Geospatial Information Systems (GIS) Strategy for Enhancing Health Sector Data Management and Decision-Making in Eswatini

Final Report

January 2024

unicef
for every child

ABBREVIATIONS

CSO	- Central Statistics Office
DHIS	- District Health Information System
eHealth	- Electronic Health
GAVI	- Gavi, The Vaccine Alliance
GDP	- Gross Domestic Product
GII	- Global Innovation Index
GIS	- Geospatial Information Systems
HMIS	- Health Management Information System
ICT	- Information and Communication Technology
mHealth	- Mobile Health
SDG	- Sustainable Development Goals
SDI	- Spatial Data Infrastructure
UNICEF	- United Nations Children's Fund
WHO	- World Health Organization

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ACKNOWLEDGEMENTS

The Government of Eswatini's Ministry of Health extends its sincerest appreciation and gratitude to all the individuals and organizations whose contributions have been vital in the completion of the GIS Needs Assessment Report for the Health Sector in Eswatini. Your valuable input, expertise, and support have played a significant role in shaping the future of geospatial information systems in the healthcare sector of our country. The production of this report is the result of collaboration between many individuals and organizations, to whom we extend our gratitude. We would like to acknowledge all those who supported us directly or indirectly, even if we cannot mention them all by name.

We would like to express our heartfelt thanks to the following contributors:

- **Central Statistics Office (CSO):** We acknowledge the CSO for their invaluable assistance in providing essential statistical data insights. Your commitment to accuracy and reliability has greatly enhanced the quality of the GIS Needs Assessment Report for the Health Sector in Eswatini, enabling us to make informed decisions in healthcare planning and resource allocation.
- **Surveyor General:** We extend our deep appreciation to the Surveyor General and their team for their expertise in mapping and geospatial data. Your contribution has been instrumental in identifying gaps and opportunities in our geospatial infrastructure, allowing us to better understand the spatial dynamics of healthcare services and improve access to quality care for all citizens.
- **World Health Organization (WHO):** We would like to express our gratitude to the WHO for their guidance and technical support throughout the process of conducting the GIS Needs Assessment Report for the Health Sector in Eswatini. Your global expertise and insights have been invaluable in aligning our geospatial strategies with international best practices, fostering a more robust and efficient healthcare system.
- **World Bank:** We extend our appreciation to the World Bank for their technical expertise. Your contributions have been pivotal in facilitating the implementation of the GIS Needs Assessment Report for the Health Sector in Eswatini, enabling us to leverage geospatial information for evidence-based decision-making and efficient resource allocation in the healthcare sector.
- **United Nations Children's Fund (UNICEF):** We would like to acknowledge the financial input from UNICEF. Your generous support has been instrumental in conducting the GIS Needs Assessment Report and the GIS Strategy for the Health Sector in Eswatini, allowing us to identify and address the specific needs of vulnerable populations, particularly in maternal and child health, immunization, and nutrition programs.

We would also like to express our gratitude to all the individuals, researchers, GIS professionals, and stakeholders who actively participated in the assessment process. Your valuable insights, feedback, and cooperation have been crucial in shaping the recommendations and future directions outlined in this report.

The Ministry of Health is immensely grateful for the collaborative efforts and contributions of all the stakeholders involved. Your commitment to advancing geospatial information systems in healthcare will undoubtedly contribute to the improvement of health outcomes and the overall well-being of our nation.

DEFINITIONS

DHIS (District Health Information System): A software platform used to collect, manage, and analyze health data at the district level.

eHealth (Electronic Health): The use of information and communication technologies (ICTs) to improve health care delivery and management.

GAVI (Gavi, The Vaccine Alliance): A global health partnership that aims to increase access to immunization in developing countries.

Geographic (or Geospatial) Information System (GIS): A collection of computer software and data used to view and manage information about geographic objects, analyse spatial relationships, and model spatial processes.

Geospatial data: Information about the location and shape of objects, geographic features and the relationships between them.

Geospatial technologies: A set of equipment, computer applications and systems to visualise, measure, and analyse Earth's features, typically involving such systems as Global Navigation Satellite System (GNSS), Geographical Information Systems (GIS), and remote sensing (RS)

HMIS (Health Management Information System): A system for collecting, analyzing, and reporting health data.

ICT (Information and Communication Technology): The use of technology to collect, store, process, and transmit information.

Master facility list: A complete, up-to-date, authoritative listing of the health facilities in a particular country

mHealth (Mobile Health): The use of mobile devices, such as smartphones and tablets, to improve health care delivery and management.

Modelled geographic accessibility: The measurement of the physical distance or travel time that quantifies the movement opportunity for people to reach existing health services

SDI (Spatial Data Infrastructure): A framework for collecting, storing, and sharing spatial data.

EXECUTIVE SUMMARY

The Geospatial Information Systems (GIS) Strategy for Eswatini's health sector aims to leverage GIS technology to improve data management, decision-making, and health outcomes. The strategy is guided by principles of data integration, stakeholder engagement, data privacy, capacity building, openness, sustainability, and evidence-based decision-making. Ethical principles such as privacy, informed consent, data accuracy, equity, data ownership, transparency, and continuous ethical review are also emphasized. The strategy is built on the findings of a GIS Needs Assessment Report for the Health Sector in Eswatini and stakeholder consultation process, which identified key challenges and opportunities for GIS adoption in the health sector. Key challenges identified included lack of centralized data governance, limited technical capacity, and inadequate infrastructure to analyze and share geospatial health data. To address these gaps, the Strategy sets out a five-year framework centered around the vision of a healthier Eswatini where all citizens have equitable access to quality care.

The vision is to create a healthier and more resilient Eswatini where geospatial intelligence and data-driven insights enable equitable access to quality healthcare, resource allocation, and informed decision-making. The mission is to establish a comprehensive GIS framework that enhances data management, facilitates evidence-based decision-making, strengthens health system resilience, improves health outcomes, and reduces health disparities through collaboration, ethical practices, and stakeholder empowerment.

The strategy outlines key objectives, including:

Data Integration and Management: Establish a central geospatial data repository, ensure data quality, and promote data sharing and interoperability across all Ministry of Health Programs and implementing partners.

Capacity Building and Training: Develop GIS skills and knowledge among health sector personnel and stakeholders.

Infrastructure Development: Enhance GIS infrastructure, including hardware, software, and network connectivity.

Applications and Services: Develop and implement GIS applications for disease surveillance, health facility planning, immunization coverage, community health worker routing, and healthcare supply chain management.

Monitoring and Evaluation: Establish a monitoring and evaluation framework to assess the effectiveness and impact of GIS implementation.

Stakeholder Engagement and Collaboration: Foster collaboration among government agencies, healthcare facilities, academic institutions, and development partners.

Ethical Considerations: Ensure compliance with ethical principles and guidelines in GIS data collection, use, and dissemination.

Implementation of the Strategy is expected to facilitate more targeted health programming, optimized resource allocation, earlier detection of outbreaks and improved monitoring of health indicators. Integration of location intelligence into core systems will empower evidence-based policymaking and resource decisions across all levels of the health sector. A results-based monitoring approach will assess outputs, outcomes and health impacts of the GIS strategy in reducing disparities. Stakeholder engagement is prioritized to maintain focus on overcoming challenges and sustaining geospatial capacity beyond the initial five years.

The successful implementation of the GIS Strategy will contribute to improved health outcomes, reduced health disparities, and a more efficient and effective health system in Eswatini.

CHAPTER 1: INTRODUCTION

1.1 BACKGROUND

The effective management and utilization of health sector data play a critical role in improving healthcare delivery and decision-making processes. In the Kingdom of Eswatini, like many other countries, the digital revolution has opened up new avenues for optimizing data management and analysis. Geospatial Information Systems (GIS) have emerged as powerful tools that can revolutionize the way healthcare data is collected, analyzed, and utilized for informed decision-making.

GIS has become increasingly important in the field of public health, enabling the collection, analysis, and visualization of spatial data to gain valuable insights and inform evidence-based decision-making. By integrating geographic data with health information, GIS provides a powerful tool for understanding the distribution of diseases, identifying vulnerable populations, and targeting interventions effectively.

In recent years, the use of Geographic Information Systems (GIS) in healthcare has undergone significant advancements, revolutionizing the way healthcare professionals collect, analyze, and visualize spatial data to improve patient outcomes. Several key trends and emerging technologies are shaping the contemporary landscape of GIS in healthcare:

1. Real-Time Data Integration and Analytics

GIS is increasingly integrated with real-time data sources, such as Internet of Things (IoT) devices and electronic health records (EHRs), enabling healthcare providers to access and analyze real-time patient data. This integration facilitates improved monitoring of patient conditions, early detection of health issues, and timely interventions.

2. Geospatial Epidemiology and Disease Surveillance

GIS plays a crucial role in geospatial epidemiology, helping healthcare organizations identify disease patterns, clusters, and risk factors by analyzing spatial data. This information supports targeted disease surveillance, outbreak management, and resource allocation for effective public health interventions.

3. Location-Based Services and Telehealth

GIS enables the development of location-based services and telehealth applications that provide patients with personalized healthcare information and services based on their geographic location. These services enhance accessibility, convenience, and continuity of care, especially for individuals in remote or underserved areas.

Some of the emerging technologies which have significant implications for the use of GIS in the health sector include the following:

1. **Artificial Intelligence (AI) and Machine Learning (ML)**

AI and ML techniques are increasingly integrated with GIS to enhance data analysis and decision-making. These technologies facilitate predictive modelling, pattern recognition, and risk assessment, enabling healthcare providers to identify high-risk patients, optimize treatment plans, and improve overall healthcare outcomes.

2. **GIS and Virtual Reality (VR)**

3D GIS and VR technologies are emerging as powerful tools for visualizing and analyzing complex spatial data. These technologies provide immersive experiences, allowing healthcare professionals to gain a deeper understanding of patient conditions, treatment options, and surgical procedures.

3. **Blockchain**

Blockchain technology is being explored for secure data sharing and management in healthcare. By leveraging blockchain's decentralized and tamper-proof nature, healthcare organizations can ensure the privacy and integrity of sensitive patient data while facilitating collaboration among different stakeholders.

These trends and emerging technologies underscore the transformative potential of GIS in healthcare, empowering healthcare professionals with data-driven insights to deliver more precise, efficient, and patient-centered care. This strategy document, titled "Geospatial Information Systems (GIS) Strategy for Enhancing Health Sector Data Management and Decision-Making in Eswatini," outlines a comprehensive approach to harnessing the potential of GIS technology within the health sector of Eswatini. By integrating geospatial data with health information systems, this strategy aims to improve the accuracy, accessibility, and timeliness of health data, enabling stakeholders to make data-driven decisions that can positively impact public health outcomes.

The implementation of this GIS strategy will involve collaboration among various stakeholders, including government agencies, healthcare providers, researchers, and technology experts. By leveraging the power of GIS technology, Eswatini can overcome the existing challenges in health data management, such as data fragmentation, lack of interoperability, and limited analytical capabilities. This strategy will guide the development and deployment of GIS solutions tailored to the unique needs and context of Eswatini's health sector, fostering a data-driven culture that empowers decision-makers to address health challenges effectively. The strategy also delves into the potential benefits that can be realized through the adoption of GIS technology in health data management, including enhanced disease surveillance, improved resource allocation, targeted interventions, and evidence-based policy formulation.

Ultimately, the successful implementation of the Strategy will pave the way for a more efficient, resilient, and responsive healthcare system. By harnessing the power of geospatial data, Eswatini can unlock new insights, identify vulnerable populations, and optimize resource allocation, leading to improved health outcomes for all its citizens.

The use of Geographic Information System (GIS) technology is also essential for effective decision-making and planning in the health sector. This strategy aims to address the identified shortcomings in Eswatini's health sector regarding the use of GIS. By leveraging GIS, the Ministry of Health can improve data management, analysis, and visualization to enhance healthcare service delivery.

1.2 PURPOSE OF THE GIS STRATEGY

The purpose of the Strategy is to provide a clear roadmap and guidelines for leveraging GIS technology to improve the management and utilization of health sector data in Eswatini. This strategy aims to address the specific challenges identified in the preceding landscape assessment report and harness the power of geospatial information to enhance decision-making processes, improve health service delivery, and ultimately contribute to better health outcomes for the population.

1.3 SCOPE AND OBJECTIVES

The scope of this strategy includes all relevant stakeholders, including the Ministry of Health (MOH), implementing partners, healthcare facilities, academic and research institutions, line ministries and other relevant organizations. The objectives of this strategy are as follows:

i. Enhance data availability: Improve the collection, management, and sharing of spatial and non-spatial data related to the health sector.
ii. Strengthen stakeholder engagement: Foster collaboration and coordination among key stakeholders to ensure effective GIS implementation.
iii. Improve system infrastructure: Develop and enhance spatial data infrastructure, platforms, and interoperability for seamless data integration and analysis.
iv. Enhance staff capacity: Provide training and skill development opportunities to build GIS literacy and digital skills among health sector personnel.
v. Promote research and innovation: Encourage targeted research initiatives to explore the potential of GIS in addressing specific health challenges.

1.4 METHODOLOGY

The development of the Strategy followed a systematic and comprehensive methodology. The process began with a landscape assessment, which served as the foundation for identifying the

current state of GIS implementation in the health sector and the challenges faced in utilizing geospatial information effectively. The methodology can be summarized as follows:

Landscape Assessment: The first step involved conducting a thorough landscape assessment to understand the existing GIS implementation in the health sector of Eswatini. This assessment involved reviewing relevant documents, data sources, and existing systems and tools. It aimed to identify the strengths, weaknesses, opportunities, and threats associated with GIS utilization in the context of health data management and decision-making. Based on the findings of the landscape assessment, a needs assessment was conducted to identify the specific challenges and gaps in GIS implementation within the health sector. This assessment involved engaging with key stakeholders, including government agencies, implementing partners, healthcare facilities, and academic institutions. Surveys and interviews were conducted to gather insights and perspectives on the current state of GIS and the requirements for improving data management and decision-making processes.

Analysis and Recommendations: The data collected from the landscape and needs assessments were analyzed to identify common themes, challenges, and opportunities. This analysis formed the basis for developing strategic recommendations to address the identified gaps. The recommendations focused on areas such as data quality and reliability, stakeholder engagement and collaboration, system infrastructure, capacity building, and policy development.

Stakeholder Engagement: Throughout the development process, stakeholders were actively engaged through consultations and feedback sessions. Their inputs and perspectives were sought to ensure that the strategy aligns with their needs and priorities. Stakeholder engagement was crucial in building consensus, fostering ownership, and ensuring the strategy's relevance and sustainability.

Strategy Development: The findings from the landscape assessment and stakeholder engagement were synthesized to formulate the GIS strategy. The strategy outlined the goals, objectives, and key actions required to enhance health sector data management and decision-making through GIS. It provided a roadmap for implementation, including timelines, responsible parties, and performance indicators.

Review and Validation: The draft strategy document underwent a rigorous review process involving key stakeholders and subject matter experts. Their feedback and recommendations were incorporated to strengthen the strategy's content, coherence, and feasibility. The review and validation process ensured that the strategy reflects the best practices, lessons learned, and contextual considerations specific to Eswatini's health sector.

Finalization and Dissemination: The strategy document was finalized, taking into account the inputs and feedback received during the review and validation process. It will then disseminated to relevant stakeholders, including government agencies, implementing partners, healthcare facilities, and academic institutions. The dissemination aims to create awareness, promote buy-in, and encourage the adoption of the strategy's recommendations.

By following this methodological approach, the Strategy was developed to provide a comprehensive and actionable roadmap for leveraging GIS technology in the health sector. The strategy's development process ensured a thorough understanding of the current landscape, identified the specific needs and challenges, and incorporated the perspectives of key stakeholders, thus increasing the likelihood of successful implementation and positive impact.

1.5 CURRENT STATE ANALYSIS

This GIS strategy for Eswatini's health sector is developed based on the findings of the GIS landscape assessment report. The assessment covered a comprehensive review of existing GIS infrastructure, data availability, software applications, and human resources in the health sector. A combination of quantitative and qualitative research methods, including surveys, interviews, and data analysis, was employed to gather information from key stakeholders. The assessment focused on both governmental and non-governmental institutions responsible for healthcare planning and healthcare facilities. Key stakeholders, including healthcare professionals, administrators, and data managers, were interviewed to gather insights into their current use of GIS and their specific needs and challenges.

The landscape assessment report provided a rapid assessment of Eswatini's geospatial data and GIS capabilities within the health sector. It identified priority areas where improved use of geographic information systems (GIS) can enhance data-driven decision making and health outcomes. The assessment answered key questions about geodata availability, GIS hardware gaps, human resource capacities, and recommendations for maximizing the impact of GIS technology. The goal was to also inform strategic investments and capacity building to fully leverage GIS to advance Eswatini's immunization program and child health initiatives. The report provided actionable insights for stakeholders across Eswatini's health landscape. The key findings are summarized as follows:

- Disease surveillance and outbreak response identified as top priority area for better geodata use
- Shortage of GIS expertise/trained GIS analysts
- There is lack of coordination between Ministry of Health departments as well as with other government departments hindering progress
- There is use of both proprietary and open-source GIS software
- Existing geospatial datasets fragmented across various ministries and partners
- Stronger data sharing policies and governance needed to improve access
- Targeted GIS training for health workers coupled with recruitment recommended
- Centralized open data platform would enhance accessibility and transparency
- Prioritize digitizing health facility locations, catchment areas, and population demographics

- GIS Technical Working Group should comprise diverse stakeholders from MoH, CSO, Surveyor-General's Office, Ministry of ICT (Royal Science and Technology Park), Development partners, NGOs, and academia.

In terms of answering key questions, the landscape assessment revealed the following answers:

Where can better decisions be made using geodata?

- Disease surveillance and outbreak response
- Health infrastructure planning and accessibility analysis
- Immunization coverage and childhood health initiatives
- Community health worker routing and household profiling
- Healthcare supply chain and medicine distribution

How can implementing and development partners make the case for GIS support for child health?

- Highlight success of GIS projects in modeling disease risk factors for children
- Demonstrate potential to optimize immunization routes based on geospatial analysis
- Show value of household mapping to identify gaps in reaching vulnerable children
- Promote transparency and accountability through interactive child health dashboards
- Position GIS as essential tool for realizing MOH mandate to reach every child

Recommended geospatial data investments:

- High resolution population demographics with child health statistics
- Digitized health facility locations with services offered /capacity data
- Transport network and infrastructure maps
- Granular data on immunization coverage and childhood disease burdens
- Geocoded community health worker assignments and household data

Priority sectors for further investigation:

- Water, sanitation and hygiene (WASH) infrastructure mapping
- Health impacts of environmental factors like air/water pollution
- Nutrition programs and food security influencing child health
- Early childhood development resources and pre-primary education access

Available geospatial datasets and collection methods:

- Fragmented across Ministry of health departments/programmes, government ministries, and external partners
- Health facility data maintained by Ministry of Health in HMIS/DHIS2

- Population demographics from national census by Central Statistics Office

GIS human resource capacity and recommendations:

- Severe shortage of GIS specialists in public health roles
- Limited knowledge of GIS applications beyond basic mapping
- Strong training and recruitment needed to build in-house expertise
- Develop partnerships with academic institutions for geospatial analytics
- Increase access to spatial data and user-friendly GIS platforms
- Change management to promote adoption of geospatial approaches
- Include GIS data and maps into routine data reporting and decision making

The findings of the landscape assessment were also used to develop the 5 strategic goals outlined in this Strategy. This Strategy, therefore, aims to address these shortcomings and improve the effective and efficient use of GIS in the health sector.

CHAPTER 2: GUIDING AND ETHICAL PRINCIPLES

2.1 GUIDING PRINCIPLES

The Strategy is underpinned by the following guiding principles:

Data Integration and Interoperability: Promote the integration of diverse data sources, including health facility data, demographic data, disease surveillance data, and environmental data, to create a comprehensive and interoperable GIS platform. Enable seamless data sharing and exchange between different systems and stakeholders to enhance data quality and accessibility.

Stakeholder Engagement and Collaboration: Foster active collaboration and engagement among key stakeholders, including the Ministry of Health, implementing partners, healthcare facilities, academic institutions, and research organizations. Encourage the sharing of data, expertise, and best practices to maximize the value and impact of GIS in the health sector.

Data Privacy and Security: Ensure robust data privacy and security measures are in place to protect sensitive health information. Implement appropriate protocols, access controls, and encryption methods to safeguard personal and confidential data in accordance with relevant regulations and ethical guidelines.

Capacity Building and Training: Prioritize capacity building initiatives to enhance the data literacy and digital literacy skills of key staff involved in GIS activities. Provide training programs and resources to improve proficiency in GIS software, data analysis, and interpretation of geospatial data. Foster a culture of continuous learning and skill development.

Openness and Collaboration: Embrace open-source GIS software and open data principles to promote transparency, innovation, and cost-effectiveness. Encourage the use of open standards and interoperable solutions to facilitate data sharing, collaboration, and knowledge exchange within the health sector and with external partners.

Sustainability and Scalability: Develop a sustainable and scalable GIS infrastructure that can accommodate future growth and evolving needs. Consider long-term resource planning, including budget allocations, human resources, and technological infrastructure, to ensure the longevity and effectiveness of the GIS strategy.

Evidence-Based Decision-Making: Emphasize the use of geospatial data and analysis to support evidence-based decision-making processes. Enable data-driven insights and visualizations to inform policy development, resource allocation, service planning, and response to public health challenges.

Continuous Monitoring and Evaluation: Implement a robust monitoring and evaluation framework to assess the effectiveness and impact of the GIS strategy. Regularly review and assess the quality, availability, and usability of geospatial data and GIS systems. Use feedback and evaluation results to inform continuous improvement and adjustment of the strategy.

By incorporating these guiding principles into the GIS Strategy, Eswatini can establish a solid foundation for leveraging geospatial information systems to improve data management, decision-making, and overall health outcomes in the country.

2.2 ETHICAL PRINCIPLES

Based on the needs assessment undertaken as part of the development of this strategy, below are some ethical principles that can guide the implementation of the GIS Strategy:

Privacy and Confidentiality: Respect and protect the privacy and confidentiality of individuals' health information. Adhere to legal and ethical standards for data collection, storage, and sharing, ensuring that personally identifiable information is appropriately de-identified, encrypted, and secured. Implement strict access controls and data governance protocols to prevent unauthorized use or disclosure of sensitive information.

Informed Consent: Obtain informed consent from individuals when collecting and using their personal health data for GIS purposes. Provide clear and understandable information about the purpose, scope, and potential risks and benefits of data collection and use. Respect individuals' right to opt-out or withdraw consent at any time.

Data Accuracy and Integrity: Strive for accuracy, reliability, and integrity of geospatial data used in the GIS systems. Take measures to ensure data quality, including validation, verification, and regular updates. Provide clear documentation of data sources, methodologies, and limitations to promote transparency and accountability.

Equity and Fairness: Promote equity and fairness in the use of GIS within the health sector. Ensure that geospatial analyses and decision-making processes do not perpetuate discrimination or bias based on race, gender, socioeconomic status, or other protected characteristics. Consider the potential impact of GIS interventions on marginalized or vulnerable populations and take steps to mitigate any negative effects.

Data Ownership and Governance: Clarify data ownership and establish clear governance mechanisms for GIS data. Define roles, responsibilities, and accountability of stakeholders involved in data collection, management, and use. Foster collaboration and partnerships while respecting the rights of data providers and stakeholders to have control over their data.

Transparency and Openness: Foster transparency and openness in the implementation of GIS initiatives. Clearly communicate the purpose, objectives, and potential implications of GIS projects to stakeholders and the public. Make efforts to share non-sensitive GIS data and findings with relevant parties to enable scrutiny, collaboration, and independent verification.

Ethical Use of GIS Outputs: Ensure that GIS outputs, such as maps, analyses, and visualizations, are used ethically and responsibly. Avoid misrepresentation, manipulation, or selective reporting of geospatial data that could lead to biased interpretations or decisions. Use GIS outputs for the public good, taking into account the potential social, economic, and environmental impacts.

Continuous Ethical Review: Establish mechanisms for ongoing ethical review and oversight of GIS activities. Regularly assess the ethical implications and potential risks associated with data collection, analysis, and use. Stay informed about emerging ethical guidelines, best practices, and regulatory requirements to ensure compliance and ethical conduct.

By adhering to these ethical principles, the implementation of the GIS Strategy in Eswatini can uphold the highest standards of integrity, privacy, fairness, and transparency, while maximizing the benefits of geospatial information systems for improving healthcare and public health outcomes.

CHAPTER 3: STRATEGIC FRAMEWORK

3.1 VISION STATEMENT

The Strategy envisions "**a future in which the power of Geospatial Information Systems (GIS) is leveraged for a healthier and more resilient Eswatini, where geospatial intelligence and data-driven insights enable equitable access to quality healthcare, resource allocation, and informed decision-making.**"

This vision statement encapsulates the overarching goal of the GIS Strategy, emphasizing the transformative potential of GIS in driving positive health outcomes in Eswatini. It highlights the importance of harnessing geospatial data and technology to create a healthcare system that is responsive, equitable, and effective in meeting the needs of the population.

3.2 MISSION STATEMENT

The mission of this Strategy is "**to establish and implement a comprehensive Geospatial Information Systems (GIS) framework that enhances data management, facilitates evidence-based decision-making, strengthens health system resilience, improves health outcomes and reduces health disparities in Eswatini through fostering collaboration, promoting ethical practices, and empowering stakeholders to leverage geospatial intelligence.**"

The mission statement outlines the key objectives and principles that will guide the implementation of the GIS Strategy. It emphasizes the need for a comprehensive GIS framework that encompasses data management, decision-making, and resilience-building within the health sector. Collaboration, ethics, and stakeholder empowerment are highlighted as essential elements for achieving the mission's goals. The mission statement reflects the commitment to leveraging GIS as a tool for improving health outcomes and reducing health disparities in Eswatini.

Table 1 outlines the theory of change as a result of introducing and strengthening the use of geospatial technology in Eswatini's health sector. It provides an illustration of how and why the desired vision and mission is expected to lead to the expected outcomes, including the key enabling actions. This is in line with Chapter 7 of the National Health Sector Strategic Plan 2019 to 2023 which addresses matters related to health information and knowledge management. A Geographic Information System (GIS) strategy can align with Chapter 7 of Eswatini's National Health Sector Strategic Plan 2019 to 2023 by supporting health information and knowledge management activities in a spatial context. Below are some ways in which a GIS strategy can align with the goals outlined in Chapter 7:

Spatial Data Collection and Analysis: A GIS strategy can facilitate the collection, management, and analysis of spatial health data. This includes geocoding health facilities, capturing disease incidence and prevalence data, and integrating geographic data with other health-related datasets. By incorporating spatial components into health information systems, decision-makers can gain a

better understanding of the geographic distribution of health issues and make data-driven decisions.

Health Facility Mapping: GIS can be used to map health facilities, including hospitals, clinics, and pharmacies, and analyze their distribution across Eswatini. This information can help identify gaps in healthcare services and support strategic planning for the equitable distribution of health resources.

Disease Surveillance and Response: GIS can enhance disease surveillance efforts by mapping the geographic spread of diseases and analyzing patterns and trends. It can support the identification of disease hotspots, help in tracking disease outbreaks, and facilitate targeted interventions and response strategies.

Resource Allocation and Planning: A GIS strategy can assist in resource allocation and planning by providing spatial insights. For example, it can help identify areas with high disease burden or underserved populations, informing the allocation of healthcare resources such as personnel, equipment, and infrastructure.

Health Information Visualization: GIS can be utilized to create maps and visualizations that communicate health information effectively. This can aid in conveying complex data to stakeholders, policymakers, and the general public, facilitating better understanding and informed decision-making.

Emergency Preparedness and Response: GIS can play a vital role in emergency preparedness and response. It can support the mapping of critical infrastructure, vulnerable populations, and evacuation routes. During emergencies, GIS can assist in real-time situational awareness, resource mobilization, and coordination of response efforts.

By incorporating GIS into the health information and knowledge management framework outlined in Chapter 7 of Eswatini's National Health Sector Strategic Plan, the country can leverage spatial data to enhance understanding, planning, and decision-making in the healthcare sector.

Similarly, the GIS strategy aligns with the National e-Health Strategy 2016-2020 for Eswatini by providing spatial data and analysis capabilities to support various aspects of healthcare delivery and management. Below are some ways in which the GIS strategy complements and enhances the aspirations of the eHealth Strategy:

1. Health Facility Mapping and Distribution Analysis: GIS can create maps of health facilities, including hospitals, clinics, and community health centers, providing a visual representation of their distribution across the country. This information can help decision-makers identify gaps in healthcare coverage, optimize resource allocation, and plan for the construction of new facilities in underserved areas.

2. Disease Surveillance and Outbreak Management: GIS can be used to map and analyze the spatial distribution of diseases, such as malaria, tuberculosis, and HIV/AIDS. By identifying disease

clusters and hotspots, health authorities can target interventions, allocate resources effectively, and monitor the spread of diseases to prevent outbreaks.

3. Population Health Analysis: GIS can integrate health data with demographic, socioeconomic, and environmental data to identify correlations between health outcomes and various factors such as income, education, housing conditions, and access to sanitation. This analysis can inform policymaking and program development to address health disparities and improve overall population health.

4. Resource Allocation and Optimization: GIS can assist in optimizing the allocation of healthcare resources by identifying areas with high demand for services and ensuring equitable distribution of resources. It can also help in planning transportation routes for medical supplies and personnel, considering factors such as road networks, population density, and accessibility.

5**. Emergency Response and Disaster Management:** GIS can support emergency response efforts by providing real-time information on affected areas, infrastructure damage, and resource availability. It can also assist in coordinating relief efforts, managing evacuation routes, and assessing the impact of disasters on health infrastructure.

6. Health Service Delivery Monitoring and Evaluation: GIS can track and monitor the performance of health services by analyzing indicators such as patient wait times, appointment availability, and service utilization rates. This information can help identify areas for improvement and inform decision-making for service delivery optimization.

7. Community Engagement and Health Promotion: GIS can be used to create health promotion campaigns targeted to specific geographic areas based on the health needs of the population. It can also facilitate community engagement by providing residents with information about nearby health facilities, services, and resources.

By integrating GIS capabilities into the e-Health strategy, Eswatini can leverage spatial data and analysis to enhance decision-making, improve healthcare service delivery, and achieve better health outcomes for its population.

Health Impact	**Reduction in disability, morbidity and mortality**		
Health Impact	≥90% of the population has access to healthcare services and equitable coverage across population subgroups based on geographic, socio-economic and cultural differences		
Improved healthcare campaigns and routine healthcare programmes			
Health Outcomes	Increased proportion of healthy population through improved target setting	Optimised healthcare resource distribution and location of services	Increased quality, timeliness, and perception of healthcare services with equity in coverage between communities
Geospatial Data and Technologies Outputs	Improved identification of under-served communities/populations through more accurate microplanning and identification of missed settlements to implement appropriate intervention strategies	Improved planning and allocation of healthcare resources through strengthened use of geospatial data, analysis and visualization	Improved service delivery through better planning, monitoring and tracking of healthcare activities for rapid problem identification and corrective action
Geospatial Data and Technologies Inputs	Produce and regularly update digital maps for health area planning based on health resources mapping through a participatory process involving local health staff to map healthcare resources	Optimize distribution of resources (workforce, funding, and supplies) based on more accurate target population distribution and identification of gaps in coverage and healthcare service accessibility based on geospatial accessibility analysis and coverage modelling	Track by location activities, healthcare sessions, supervision and allocation of financial resources

Geospatial Data Foundations	Health System Mapping (essential): Develop and maintain master lists and data standards for health facilities, delivery sites and cold chain, settlements, infrastructure, health area boundaries and other core geographic objects
	Population Estimation (essential): Generate and use accurate population estimates (human density and distribution) to establish targets (denominators) in healthcare programme planning.
	Analytics & Modelling for Accessibility, Coverage, and Surveillance Planning and Monitoring: Use modelling to understand geographic accessibility to services, resource distribution, and healthcare coverage with links to data (through CMIS, HMIS) on preventable diseases and adverse events following immunization.
Enablers	• Clearly defined vision, strategy and plan for a geo-enabled healthcare programmes
	• Information system governance structure covering geospatial data and technologies
	• Policies supporting and enforcing the strategy and governance, including data accessibility
	• Necessary human and financial resources to ensure effective use and sustainability of geospatial data over the long-term

Figure 1: Theory of change for the use of geospatial technologies for healthcare programming (adapted from Gavi, The Vaccine Alliance, in Collaboration with UNICEF, 2020].

3.3 STRATEGIC GOAL 1: ENHANCE DATA GOVERNANCE AND MANAGEMENT

To ensure the effective utilization of GIS, establishing a robust data governance framework is paramount. The first strategic goal focuses on developing a Health Sector Spatial Data and GIS Policy, implementing a data quality assurance program, digitally archiving historical health datasets, and achieving compliance with geospatial metadata population. By Q4 2024, a comprehensive policy will guide data collection, ownership, standards, access, and use across the health sector. A data quality assurance program, defined by Q1 2024, will ensure the accuracy and reliability of datasets. Digitization of legacy data and implementation of an electronic document management system will preserve valuable historical information. Furthermore, attaining at least 90% compliance on geospatial metadata will facilitate data sharing and accessibility.

1. By 2024, develop a Health Sector Spatial Data and GIS Policy to guide geospatial data standards, access and use.

Activities:

- Convene a technical working group by Q1 2024
- Research best practices and draft policy document that is in alignment with other policies by Q3 2024
- Undertake stakeholder consultations by Q2 2024
- Incorporate feedback and finalize policy by Q3 2024
- Launch and disseminate policy nationally by Q4 2024

2. By 2025, implement a robust data quality assurance program for priority health datasets.

Activities:

- Define QA/QC processes and metrics by Q2 2024
- Develop validation rules and workflows in GIS/DHIS2 by Q3 2024
- Conduct desk audits on periodic sample of datasets by Q4 2024
- Implement automated validation on data entry by Q1 2025
- Generate routine data quality reports for stakeholder review

3. By 2024, digitally archive all historical health datasets and reports.

Activities:

- Assess types and volumes of legacy data by Q3 2024
- Procure electronic document management system by Q1 2025
- Develop file naming and metadata standards by Q2 2025
- Commence scanning and upload of paper records by Q3 2025
- Conduct user training on GIS-HMIS use by Q4 2025

- Implement records retention and disposal schedule

4. By 2025, attain at least 90% compliance on routine geospatial metadata for all maps and datasets.

Activities:

- Customize metadata profiles and forms by Q1 2024
- Train staff and integrate metadata workflows by Q2 2024
- Audit compliance periodically and address issues
- Automated metadata generation for future datasets
- Recognize and reward exemplary metadata compliance

3.4 STRATEGIC GOAL 2: STRENGTHEN GIS INFRASTRUCTURE AND SYSTEMS

The second strategic goal aims to establish a centralized Spatial Data Infrastructure (SDI) to facilitate seamless geospatial data management and sharing. By Q3 2024, an SDI governance framework will be designed and implemented, enabling the establishment of a centralized SDI server. Priority datasets will be migrated, and metadata profiles developed by Q4 2024. This infrastructure will empower stakeholders with timely access to accurate geospatial information. Additionally, digitization and integration of core health facility registry and demographic datasets will strengthen spatial analytics capabilities. High-performance GIS/analytics workstations will be procured and installed at national, regional, and program levels, ensuring adequate infrastructure for spatial analysis.

1. By 2025, establish a centralized Spatial Data Infrastructure (SDI) to facilitate geospatial data management and sharing across the health sector.

Activities:

- Convene inter-ministerial SDI taskforce by Q2 2024 (this could link to the SDI being established by the SGO)
- Design and implement SDI governance framework by Q1 2024
- Procure centralized SDI server and install at RSTP by Q3 2024
- Develop metadata profiles and catalog by Q4 2024
- Migrate priority datasets and begin populating SDI by Q1 2025
- Roll out SDI access to regional/district offices in phases by 2025
- Establish routine dataset updates and quality assurance process

2. By 2024, digitize and integrate core health facility registry and demographic datasets to strengthen spatial analytics capabilities.

Activities:

- Compile data inventory and identify priority datasets by Q3 2024
- Develop a comprehensive national health facility master list by Q3 2024.
- Develop data collection apps/forms for field capture by Q2 2025
- Train field staff and commence data collection by Q3 2024
- Implement geocoding and QA/QC on captured data by Q4 2024
- Integrate datasets into SDI and visualization tools by Q2 2025
- Conduct advocacy initiative on core health facility data by Q4 2024.

3. By 2025, implement high-performance GIS/analytics workstations at national and regional health offices as well each health programmes.

Activities:

- Procure and install workstations at national and 4 regions by Q4 2024
- Procure laptops for district-level mobile mapping by Q1 2025
- Provide training and technical support to GIS teams
- Establish hardware refresher procurement plan

4. By 2025, operationalize integrated routine disease surveillance using spatial analytics.

Activities:

- Map surveillance data flows and identify gaps by Q1 2024
- Design integrated eSurveillance database in DHIS2 by Q3 2024
- Pilot integrated surveillance in 2 districts by Q1 2025
- Roll out nationally with training and support by Q4 2025
- Implement functionality for real-time spatial monitoring

3.5 STRATEGIC GOAL 3: BUILD CAPACITY AND SKILLS IN GIS

Recognizing the importance of skilled personnel, the third strategic goal focuses on capacity building and skills development. A formalized health sector GIS training program will be established through partnerships with academic institutions and development partners. This program aims to provide accredited programs, ensuring a steady stream of trained GIS professionals. Spatial literacy will be integrated into pre-service curricula for Community Health Workers, Nurses, and Environmental Health Technicians, equipping them with basic map knowledge and interpretation. Furthermore, 80% of health managers are targeted to routinely use geospatial information-based dashboards for health monitoring and planning by Q4 2024.

1. By 2025, establish a formalized health sector GIS training program through partnerships between the Ministry of Health, academic institutions (e.g. UNESWA) and development partners.

Action points:

- Convene a taskforce by Q1 2024 to design the training/capacity building framework.
- Sign MoUs with UNISWA and regional training centers by Q3 2024 to begin offering courses.
- Recruit inaugural class of 20 trainees from across health programs by Q4 2024.
- Conduct needs assessment to identify priority subject areas annually.

2. By 2026, establish functional GIS units within each of the health programs, with dedicated full-time staff to support spatial analysis needs.

Action points:

- Conduct job analysis and develop job descriptions for GIS positions by Q2 2024.
- Budget for and recruit GIS Officers per Health programme by 2024.
- Stock GIS workstations and ensure internet connectivity by 2024.
- Implement mentoring program between regional and national GIS units.
- Convene quarterly GIS coordination meetings at regional level.

3. By 2026, integrate core GIS literacy into curricula for Community Health Workers and Environmental Health Technicians.

Action points:

- Engage Training Institutions by Q1 2024 to revise curricula.
- Pilot GIS modules with 50 trainees each for identified cadres by 2025.
- Formally incorporate GIS course requirement by 2026.
- Develop online materials and train faculty to teach GIS components.

4. By 2026, 80% of health managers routinely use geospatial information-based dashboards for health monitoring and planning on a quarterly basis.

Action points:

- Identify priority dashboard indicators by Q3 2024.
- Automate indicator geoprocessing workflows by Q2 2025.
- Develop interactive dashboard prototype within DHIS2 and other systems by Q3 2025.
- Train managers nationally on interpretation and use by Q4 2025.
- Implement feedback and refinement process.

3.6 STRATEGIC GOAL 4: PROMOTE STAKEHOLDER ENGAGEMENT AND COLLABORATION

Fostering stakeholder engagement and collaboration is vital for the successful implementation of GIS in the health sector. The fourth strategic goal aims to strengthen and ensure a fully functional Health Sector GIS Technical Working Group, formalize bilateral agreements with academic/research institutions, enhance information exchange through an online Health GIS stakeholder portal, and increase stakeholder participation in national GIS conferences. These initiatives will promote knowledge sharing, collaboration, and the dissemination of GIS-related research findings.

1. By June 2024, establish a fully functional and constituted Health Sector GIS Technical Working Group to facilitate coordination and partnership development.

Activities:

- Finalise composition and invite representative members by Q2 2024
- Develop and ratify terms of reference by Q2 2024
- Conduct quarterly coordination meetings
- Establish communication channels and workplans
- Monitor progress and resolve challenges

2. By 2025, formalize at least 5 bilateral agreements with academic/research institutions to support GIS training and applied research.

Activities:

- Map local institutions and their capacities by Q3 2024
- Draft model MOU templates by Q3 2024
- Engage priority institutions to secure commitments by Q4 2024
- Formalize cooperative agreements/MOUs by Q1 2025
- Implement at least 2 joint projects annually

3. By 2025, enhance information exchange through an online Health GIS stakeholder portal.

Activities:

- Develop functional requirements by Q3 2024
- Engage consultants to build portal on RSTP servers by Q1 2025
- Populate portal and roll-out access by Q2 2025
- Moderate discussion forums and share updates
- Track portal usage and gather user feedback

4. By 2025, increase stakeholder participation in national GIS conferences by 30% annually (This could optionally be incorporated into existing annual conferences of the Ministry of Health).

Activities:

- Host inaugural conference in Q4 2024

- Develop communications plan for subsequent conferences
- Increase regional participation through travel support
- Incorporate virtual participation options
- Recognize outstanding stakeholders annually

3.7 STRATEGIC GOAL 5: PROMOTE RESEARCH AND INNOVATION IN TARGETED AREAS

The final strategic goal emphasizes research and innovation to address knowledge gaps and advance GIS applications in the health sector. Targeted research projects will be initiated to address disease surveillance and control. Publication of research papers in peer-reviewed journals and organization of an annual conference will disseminate GIS-based research findings. Additionally, prototype GIS tools and applications will be developed to address priority health sector needs. The priority programmes are as follows:

a. Expanded Programme on Immunization (EPI): Investigate the use of GIS to optimize vaccine coverage and identify underserved populations.
b. Malaria Control: Explore GIS applications for malaria vector mapping, hotspot identification, and targeted intervention strategies.
c. HIV/AIDS Prevention and Treatment: Assess the potential of GIS in improving access to HIV/AIDS prevention and treatment services.
d. Tuberculosis (TB) Control: Study the use of GIS in TB case detection, contact tracing, and treatment monitoring.
e. Emergency Preparedness and Response (EPR): Investigate the role of GIS in enhancing emergency response planning, resource allocation, and coordination.
f. Non-Communicable Diseases (NCDs): Use GIS to investigate the geographic distribution of emerging NCDs and the possible underlying socio-economic, behavoral and environmental drivers.
g. Neglected Tropical Diseases (NTDs): Use GIS to investigate the geographic distribution of emerging NCDs and the possible underlying socio-economic and environmental drivers.
h. Central Medical Stores (CMS): Use GIS to monitor and track the movement and distribution of medical supplies.

1.By 2025, initiate 3 targeted research projects to address knowledge gaps identified in diseases surveillance and control.

Activities:

- Identify priority research topics in diseases surveillance such as malaria, TB, NTDs, etc.

- Form research committees with stakeholders including Ministry of Health, academic institutions etc.
- Develop terms of reference and protocols for each project
- Mobilize required funding and resources
- Establish timelines and monitor progress

2. By 2026, build capacity of Eswatini institutions to offer GIS-based courses.

Activities:

- Identify target institutions such as universities, technical colleges etc.
- Assess existing infrastructure, faculty and curricula
- Develop customized GIS course curricula
- Train 15 faculty members from target institutions through external certification programs
- Procure required software and hardware
- Enroll first batch of 20 students in each institution
- Evaluate programs and certify graduates regularly

3. By 2026, 5 research papers in peer-reviewed journals using GIS.

Activities:

- Identify priority research topics and problems
- Form multidisciplinary research teams
- Develop research proposals and get necessary approvals
- Collect, analyze data using GIS and interpret results
- Disseminate findings through conferences and publish final papers
- Analyze citation and impact of published papers

4. By 2025, organize an annual conference to disseminate GIS-based research findings.

Activities:

- Form an organizing committee (could be derived from the TWG)
- Identify themes and invite abstracts/papers
- Mobilize resources - funding, logistics, publicity etc.
- Plan the conference program - presentations, panel discussions etc.
- Execute the conference and document proceedings
- Widely disseminate conference outcomes

5. By 2025, develop 5 innovative prototype GIS tools/applications to address health sector priority needs.

Activities:

- Conduct a needs assessment to identify priority tools required
- Engage university students/faculty to develop the tools
- Test, iterate and refine the tools
- Demonstrate the tools to stakeholders for validations and feedback
- Create management plans for sustaining the tools.
- Demonstrate the effectiveness and impact of the GIS products in decision-making and health outcomes.

CHAPTER 4: IMPLEMENTATION PLAN

This Strategy's implementation takes into consideration the existing resources, coordination structures, and partnerships available to achieve its objectives. Each of the implementation strategic goals has been formulated to be actionable, as detailed in the implementation plan. The Strategy's implementation will be monitored and, as necessary, adapted to integrate lessons learned and good practices and to respond to evidence and trends that emerge during the Strategy's lifespan.

The implementation plan outlined below provides a comprehensive roadmap for leveraging GIS technology to transform the health sector of Eswatini. By achieving these strategic goals, the country will enhance data governance, strengthen GIS infrastructure, build capacity, promote stakeholder engagement, and foster research and innovation. This concerted effort will ultimately lead to improved health outcomes and a more resilient healthcare system.

Strategic Objective	Activity	Timeframe	Responsible Institution	Estimated Budget (USD)
Enhance Data Governance and Management	Develop a Health Sector Spatial Data and GIS Policy	Q1 2024 - Q4 2024	Ministry of Health, Central Statistics Office, Ministry of ICT (Royal Science and Technology Park)	50,000
	Implement a robust data quality assurance program for priority health datasets	Q1 2024 - Q1 2025	Ministry of Health, Central Statistics Office	30,000
	Digitally archive all historical health datasets and reports	Q3 2024 - Q4 2025	Ministry of Health, Central Statistics Office, Surveyor-General's Office	20,000
	Attain at least 90% compliance on routine geospatial metadata population for all maps and datasets	Q1 2024 - Q4 2024	Ministry of Health, Central Statistics Office	15,000
Strengthen GIS Infrastructure and Systems	Acquire GIS hardware and software for use in the collection, mapping and analysis of health data	Q3 2024	Ministry of Health, Ministry of ICT (Royal Science and Technology Park), Surveyor-General's Department	150,000
	Establish a centralized Spatial Data Infrastructure (SDI) to facilitate geospatial data management and sharing across the health sector	Q2 2024 - Q1 2025	Ministry of Health, Central Statistics Office, Ministry of ICT (Royal Science and Technology Park)	100,000
	Digitize and integrate core health facility registry and demographic datasets to strengthen spatial analytics capabilities	Q3 2023 - Q1 2025	Ministry of Health, Central Statistics Office, Surveyor-General's Office	50,000
	Implement high-performance GIS/analytics workstations at national and regional health offices as well each health programmes	Q4 2022 - Q1 2023	Ministry of Health, Ministry of ICT (Royal Science and Technology Park)	75,000
	Operationalize integrated routine disease surveillance using spatial analytics	Q1 2024 - Q4 2025	Ministry of Health, Central Statistics Office, Surveyor-General's Office	40,000
Build Capacity and Skills in GIS	Establish a formalized health sector GIS training program through partnerships between the Ministry of Health, academic institutions (e.g. UNESWA) and development partners	Q1 2024 - Q4 2024	Ministry of Health, University of Eswatini, WHO, UNICEF	50,000

	Establish functional GIS units within each of the key programmes and units, with dedicated full-time staff to support spatial analysis needs at national and regional levels	2024	Ministry of Health, Surveyor-General's Office	150,000
	Integrate core GIS literacy into curricula for Community Health Workers, Nurses, and Environmental Health Technicians	2024	Ministry of Health, University of Eswatini, Ministry of Education	60,000
	Ensure 80% of health managers routinely use GIS dashboards for health monitoring and planning on a quarterly basis	2024	Ministry of Health	20,000
Promote Stakeholder Engagement and Collaboration	Establish a fully functional and constituted Health Sector GIS Technical Working Group to facilitate coordination and partnership development	Q2 2024 - Q3 2024	Ministry of Health	10,000
	Formalize at least 5 bilateral agreements with academic/research institutions to support GIS training and applied research	2024	Ministry of Health, University of Eswatini, UNICEF	15,000
	Enhance information exchange through an online Health GIS stakeholder portal	Q3 2024 - Q2 2025	Ministry of Health, Ministry of ICT (Royal Science and Technology Park)	30,000
	Increase stakeholder participation in national GIS conferences by 30% annually	2024+	Ministry of Health	15,000
Promote Research and Innovation in Targeted Areas	Initiate 3 targeted research projects within 1 year to address knowledge gaps identified in diseases surveillance and control	Q4 2024	Ministry of Health, University of Eswatini, UNICEF	100,000
	Engage Eswatini institutions to offer GIS-based certificate courses within 2 years.	Q3 2024	Ministry of Health, University of Eswatini, UNICEF	10,000
	Publish research papers in peer-reviewed journals using GIS within 3 years.	Q1 2025	Ministry of Health, University of Eswatini, UNICEF	10,000
	Organize an annual conference to disseminate GIS-based research findings.	Q1 2025	Ministry of Health, University of Eswatini, UNICEF	35,000
	Develop 5 prototype GIS tools/applications to address health sector priority needs by 2025.	Q4 2024	Ministry of Health, University of Eswatini, UNICEF	100,000

4.1 RESOURCE ALLOCATION AND BUDGET

The total budget for the implementation of the GIS strategy will be used to cover the costs of:

- Developing the national Health GIS data repository/infrastructure
- Establishing the mechanism for data sharing and collaboration
- Providing training and support to health sector staff on GIS
- Developing the plan for the sustainable implementation of GIS
- Monitoring and evaluating the GIS strategy

The budget will be funded by a combination of sources, including the government of Eswatini, development partners, and the private sector. Hence, the Ministry of Health needs to:

a. Seek partnerships with international organizations, such as the World Health Organization (WHO), United Nations Children's Fund (UNICEF), and Global Alliance for Vaccines and Immunization (GAVI), to leverage their expertise, resources, and funding opportunities.
b. Explore public-private partnerships to mobilize additional financial and technical resources for GIS implementation in the health sector.
c. Increase investment and resource allocation into hiring the required personnel as well as other required resources.

The successful implementation of the Strategy for the health sector in Eswatini largely depends on effective resource allocation and strategic investments. While most of the associated costs are being managed through existing activities within the health departments and programs, it is crucial to ensure sustainability and progress. The Ministry of Health, in collaboration with key stakeholders, will oversee the monitoring and evaluation of the strategy's implementation. This includes incorporating geospatial considerations into the budget planning processes of the health departments and programs. By doing so, the Strategy aims to optimize resource utilization and enhance coordination among various stakeholders. The following key priorities have been identified for successful implementation:

Establishing/Strengthening a GIS Unit: Invest in and develop the national Health GIS Unit as the central hub for geospatial analysis and coordination within the health sector. This Unit must serve as a focal point for data management, analysis, and dissemination, ensuring efficient and standardized geospatial practices across the MoH departments and programs.

Data Acquisition and Accessibility: Prioritize the acquisition of public, commercial, and academic sources of geospatial data relevant to the health sector. Develop mechanisms to make these data easily accessible to health professionals, researchers, and policymakers, fostering data-driven decision-making and analysis. Develop a national health facility master list that will be maintained and quality-controlled to ensure a single, reliable and accurate source of health facility data for Eswatini.

Strengthening Existing Investments: Enhance the linkages between existing geospatial investments, such as disease surveillance systems, health facility mapping, and community health

programs, to ensure comprehensive and integrated data analysis. This will enable a more holistic understanding of health-related issues and facilitate targeted interventions.

Establishing a GIS Coordinator Role: Designate a GIS Coordinator within the MoH and recognize this role as the Senior Official for Geospatial Information, as defined by relevant national and international standards. This will provide strategic leadership and coordination for geospatial activities within the health sector.

Enterprise Geospatial Infrastructure: Develop an enterprise geospatial infrastructure solution that minimizes inefficiencies and duplication of efforts in GIS software, hardware and data purchases across different health departments and programs. This will optimize resource allocation and promote standardization.

Geospatial Data Stewardship: Invest in geospatial data stewardship to enhance the capacity for managing and maintaining enterprise geospatial data master lists. Develop and implement standards to ensure interoperability, usability, and data quality.

Capacity Building for Ministry of Health IT: Strengthen the Ministry of Health's Information Technology (IT) department to integrate geospatial technology and data effectively. This includes providing the necessary resources, training, and support to leverage geospatial capabilities within the broader IT architecture of the health sector.

Customized Geospatial Training: Continue to develop and update training programs tailored to the diverse needs and applications of geospatial analysis across the health sector using both low tech (maps) and high tech (GIS) tools. This will ensure that health professionals and staff have the necessary skills and knowledge to utilize geospatial tools and data effectively.

Implementing Geospatial Standards: Enforce the adoption of national (SWASA) and international geospatial standards, such as standardized location and place names, as well as requirements for collecting activity location data. This will ensure consistency, accuracy, and comparability of geospatial data across the health sector.

Geospatial Research Agenda: Establish a geospatial research agenda aligned with the health sector's strategic priorities. Guide the implementation of research initiatives to address critical knowledge gaps and inform evidence-based decision-making.

Collaboration with Key Partners: Foster collaboration and partnerships with key stakeholders, including other government agencies, international organizations, academic institutions, and non-governmental organizations, to leverage their expertise and resources in geospatial applications for health.

By implementing these priorities, the Strategy for the health sector in Eswatini aims to optimize resource allocation, enhance data-driven decision-making, and improve health outcomes for the population.

4.2 MONITORING AND EVALUATION FRAMEWORK

The success of the GIS strategy will be monitored and evaluated through tracking the strategy activities, particularly the following key indicators:

- Number of GIS datasets available in the national GIS data repository
- Number of stakeholders, departments/programmes effectively using GIS data
- Number of health sector staff trained on GIS
- Level of collaboration and coordination among stakeholders
- Sustainability of GIS implementation
- Number of programmes/departments actively using GIS
- Number of publications applying GIS in healthcare in Eswatini
- Number of GIS-based dashboards and information portals.
- Number of geospatial data product users trained

The GIS strategy will be reviewed annually to assess progress and make adjustments as needed.

4.3 RISK ASSESSMENT AND MITIGATION STRATEGIES

The following are some of the risks that could impact the implementation of the GIS strategy:

- Lack of political support
- Insufficient funding
- Lack of technical capacity
- Resistance to change
- Data privacy and security concerns
- Limited sharing of and access to key datasets
- Lack of public trust in the data

The following mitigation strategies will be put in place to address these risks:

- Obtain high-level support for the GIS strategy from the government of Eswatini
- Secure funding from a variety of sources
- Build the capacity of health sector staff to use and understand GIS
- Manage change effectively
- Develop and implement a data privacy, data standards, quality and security policies.

CHAPTER 5: CONCLUSION

This Strategy serves as a compelling call to action for the Ministry of Health (MoH) and the broader health community in Eswatini to embrace and harness the rapidly evolving geospatial technology and data for the advancement of healthcare delivery and improved health outcomes. It presents an exceptional opportunity to strategically plan, align, and coordinate the MoH's geospatial investments, ensuring their effective and efficient utilization to maximize their impact. By positioning the MoH to leverage the most promising geospatial technologies as they emerge, this Strategy aims to revolutionize healthcare planning, implementation, and monitoring.

However, institutionalizing a geographic approach requires more than just geospatial technology. It demands a fundamental shift in how healthcare actors utilize data to inform their programming—transitioning from sector- or issue-driven analyses to a more holistic, integrated, and efficient model that acknowledges the intricate complexities of specific locations. The successful implementation of this Strategy will empower the MoH to realize this transformative shift through targeted investments in geospatial data, systems, training, policies, and partnerships. By doing so, the MoH will emerge as a stronger partner to the communities it serves, enabling them to harness the transformative power of geospatial technologies for improved health and well-being.

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We also acknowledge the use of generative AI to refine the English language and to proofread some parts of this report.

APPENDICES

APPENDIX A: SPATIAL DATA INVESTMENT PROGRAM

Introduction:

The geospatial data investment strategy aims to guide the Ministry of Health in Eswatini in effectively harnessing and utilizing geospatial data for data-driven decision-making. The strategy focuses on identifying key datasets that need to be collected and archived to address the specific needs of the Ministry of Health.

Goals and Objectives:

- Improve the availability and accessibility of geospatial data within the Ministry of Health.
- Enhance the capacity of staff in geospatial data analysis and interpretation.
- Foster collaboration and partnerships for data sharing and utilization.
- Support evidence-based decision-making and policy formulation in the health sector.

Based on the landscape assessment report accompanying this strategy, below is a comprehensive data investment program outline tailored to the needs of the Ministry of Health. The program identifies key datasets that must be collected and archived for data-driven decision-making and such data must be available at the highest possible spatial resolution or level, e.g. facility, community or household level.

1. **Key Datasets:**

A. Health Facilities and Infrastructure:

- Location and attributes of all health facilities (hospitals, clinics, dispensaries, etc.).
- Health facility services and capacities.
- Infrastructure data (water supply, electricity, waste management, etc.).
- Equipment and resources inventory.

B. Epidemiology and Disease Surveillance:

- Disease incidence and prevalence data.
- Demographic data (population, age, gender, etc.).

- Spatial distribution of diseases and outbreaks.
- Environmental data (air quality, water quality, etc.).
- Immunization coverage data.
- Health risk factors data (smoking, obesity, etc.).

C. Environmental Health:

- Environmental monitoring data (air pollution, water quality, etc.).
- Hazardous waste disposal sites and contaminated areas.
- Vector-borne disease surveillance data.
- Food safety inspection data.
- Occupational health and safety data.

D. Health Service Utilization and Access:

- Patient records and health service utilization data.
- Accessibility and geographical coverage of health services.
- Health service demand and utilization patterns.
- Health service wait times and referral patterns.

E. Health Workforce:

- Health workforce data (doctors, nurses, specialists, etc.).
- Geographic distribution of health workforce.
- Skills and qualifications of health workforce.
- Workforce capacity and training data.

2. Data Collection and Archiving:

A. Data Collection Methods:

- Implement routine data collection mechanisms within health programs.
- Develop standardized data collection tools and protocols.
- Utilize electronic health records (EHR) systems for capturing patient data.
- Establish data sharing agreements with relevant stakeholders (hospitals, clinics, laboratories, etc.).
- Leverage mobile data collection technologies for field data collection.

B. Data Archiving and Management:

- Establish a centralized data repository or data warehouse.
- Implement data governance policies and protocols.
- Ensure data security and privacy measures.
- Develop data quality assurance mechanisms.
- Enable interoperability between different health information systems.
- Promote data sharing, access and collaboration across departments.

- Regularly update and maintain datasets to ensure accuracy and relevance.

3. Data-Driven Decision-Making:

A. Analytics and Reporting:

- Develop data analysis tools and dashboards for visualizing and analyzing data.
- Ensure public access to some information of public interest.
- Implement data integration and analytics platforms.
- Conduct regular data analysis and reporting on key performance indicators.
- Generate actionable insights from data to inform decision-making.

B. Capacity Building and Training:

- Provide training on data collection protocols and tools.
- Build capacity in data analysis, interpretation and use.
- Promote data literacy and data-driven decision-making culture.
- Foster collaboration between data analysts, program managers and other key data users and officers.

C. Evidence-Based Policy Development:

- Use data insights to inform policy formulation and evaluation.
- Conduct research and studies based on available datasets and their use to improve programs.
- Monitor and evaluate the impact of policies and interventions.

NB: The data investment program should be dynamic and adaptable to evolving needs and technological advancements. Regular evaluations and feedback loops should be established to assess the effectiveness of the strategy and make necessary adjustments.

By implementing this data investment program, the Ministry of Health can ensure the availability of comprehensive and reliable datasets for data-driven decision-making, leading to improved health outcomes, resource allocation, and policy development.

APPENDIX B: CAPACITY BUILDING PROGRAM OUTLINE

On the basis of the landscape analysis (see accompanying report) findings, as well as considering contemporary trends in geospatial data analytics and artificial intelligence applications in the health sector, the following capacity building program is recommended:

Program Objectives:

1. Enhance participants' knowledge and skills in geospatial data analytics.
2. Enable participants to leverage artificial intelligence techniques in geospatial analysis.
3. Equip participants with the ability to apply advanced geospatial analytics and AI methodologies to address public health challenges.
4. Foster collaboration and knowledge sharing among participants and stakeholders in the field of geospatial data analytics and AI.

The program covers both foundational and advanced GIS concepts and techniques, including AI-based approaches:

Thematic Area 1: Vaccination/Immunization

Foundational GIS Training

- Introduction to GIS: Overview of GIS concepts, components, and applications in the health sector.
- Geospatial Data Management: Techniques for data collection, data quality assurance, and data integration.
- Spatial Analysis: Methods for spatial data visualization, spatial queries, and basic spatial analysis techniques.
- Cartography and Map Design: Principles of map design, symbolization, and effective communication of spatial data.
- GIS Software Training: Hands-on training on popular GIS software, such as ArcGIS or QGIS, covering data input, manipulation, and basic analysis functionalities.
- Field Data Collection with Mobile GIS: Training on using mobile devices and GIS applications for data collection in the field.

Advanced GIS Training

- Advanced Spatial Analysis: Techniques for advanced spatial analysis, including hotspot analysis, spatial interpolation, and network analysis.
- Spatial Modeling: Introduction to spatial modeling techniques, such as spatial regression and suitability analysis, to identify factors influencing immunization coverage in zero-dose communities.
- Remote Sensing and Image Analysis: Introduction to remote sensing data, image processing techniques, and applications in health, including monitoring vegetation indices (e.g., NDVI) for disease surveillance and environmental impact assessment.
- Spatial Data Visualization and Storytelling: Advanced techniques for visualizing spatial data, creating interactive maps, and communicating complex information effectively.
- Geospatial Data Mining and AI-based GIS: Introduction to geospatial data mining techniques, machine learning, and artificial intelligence (AI) applications in GIS for predictive modeling and decision support in immunization campaigns.
- GIS Project Management: Best practices in managing GIS projects, including data acquisition, project planning, and stakeholder engagement.

GIS for Public Health Professionals

- Disease Mapping and Surveillance: Techniques for mapping disease incidence, prevalence, and outbreaks using GIS, and integrating surveillance data with spatial analysis.
- Health Equity and Access Analysis: Introduction to GIS-based techniques for analyzing health equity and access to immunization services, including spatial equity analysis and accessibility modeling.
- Program Evaluation and Impact Assessment: Methods for evaluating the impact of immunization programs using GIS, including spatial-temporal analysis and outcome evaluation.
- GIS in Emergency Response: Application of GIS in emergency preparedness and response, including mapping vulnerable populations, resource allocation, and real-time data visualization during health emergencies.
- Spatial Epidemiology: Advanced techniques for analyzing disease patterns, spatial clustering, and identifying high-risk areas using GIS.
- Ethical Considerations in GIS: Discussion of ethical issues related to geospatial data, privacy, and data sharing in the context of public health.

Build capacity of existing officers

Health Information Officers or other DHIS2/information system users

- Understand how to use the data in the HMIS system(s) in a spatial way
- Spot and understand spatial data errors
- Understand how to use the maps for district and facility level planning
- Utilize GIS capabilities (such as the Maps App in DHIS2) to create basic maps for dashboards and for use at the facility level.

Map use training for central level program managers including senior officers

- Understand the data and methodology for its creation, especially modelled data or data created through advanced spatial analyses
- Comprehend how the data/maps can be used for making high level decisions
- Spot errors and give feedback to technical staff to quality check data
- Understand how data visualizations can be misleading or politically sensitive (I.e. the use of red to display data that may show an improvement).
- Spot sensitive data which should not be shared publically
- Decide which data visualizations can be made public
- Understand what spatial products could be added to existing national strategic documents
- Be capacitated to ask GIS officers for spatial products which are not yet in use and to give directions to any spatial research questions that should be investigated.
-

Map use training for pre and in service health professionals at local levels

- Understanding quality and source of data in the maps
- Spotting data errors
- Orientation within the maps (I.e. name unnamed villages appearing in the map)
- Using the maps for resource planning (I.e. measuring distances, using population data)
- Establishing the catchment area/area of operation to ensure no child/village is missed
- Using the maps to find settlements in the field
- Giving feedback on data quality and update needs

Thematic Area 2: Epidemiology and Disease Surveillance

Foundational GIS Training Program:

Objective:

To provide epidemiologists and disease surveillance officers with the foundational knowledge and skills to effectively utilize GIS in disease surveillance and outbreak response.

Topics Covered:

- Introduction to GIS and its applications in epidemiology and disease surveillance.
- Spatial data types and formats.
- GIS software and basic functionalities.
- Geospatial data collection and quality assurance.
- Data visualization techniques for disease mapping.
- Basic spatial analysis techniques for disease surveillance.

Advanced GIS Training Program:

Objective:

To enhance the skills of epidemiologists and disease surveillance officers in advanced GIS techniques and AI-based approaches for improved disease surveillance and response.

Topics Covered:

- Advanced spatial analysis techniques for disease surveillance, including spatial clustering and hotspots analysis.
- Geospatial modeling for disease prediction and resource allocation.
- Introduction to AI-based approaches in disease surveillance.
- Machine learning algorithms for disease classification and prediction.
- Integration of remote sensing and GIS in disease surveillance.
- Ethical considerations in GIS and AI-based disease surveillance.

Thematic Area 3: Health Facilities and Resource Planning

Foundational GIS Training Program:

Objective:

To equip health facilities and resource planning officers with the foundational knowledge and skills to utilize GIS for effective health facility planning and resource allocation.

Topics Covered:

- Introduction to GIS and its applications in health facility planning.
- Geospatial data sources and data collection methods.

- GIS software and data management techniques.
- Spatial analysis for health facility location analysis.
- Basic mapping techniques for health facility mapping and visualization.
- Introduction to spatial decision support systems.

Advanced GIS Training Program:

Objective:

To enhance the skills of health facilities and resource planning officers in advanced GIS techniques and AI-based approaches for optimized health facility planning and resource allocation.

Topics Covered:

- Advanced spatial analysis techniques for healthcare resource allocation and planning.
- GIS-based modeling for optimized health facility location analysis.
- Geospatial analysis of healthcare accessibility and equity.
- AI-based approaches for healthcare demand forecasting.
- Integration of GIS and optimization models in health facility planning.
- Ethical considerations in GIS and AI-based health facility planning.

Thematic Area 4: Environmental Health

Foundational GIS Training Program:

Objective:

To provide environmental health officers with the foundational knowledge and skills to utilize GIS for environmental health monitoring and risk assessment.

Topics Covered:

- Introduction to GIS and its applications in environmental health.
- Geospatial data sources and collection methods for environmental health.
- GIS software and basic functionalities for environmental health analysis.
- Spatial analysis techniques for environmental health monitoring.
- Mapping and visualization of environmental health data.
- Introduction to spatial epidemiology in environmental health.

Advanced GIS Training Program:

Objective:

To enhance the skills of environmental health officers in advanced GIS techniques and AI-based approaches for comprehensive environmental health analysis and risk assessment.

Topics Covered:

- Advanced spatial analysis techniques for environmental health monitoring, including hotspot analysis.
- GIS-based modeling for environmental health risk assessment.
- Integration of remote sensing and GIS in environmental health analysis.
- AI-based approaches for environmental health data analysis and prediction.
- Geospatial analysis of environmental health disparities.
- Ethical considerations in GIS and AI-based environmental health analysis.

NB: These training programs should be tailored to the specific needs and context of Eswatini, considering the existing capacity of staff and available resources. Additionally, it is recommended to collaborate with academic institutions such as UNESWA, international organizations, and experienced GIS professionals to deliver the training programs, provide mentorship, and support ongoing capacity-building initiatives within the Ministry of Health.

The duration and depth of each training program can be adjusted based on the participants' existing knowledge and available resources. Practical exercises, case studies, and hands-on workshops should be included to facilitate the application of GIS techniques in specific departmental contexts. Regular assessments and evaluations should be conducted to measure participants' progress and provide feedback for improvement. Additionally, technical support and resources should be provided to participants during and after the training programs to support their ongoing use of GIS in their respective departments.

Evaluation and Follow-up:

- Conduct post-training assessments to measure participants' knowledge and skills acquisition.
- Provide ongoing support and resources for participants to apply their new skills in their work.
- Encourage collaboration and networking among participants through online platforms or communities of practice.

It is important to note that the program can be adapted and tailored based on the specific needs, resources, and expertise available within the context of Eswatini's Ministry of Health’s departments, programmes and related stakeholders.

APPENDIX C: GIS GOVERNANCE STRUCTURE PROPOSAL

The following is a proposed GIS governance structure tailored to the needs of the Ministry of Health. The structure includes a multi-stakeholder Technical Working Group and the roles of GIS Coordinator and GIS officers within each health program:

GIS Governance Structure:

A. Multi-Sectorial Stakeholder Technical Working Group (TWG):

Objective:

The TWG serves as the central body responsible for coordinating and overseeing GIS activities within the Ministry of Health. It ensures effective governance, collaboration, and decision-making related to GIS implementation and utilization.

Responsibilities:

1. Provide strategic guidance and direction for GIS initiatives.
2. Develop policies, standards, and protocols for GIS data management and utilization.
3. Coordinate and monitor GIS projects and activities across departments.
4. Evaluate and prioritize GIS requirements.
5. Facilitate capacity building initiatives and knowledge sharing.
6. Foster collaboration with external stakeholders, such as other government agencies, academic institutions, and NGOs.
7. Provide technical advice and support to health programs and departments.
8. Ensure compliance with data privacy and security regulations.

Composition:

The TWG should consist of representatives from various departments and stakeholders within the Ministry of Health. The composition may include:

1. Director or Deputy Director from the Ministry of Health (Chair)
2. GIS Coordinator (Secretary)
3. Representatives from key health programs (e.g., EPI, Epidemiology, Malaria, Environmental Health, etc.)
4. Representatives from key development partners (WHO, UNICEF)

5. SID representative
6. RSTP representative
7. CSO representative
8. SGO representative
9. Academia representative
10. Representative from implementing partners

B. GIS Coordinator / Focal Point:

Objective:

The GIS Coordinator or Focal Point is responsible for overseeing and coordinating GIS activities within the Ministry of Health. They serve as the focal point for GIS-related matters and act as a liaison between the TWG, health programs, and other stakeholders.

Responsibilities:

1. Coordinate and facilitate the implementation of GIS initiatives across the Ministry of Health.
2. Work closely with health programs to identify GIS requirements and ensure alignment with program objectives.
3. Develop and implement GIS strategies and action plans in collaboration with the TWG.
4. Provide technical guidance and support to health program GIS officers.
5. Ensure adherence to GIS data management protocols and standards.
6. Monitor the progress of GIS projects and initiatives.
7. Facilitate communication and collaboration between stakeholders involved in GIS activities.
8. Stay updated on emerging trends and technologies in GIS for health applications.
9. Ensure the capacity to use GIS and its end products are strengthened from the central to the local level through targeted trainings and mentorship?.
10. Supervise data quality concerns coming from the data users and ensure these are addressed by technical staff
11. Review quality of geospatial end products (I.e. maps) which are published and/or used by decision makers and planners at central and local levels.

C. GIS Officers within Health Programs:

Objective:

Each health program will have dedicated GIS officers responsible for implementing GIS within their respective programs. The number of GIS officers may vary based on the size and scope of the program. As a last resort, if funds are very limited, these may be existing IT personnel who may be capacitated on the use of GIS. They will work closely with the GIS Coordinator, TWG, and program managers to integrate GIS into program activities.

Responsibilities:

1. Develop and maintain GIS databases, maps, and spatial data sets specific to the program's needs.
2. Conduct spatial data analysis and visualization to support program objectives.
3. Provide technical support and training to program staff in GIS data collection, analysis, and interpretation.
4. Collaborate with program managers to identify and address GIS needs and requirements.
5. Assist in the design and implementation of GIS-based projects within the program.
6. Ensure compliance with data privacy and security regulations.
7. Collaborate with other GIS officers and share best practices and lessons learned.
8. Stay updated on GIS advancements and techniques relevant to the program's focus area.

Note: The GIS governance structure should emphasize collaboration, communication, and knowledge sharing among stakeholders. Regular meetings of the TWG should be conducted to discuss GIS-related issues, progress, and future plans. The GIS Coordinator should maintain close coordination with health programs and act as a resource for technical guidance and support. The GIS officers within health programs should have a dedicated focus on integrating GIS into program activities and building program-specific GIS capacity. By implementing this GIS governance structure, the Ministry of Health can ensure effective coordination, governance, and utilization of GIS across departments, leading to improved decision-making, resource allocation, and health outcomes.

APPENDIX D: LIST OF GIS STANDARDS FOR ESWATINI

STANDARD CODE	TITLE	SCOPE
SZNS ISO 19101:2002	Geographic Information - Reference Model	This International Standard defines the framework for standardization in the field of geographic information and sets forth the basic principles by which this standardization takes place. This framework identifies the scope of the standardization activity being undertaken and the context in which it takes place. The framework provides the method by which what is to be standardized can be determined and describes how the contents of the standards are related. Although structured in the context of information technology and information technology standards, this International Standard is independent of any application development method or technology implementation approach.
SZNS ISO/ TS 19103:2005	Geographic Information - Conceptual Schema Language	This standard provides rules and guidelines for the use of a conceptual schema language within the national geographic information standards. The chosen conceptual schema language is the Unified Modeling Language (UML). It also provides a profile of UML for use with geographic information. In addition, it provides guidelines on how UML should be used to create standardized geographic information and service models.
SZNS ISO/TS 19104:2008	Geographic Information - Terminology	This standard specifies the terminology applicable to international communication in the field of geographic information. It provides the guidelines for collection and maintenance of terminology in the field of geographic information. It establishes criteria for selection of concepts to be included in other standards concerning geographic information, which are developed by ISO/TC 211, specifies the structure of the terminological record, and describes the principles for definition writing. It also lays down the guidelines for maintenance of a Terminology Repository.
SZNS ISO 19105:2005	Geographic Information – Conformance and Testing	This standard specifies the framework, concepts and methodology for testing and criteria to be achieved to claim conformance to the family of ISO geographic information standards. It provides a framework for specifying abstract test suites (ATS) and for defining the procedures to be followed during conformance testing. Conformance may be claimed for data or software products or services or by

		specifications including any profile or functional standard.
SZNS ISO 19106:2004	Geographic Information – Profiles	This standard is intended to define the concept of a profile of the ISO geographic information standards developed by ISO/TC 211 and to provide guidance for the creation of such profiles. Only those components of specifications that meet the definition of a profile contained herein can be established and managed through the mechanisms described in this International Standard. These profiles can be standardized internationally using the ISO standardization process. This document also provides guidance for establishing, managing, and standardizing at the national level (or in some other forum).
SZNS ISO 19111:2007	Geographic Information - Spatial referencing by coordinates	SO 19111:2007 defines the conceptual schema for the description of spatial referencing by coordinates, optionally extended to spatio-temporal referencing. It describes the minimum data required to define one-, two- and three-dimensional spatial coordinate reference systems with an extension to merged spatial-temporal reference systems. It allows additional descriptive information to be provided. It also describes the information required to change coordinates from one coordinate reference system to another. In this standard, a coordinate reference system does not change with time. For coordinate reference systems defined on moving platforms such as cars, ships, aircraft and spacecraft, the transformation to an Earth-fixed coordinate reference system can include a time element. The standard is applicable to producers and users of geographic information. Although it is applicable to digital geographic data, its principles can be extended to many other forms of geographic data such as maps, charts and text documents. The schema described can be applied to the combination of horizontal position with a third non-spatial parameter which varies monotonically with height or depth. This extension to non-spatial data is beyond the scope of this standard but can be implemented through profiles.
SZNS ISO 19112:2003	Geographic Information - Spatial referencing by geographic identifiers	This standard defines the conceptual schema for spatial references based on geographic identifiers. It establishes a general model for spatial referencing using geographic identifiers, defines the components of a spatial reference system and defines the essential components of a gazetteer. Spatial referencing by coordinates is

		not addressed in this document; however, a mechanism for recording complementary coordinate references is included. It also assists users in understanding the spatial references used in datasets. It enables gazetteers to be constructed in a consistent manner and supports the development of other standards in the field of geographic information. It is applicable to digital geographic data, and its principles may be extended to other forms of geographic data such as maps, charts and textual documents.
SZNS ISO 19119: 2005	Geographic Information-Systems	This standard covers the identification and definition of the architecture patterns for service interface used for geographic information and definition of the relationships to the Open Systems Environment model. This standard presents geographic services taxonomy. The standard prescribes how to create a platform-neutral service specification, how to derive platform- specific service specifications that are conformant with this and provides guidelines for the selection and specification of geographic services from both platform- neutral and platform- specific perspective.
SZNS ISO 23081-1:2006	Information and documentation — Records management processes — Metadata for records — Part 1: Principles	This part of ISO 23081 covers the principles that underpin and govern records management metadata. These principles apply through time to: • records and their metadata; • all processes that affect them; • any system in which they reside; • any organization that is responsible for their management.
SZNS ISO/IEC 19115-1:2014	Geographic Information-Metadata- Part 1-Fundamentals	This part of the Standard defines the schema required for describing geographic information and services by means of metadata. It provides information about the identification, the extent, the quality, the spatial and temporal aspects, the content, the spatial reference, the portrayal, distribution, and other properties of digital geographic data and services. The standard is applicable to: • the cataloguing of all types of resources, clearinghouse activities, and the full description of datasets and services; • geographic services, geographic datasets, dataset series, and individual geographic features and feature properties. It also defines: • mandatory and conditional metadata sections, metadata entities, and metadata elements; • the minimum set of metadata required to serve most metadata applications (data discovery, determining data fitness for use,

		data access, data transfer, and use of digital data and services); • optional metadata elements to allow for a more extensive standard description of resources, if required; • a method for extending metadata to fit specialized needs. Though this standard is applicable to digital data and services, its principles can be extended to many other types of resources such as maps, charts, and textual documents as well as non-geographic data. Certain conditional metadata elements might not apply to these other forms of data.
SZNS ISO/IEC 11179-1:2004	Information technology – Metadata registries(MDR)part 1 – Framework	This Standard provides the means for understanding and ISO/IEC 11179 specifies the kind and quality of metadata necessary to describe data, and it specifies the management and administration of that metadata in a metadata registry (MDR). It applies to the formulation of data representations, concepts, meanings, and relationships between them to be shared among people and machines, independent of the organization that produces the data. It does not apply to the physical representation of data as bits and bytes at the machine level. In this standard, metadata refers to descriptions of data. SZNS ISO/IEC 11179 does not contain a general treatment of metadata. This standard also provides the means for understanding and associating the individual parts of SZNS ISO/IEC 11179 and is the foundation for a conceptual understanding of metadata and metadata registries.
SZNS ISO/IEC 11179-2:2005	Information Technology- Metadata registries (MDR), Part 2 – Classification	This standard restates and elaborates on the procedures and techniques of ISO/IEC 11179-3:2003 for registering classification schemes and classifying administered items in a metadata registry (MDR). All types of administered items can be classified, including object classes, properties, representations, value domains, and data element concepts, as well as data elements themselves. It also develops a set of principles, methods, and procedures for specifying what is needed (at a minimum) to document the association between the various types of administered items and one or more classification schemes. This includes the names, definitions, and other aspects of the classification scheme and its contents. These can be captured through the use of a set of attributes. Particular attributes are specified in this standard, along with a structure for the contents of these attributes. Users may extend the set of attributes as necessary. Additional information may accompany a taxonomy or ontology; for example, to provide a suggested set of qualifiers

		that could be applied to the object class, property, or representation taxa to more fully qualify the classification of the particular administered item. The standard also summarizes the basic attributes and model specified in ISO/IEC 11179-3:2003.
SZNS ISO 8601:2014	Data elements and interchange formats, Information interchange Representation of dates and times	This Standard is applicable whenever representation of dates in the Gregorian calendar, times in the 24-hour timekeeping system, time intervals and recurring time intervals or of the formats of these representations are included in information interchange.
SZNS ISO 15836:2009	Information and documentation - The Dublin Core metadata element set	This Standard establishes a Standard for cross-domain resource description, known as the Dublin Core Metadata Element Set. Like RFC 3986, this Standard does not limit what might be a resource. This Standard defines the elements typically used in the context of an application profile which constrains or specifies their use in accordance with local or community-based requirements and policies. However, it does not define implementation detail, which is outside the scope of this standard.
SZNS ISO/IEC 10646:2000	Information technology – Universal Multiple-Octet Coded Character Set (UCS)- Part 1: Architecture and Basic Multilingual	This Standard specifies the Universal Multiple-Octet Coded Character Set (UCS). It is applicable to the representation, transmission, interchange, processing, storage, input, and presentation of the written form of the languages of the world as well as of additional symbols. The UCS is a coding system different from that specified in ISO/IEC 2022. A graphic character will be assigned only one code position in ISO/IEC 10646:2003, located either in the BMP or in one of the supplementary planes. NB: The Unicode Standard, Version 4.0 includes a set of characters, names, and coded representations that are identical with those in this standard. It additionally provides details of character properties, processing algorithms, and definitions that are useful to implementers. Version 4.0 strengthens Unicode support for worldwide communication, software availability, and publishing. By defining a consistent way of encoding multilingual text this standard enables the exchange of data internationally. The information technology industry gains data stability, greater global interoperability and data interchange. This standard has been widely adopted in new Internet and W3C protocols and mark up languages such as XML and HTML, and implemented in modern operating systems and computer programming languages. This edition covers over 96 000 characters from the world's script.

Geospatial Information Systems (GIS) Strategy for Enhancing Health Sector Data Management and Decision-Making in Eswatini