).
            2. Derivatives may be created by itself or in combination with 3rd party data (e.g. a map from google maps, a population database from open sources). AFRICA CDC/ASLM/PARTNER must fulfill the licensing terms for derivatives as specified below in IV Intellectual Property and Licensing.
            3. AFRICA CDC/ASLM/PARTNER may use 3rd parties to help with creation of derivatives. These 3rd parties or the derivatives produced by them must be contractually bound by the same terms of this agreement by enforcement

of AFRICA CDC/ASLM/PARTNER. AFRICA CDC/ASLM/PARTNER must keep records of what data is shared with what 3rd parties for what purposes.

2. AFRICA CDC/ASLM/PARTNER must make derivatives that used the primary datasets available to the Provider through broad publication on the internet or upon request, following the section IV. Intellectual Property and Licensing.

4. Provider control of data
    1. If requested by Provider through the specified points of contact, AFRICA CDC/ASLM/PARTNER must be able to delete/remove the data from its custody within 90 days. Data deletion should be done following professional practices including archival of backups and appropriate disposal of physical media.
    2. Provider acknowledges that a request for data deletion/removal may not retroactively affect derivatives. (e.g. a pie chart drawn the previous year).

IV. Intellectual Property and Licensing

1. Provider must have ownership rights to primary dataset, specifically rights to enact this agreement. Provider must guarantee that information is ethically sourced and that data collection methods have implemented appropriate informed consent, opt-out, and chain of custody practices.
2. Provider must assure the datasets being shared are respectful of individuals' privacy and are de-identified, and anonymized, or otherwise transformed in ways that preserve privacy of individuals.
3. Provider acknowledges some accessory datasets, and are just exchanged for correct interpretation of the primary dataset, may be treated as being in the public domain (e.g. a list of province names and IDs, or a list of disease codes) and are immaterial to licensing terms of the primary dataset, so are excluded from this agreement for practical reasons.
4. Provider is responsible for authoring and providing AFRICA CDC/ASLM/PARTNER appropriate attribution text (e.g. "This work is based on data provided by the Tuberculosis Control program of the Nigeria Ministry of Health").
5. Provider must give data to AFRICA CDC/ASLM/PARTNER under the CC BY-NC-SA 4.0 license.
    i. 1. This is a legal international license appropriate for databases and other work, found in Definitions.
    ii. 2. It guarantees AFRICA CDC/ASLM/PARTNER must add attribution to Provider's contribution if derivative work is produced, as specified in license text.
    iii. 3. It guarantees that AFRICA CDC/ASLM/PARTNER cannot perform commercial work using the dataset, as specified in license text.
    iv. 4. It guarantees that secondary derivatives also must follow these terms, as specified in license text. (eg someone creates a presentation using an AFRICA CDC/ASLM/PARTNER -generated graph that's based on data from a Provider in Nigeria)
    v. 5. If Provider is sending documents or additional data beyond the primary dataset that Provider considers is under the terms of this sharing agreement, it must annotate it with the following text to make sharing terms explicit and unambiguous:
    "© Provider Name, Year, Licensed as CC BY-NC-SA 4.0"
    (Example: "© Ministry of Health of Zambia, 2018, Licensed as CC BY-NC-SA 4.0")
6. Provider may choose to share data with AFRICA CDC/ASLM/PARTNER under additional data licenses, or under additional terms outside of the terms of this Data Sharing Agreement. This puts Provider in control of how and when additional data uses by AFRICA CDC/ASLM/PARTNER are possible.
    i. 1. If AFRICA CDC/ASLM/PARTNER were to encounter the opportunity to generate commercial work (eg with a diagnostics company), it must work with Provider to get the same dataset licensed under different terms (for example CC BY-SA 4.0, which requires attribution but does not restrict commercial use, but any license can be used including licenses not based on Creative Commons). This gives the

Provider an opportunity to negotiate with ALSM the terms under which its AFRICA CDC/ASLM/PARTNER or 3rd parties achieve commercial use of derivatives.

7. AFRICA CDC/ASLM/PARTNER must license derivatives under CC BY-NC-SA 4.0
    i. 1. This is a legal international license appropriate for databases and other work.
    ii. 2. It legally guarantees the Provider shall have access to derivatives.
    iii. 3. It guarantees further derivatives beyond those created by AFRICA CDC/ASLM/PARTNER are also bound by the same transfer terms, as specified in license text.
    iv. 4. When creating derivatives, AFRICA CDC/ASLM/PARTNER must follow CC BY-NC-SA 4.0 terms by:
        - 1. Adding attribution credit information to all subsequent derivatives, as specified in license text. The
        - Creative Commons website provides simple text-based and image-based guidelines to achieve this.
        - 2. Notifying the Provider of derivatives and giving Provider royalty-free access, or placing them in public domain, as specified in license text.
        - 3. Not sharing the raw data with 3rd parties for commercial purposes (as defined in license text), or using data directly for commercial purposes, without entering a additional licensing agreement with Provider.

V. Additional Provisions

1. Parties agree to keep each other's point of contact information as specified in Addendum A: Data Sharing Worksheet updated and current.
2. Warranties (...)
3. Termination (...)
4. Force Majeure (...)
5. Governing law (...)

VI. Signatures

1. AFRICA CDC/ASLM/PARTNER (...)
2. Provider (...)

Addendum A: Data Sharing Worksheet

Data Provider: Organization Name, Department, Address
Data Sharing terms

Description of data to be shared, including criteria in terms of time ranges, types and sources of events, and specific data fields or events to be included.
Description of method of sharing data
Description of frequency or timeliness from AFRICA CDC/ASLM/PARTNER request in which data will be shared
Description of the purpose for which AFRICA CDC/ASLM/PARTNER is requesting the data
Provider Agreements

Provider assures they have rights to primary dataset as in IV.1.	Yes No
Provider assures the datasets being shared are respectful of individuals as in IV.2.	Yes No
Text to be used for attribution of the Provider in derivative works produced by AFRICA CDC/ASLM/PARTNER or subsequent uses, as described in in IV.4.	E,g, "Data provided by Ministry of Health of Nigeria disease control department"
Provider understands and agrees that the restrictions on the use of data encoded in CC BY-NC-SA 4.0 are appropriate for AFRICA CDC/ASLM/PARTNER.	Provider understands what Attribution means: Yes No Provider understands what NonCommercial use means: Yes No Provider understands what Share-Alike means: Yes No
Contact Information	
Provider Point of Contact for all topics regarding data sharing agreement	Main (Name, email and mobile phone): Backup (Name, email and mobile phone):
Provider Technical contacts for issues and questions regarding data transfer and interpretation	Main (Name, email and mobile phone): Backup (Name, email and mobile phone):
AFRICA CDC/ASLM/PARTNER Point of Contact for all topics regarding data sharing agreement	Main (Name, email and mobile phone): Backup (Name, email and mobile phone):
AFRICA CDC/ASLM/PARTNER Technical contacts for issues and questions regarding data transfer and interpretation	Main (Name, email and mobile phone): Backup (Name, email and mobile phone):

Annex 4: Master Laboratory Facility list template

One Health Sector	Laboratory name	Admin Level	Tier	Affiliation	contact name	Title of contact person	Phone	Email

Annex 5: Scope of work for focal person

The job description should be used to select the focal person among the One Health Sectors stakeholders.

Duties

- Serve as the primary liaison between different parties, ensuring smooth information flow and collaboration among One Health sector stakeholders , or external partners.
- Keep stakeholders informed about program status, results, and impacts, ensuring they have the necessary information at the right time.
- Develop clear goals, identify priority activities, and adjust plans as needed to align with strategic objectives.
- Track progress, monitor project implementation, and generate regular reports on activities, outcomes, and challenges to supervisors and relevant bodies.
- Encourage and facilitate participation from various One Health stakeholders, building partnerships to ensure initiatives are grounded in local realities.
- Manage and allocate appropriate resources, including time, staff, and budgets, to complete tasks effectively and efficiently.
- May also be responsible for training data collectors, staff, or volunteers on tools and techniques relevant to their specific role.
- Identify potential risks, anticipate problems, and develop contingencies to ensure successful program delivery.

Requirements

- Government employee in one of the One Health sectors
- Nominated by the One Health Laboratory Technical Working Group
- Background in Laboratory medicine, public health programming
- Ability to work across the One Health sectors

Annex 6: Capacity strengthening plans template

Gap Identified	Intervention	Output	Indicator	Target	Timelines	Sector Lead	Status

Annex 7: Roles and responsibilities

Roles of Country MOH/NPHI

- Officially request for LabMap activities
- Sign Memorandum of Understanding(MOU) including data sharing agreement
- Designate a MOH/NPHI core team that include focal person, data administrator and Health Informatics staff drawn across the One Health sectors
- Form a One Health multi-disciplinary coordinating team of 5-10 people with representatives from NPHI, MOH, Focal person, Veterinary, envornmental health and development partners involved in one-health laboratories.
- Share strategic laboratory documents and other documents as available
- Facilitate communication, administrative and logistic arrangements for LabMap activity
- Commit to mobilize necessary resources to ensure successful implementation of LabMap

Roles of Africa CDC, ASLM and implementing partners

- Receive and review the Member state country request
- Submit MoU to country for signature (draft and generic MoU to be developed)
- Designate a country support team
- Develop agenda and presentations for the introduction meeting.
- Organize engagement meetings with countries (introduction meeting and technical engagement meeting)
- Train One Health sector staff on LabMap data collection
- Train One Health sector staff on LabMap data analysis and utilization cases

Role of development partner

- Define with Member state a resource mobilisation, communication and support strategy.

Annex 8: Field Activity plan

Admin Level 2	Team	Team Leader	Route	Laboratory name	Tier	One Health Sector Name	Vehicle	Data Collector Name(s)	Date of interview

REFERENCES

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2. https://www.afro.who.int/news/africa-63-jump-diseases-spread-animals-people-seen-last-decade
3. https://pmc.ncbi.nlm.nih.gov/articles/PMC4911720/
4. Risk Ranking and Prioritization of Epidemic-Prone Diseases – Africa CDC
5. Geo-Mapping of Laboratory Capacity – Africa CDC

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Africa CDC is a continental autonomous health agency of the African Union established to support public health initiatives of Member States and strengthen the capacity of their public health institutions to detect, prevent, control and respond quickly and effectively to disease threats.

An entity of the African Union

Safeguarding Africa's Health

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