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Assessment for the development of a local Spatial Data Infrastructure to improve geospatial data management for the Indigenous community in Kwamalasamutu, Suriname

Final Thesis report

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Abstract

Effective spatial data management is critical for sustainable development and resource management, especially for indigenous communities with unique cultural and environmental needs. Kwamalasamutu, located in the remote southern region of Suriname, faces significant challenges in accessing and using geospatial data due to its isolated location and limited technological infrastructure. This study assesses the status of the National Spatial Data Infrastructure of Suriname (NSDI) and the challenges, needs and requirements of developing a Local Spatial Data Infrastructure (LSDI) for the Indigenous community of Kwamalasamutu in Suriname.

The main research question is therefore, how can the development of a local SDI strengthen the spatial data management of the community in Kwamalasamutu and enhance collaboration with other organizations?

A mixed methods approach, combining qualitative interviews with community members of Kwamalasamutu and organizations with quantitative analysis of existing geospatial data and infrastructure. Findings indicate that an LSDI can enhance the community's capacity to manage natural resources, preserve cultural heritage, and support local governance and decision-making processes. Key components of the proposed LSDI include the establishment of a reliable energy source and the availability of internet, training programmes for local data coordinators, and the establishment of formal agreements between Kwamalasamutu and organizations regarding spatial data management. The study highlights the importance of resource allocation and capacity building in the development of the local spatial infrastructure. The study concludes that the implementation of an LSDI in Kwamalasamutu has significant potential to empower the Indigenous community through improved data access, resource management and self-governance, thereby contributing to the broader goals of sustainable development and cultural preservation in the region.

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ACT	Amazon Conservation Team
CARE	Collective Benefit, Authority, Responsibility, and Ethics
CRS	Coordinate reference system
CSDGM	Content Standard for Digital Geospatial Metadata
CSV	Comma-separated values
ECLAC	Economic Commission Latin America and the Caribbean
FGDC	Federal Geographic Data Committee
GEO	Geohazards Exploitation Platform
GEP	Group on Earth Observation
GGIM	Global Geospatial Information Management
GIS	Geographical Information System
GISSAT	Geographical Information Systems Software, Application, and Training
GML	Geography Markup Language
GPS	Global Positioning System
INDE	Brazil National Spatial Data Infrastructure
ISO	International organization for Standardization
IWGIA	International Work Group for Indigenous Affairs
KML/KMZ	Keyhole Markup Language
LSDI	Local Spatial Data Infrastructure
MAS	Maritieme Autoriteit Suriname
MI-GLIS	Management Instituut Grond registratie en Land Informatie Systeem
NARENA	Natural Resources and Environmental Assessment Departement
NIMOS	Natuur Instituut voor Milieu en Ontwikkeling in Sutiname
NGO	Non-Governmental Organization
NSDI	National Spatial Data Infrastructure
OGC	Open Geospatial Consortium
QGIS	Quantum Geographic Information System
SDG	Sustainable Development Goals
SDI	Spatial Data Infrastructure
VIDS	Vereniging Inheemse Dorpshoofden in Suriname
MI-GLIS	Management Instituut Grond registratie en Land Informatie Systeem
MOU	Memorandum of Understanding
TRIJANA	Trio and Wayana Indigenous organization
WGS	World Geodetic System
WFS	Web Feature Service
WMS	Web Map Service
WMTS	Web Map Tile Server
UN	United Nations
UNGEGN	United Nations

1 Introduction

1.1 Background

Suriname, located on the northern coast of South America, currently lacks formal recognition of land rights for Indigenous and Maroon peoples, putting it among the few countries on the continent without such legal provisions (The Guardian, 2023). However, a bill addressing these issues was recently introduced and is currently under parliamentary review (IWGIA, 2023). Recognition of these rights is a crucial step toward achieving autonomy for these communities (Binder & Binder, 2016). As national discussions continue regarding formal recognition, multiple organizations are engaged at the local community level to educate and empower these communities to enhance their abilities in territorial and sustainable management of resources (Ramirez-Gomez et al., 2013). One important aspect that is focused on is geospatial data collection for territorial management and informed decision-making (Ting & Williamson, 2000). An essential tool for effective geospatial data management and decision-making is a Spatial Data Infrastructure that could create a framework of agreements and procedures according to the needs of its users (van Loenen, 2006). As different levels of SDIs exist, ranging from Global to Local SDIs, there is at this stage no existing SDI in effect on the national- and local community level in Suriname. Although there is a national spatial data infrastructure (NSDI) in Suriname it is still in the initial phase (Merodio Gómez et al., 2019). The purpose of this NSDI is to promote collaboration between governmental institutions, organizations, businesses, and communities. However, communities and non-governmental organizations that collect geospatial data in the forest interior in South Suriname were not considered. As the communities are actively collecting geospatial data, a local SDI for Indigenous communities based on their geospatial data management needs and priorities might strengthen the communities' initiatives regarding territorial governance and sustainable resource management. Also, the establishment of a spatial data infrastructure on a local level could support the existing NSDI (Rajabifard, 2001) of Suriname.

1.2 Scope

Several local communities live in and of the forest in Suriname. These communities can be divided into two main groups, which are indigenous communities and tribal or maroon communities (Kambel, 2006). The focus of this research will be on the Indigenous Communities in South Suriname. One specific village that will be used as a case study is Kwamalasamutu, as shown in figure1. This is the biggest Indigenous village in South Suriname and home to the paramount chief. As with other villages, Kwamalasamutu relies mainly on the support of local and international non-profit organizations related to environmental conservation (Heemskerk & Delvoye, 2007) and human rights organizations, from which the latter specifically focused on Indigenous rights (VIDS, 2020). The various organizations support the community in their development needs while considering sustainable use of the forest and cultural preservation of the people (Ramirez-Gomez, et al., 2013). Compared to the other indigenous villages Kwamalasamutu has the highest population of 1300 people (UNITED NATIONS Caribbean, 2024) and is, therefore, the village that gets the most attention from the central government and organizations regarding the distribution of resources and basic amenities (Heemskerk &

Delvoye, 2007). In that sense, it is no surprise that the collection of indigenous information regarding culture preservation and sustainable resource management is more frequently done here than in other villages. Although the spatial data collection activities should lead to awareness of sustainable management of their resources and strengthen the community in their territorial governance, there are multiple challenges when it comes to the management of the geospatial data regarding data collection, storage, access, and distribution of geospatial data with external parties.

1.3 Problem Statement

As with most Indigenous communities in Suriname, the collection of geospatial data in Kwamalasamutu takes place through engagement with local community members (Ramirez-Gomez et al., 2013). However, these communities have a complex relationship with national and local organizations and governmental institutions when it comes to spatial data management (Haalboom, 2011). One main problem is that although the community is actively involved in the data collection projects mainly coordinated by organizations and the government, they have limited control over how their geospatial data is stored, used, accessed, and shared (Ramirez-Gomez et al., 2013). The community lacks the technical knowledge, skills, and resources to manage their geospatial data despite being the primary users and owners of this data (Ramirez-Gomez et al., 2013). National and local organizations store geospatial data within their environments because the data collection activities are done through projects coordinated and funded by these organizations. Also, these organizations use and share the spatial data collected by the Indigenous communities with other stakeholders who co-fund some of the projects such as the government, other non-governmental organizations, international organizations, or other project donors (VIDS, 2020). This leads to a lack of trust between the community and the organizations, and between the organizations and the government, due to unclear ownership of the data (Guérin-McManus et al., 1998). A possibility to solve this problem is to develop a local SDI according to the needs of the Kwamalasamutu community (Saab, 2009) and adhere to the requirements on the national level to support the NSDI. The local SDI would strengthen the geospatial data management of the community and contribute to the effective use and distribution of geospatial data with and between external parties outside the community.

1.4 Research objectives & research questions.

The objective of this research is to provide a better understanding of how a local spatial data infrastructure can strengthen the Indigenous Community of Kwamalasamutu in South Suriname so that they have better control over how their data is stored, accessed, and shared by themselves and with other stakeholders. The sub-objectives supporting this research objective will be to identify the current state of the spatial data infrastructure on a national level in Suriname. By analyzing the state of the NSDI a better understanding will be provided of how the development of a local spatial data infrastructure in Kwamalasamutu can be achieved. In addition, the users and other beneficiaries will be identified, and what their needs are for the development of a local SDI will be assessed. Finally, the requirements for the development of such an SDI will be

investigated and recommendations will be provided regarding the development of the local SDI to empower the spatial data management of the community and to improve collaboration between organizations and government institutions in Suriname. The main research question to reach the objective of this study is:

How can the development of a local SDI strengthen the spatial data management of the community in Kwamalasamutu and enhance collaboration with other organizations?

As for the main research objective, sub-questions are provided to support the sub-objectives of this research. These sub-questions are:

1. What is the status of the National Spatial Data Infrastructure (NSDI) in Suriname?
2. What are the challenges for the development of a local SDI to enhance geospatial data management?
3. Who are the users of the local SDI, and what are their needs for the development of a local SDI for Kwamalasamutu?
4. What are the requirements for the development of a local SDI to enhance collaboration with other organizations?

The outcomes of these sub-questions will help to answer the main research question. Each sub-question will provide information on a specific aspect of the main research question. The first sub-question will provide information regarding the status of the national spatial data infrastructure of Suriname and how this can be related to the development of the local spatial data infrastructure for Kwamalasamutu. Because the local SDI is for the community, sub-question 2 will identify the challenges the community faces regarding the data management of their resources. Sub-question 3 will identify the users and their needs for the creation of the local SDI. Finally, sub-question 4 will assess the requirement of such an SDI for the sustainable management of their resources.

1.5 Research innovation and limitations.

There has no research been done to assess the local SDI development in Suriname. Also, the concepts of data and technology are new to these communities who have limited understanding due to their low education level. Therefore, this research would be important because it would provide insights into how an SDI can be used to strengthen the data management capacities of Indigenous communities by starting with the community in Kwamalasamutu. The research would also contribute to the actual development of such an SDI which will be relevant to a variety of stakeholders, including:

- Indigenous communities in South Suriname.
- International organizations working on Indigenous Rights and environmental conservation, researchers, academics, organizations, and businesses that collect and use indigenous data.
- Government institutions regarding development and management plans for the Indigenous communities. The national Government can eventually integrate the local SDI into a National SDI.

The implementation of an SDI in Kwamalasamutu aligns directly with several of the United Nations Sustainable Development Goals (SDGs). SDG 15, "Life on Land," calls for the sustainable use of terrestrial ecosystems and the protection of biodiversity. An SDI can contribute to this goal by supporting sustainable forest management practices, reducing deforestation, and preserving habitats for endangered species. SDG 6, "Clean Water and Sanitation," emphasizes the importance of protecting water resources and ensuring access to safe drinking water. An SDI can aid in this endeavor by mapping groundwater resources, identifying potential sources of pollution, and developing plans for water conservation and sanitation. SDG 13, "Climate Action," urges immediate action to address climate change and its impacts. An SDI can play a crucial role in climate mitigation and adaptation by facilitating the assessment of climate risks, the identification of vulnerable areas, and the development of climate-resilient land-use strategies. The creation of a local SDI in Kwamalasamutu holds immense potential for empowering the indigenous community by providing access to spatial data and fostering a culture of data-driven decision-making. The SDI can catalyze the preservation of the community's traditional knowledge and ensure a harmonious coexistence with the natural environment contributing to the achievement of the United Nations SDGs.

Although there are several indigenous communities in Suriname, this research focuses mainly on the Indigenous Community of Kwamalasamutu in the Southern Forest interior of Suriname. Also, this research only provides a theoretical approach towards the conditions that must be in place for SDI development. The actual implementation of such strategies or systems is not part of this research. Still, the methodological approach and analysis of this research can be applied to communities that face the same challenges under similar conditions and can be adjusted if conditions vary.

1.6 Reading guide.

Throughout this research, the sub-questions will be answered according to the following chapters. While the first chapter gives an overall overview of the research, the second chapter will provide the theoretical background answering sub-questions 1, 2, and 3. Here information will be provided regarding SDI, the status of the NSDI in Suriname, and local community SDI for sustainable resource management. The following third chapter will address the research methodology of a user needs assessment, stakeholder interviews, and the development of a participatory game for the local SDI. Thereafter, Chapter 4 will provide the results from the methodological process applied. Chapter 5 will discuss the results and finally, in the last chapters, a conclusion and recommendations will be provided.

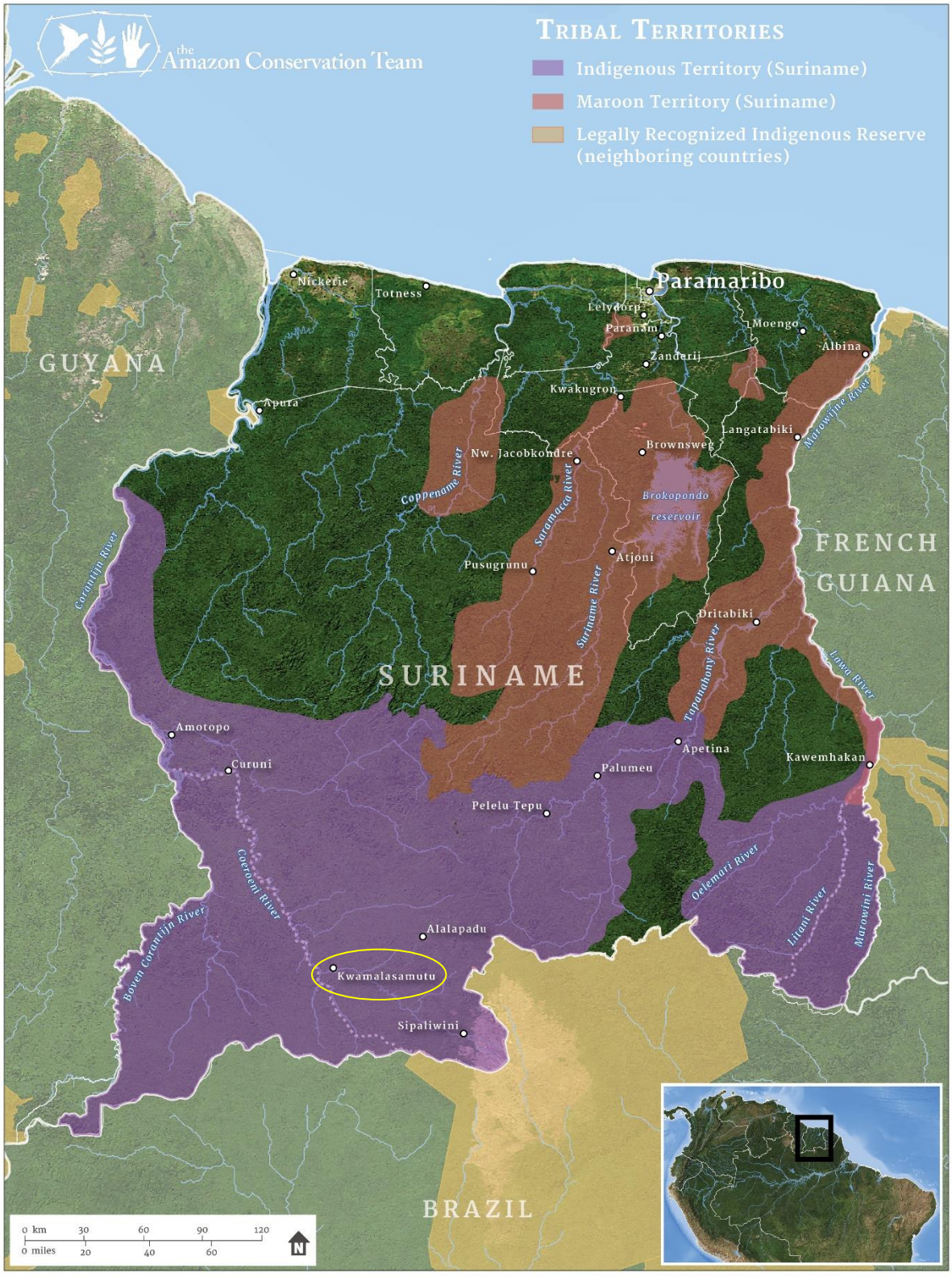

Figure 1: Map indicating the village of Kwamalasamutu in the yellow circle with the surrounding Indigenous villages and territories in Suriname (Source: The Amazon Conservation Team Suriname)

2 Background information Spatial Data Infrastructure and Suriname.

2.1 Spatial Data Infrastructures

In an increasingly interconnected world, where data drives decisions and innovations, Spatial Data Infrastructure (SDI) has emerged as a crucial enabler to efficiently manage and disseminate geospatial information. It has become vital for various sectors, from urban planning and business operations to disaster management, environmental conservation, sustainable resource management, and countless other fields (Ting & Williamson, 2000; Vancauwenberghe et al., 2014). Spatial Data Infrastructure (SDI) is a comprehensive framework or set of policies, standards, and technologies designed to facilitate the discovery, sharing, and use of geospatial data and related services (Feeney et al., 2001; McDougall et al., 2009). This infrastructure encompasses both the technical and organizational aspects necessary to enable seamless data exchange among diverse users within a specific organization, region, or country. SDIs are typically established by government agencies or organizations to ensure that geospatial data is managed efficiently, consistently, and made accessible to various stakeholders (Rajabifard et al., 2002). At its core, SDI is guided by principles such as interoperability, standardization, and accessibility, allowing for the integration of geospatial data from various sources that focus on data governance, data sharing, data access, and data (re-)use (van Loenen, 2006). The components of SDIs revolve around a centralized or coordinated approach to data management of which each of them plays a critical role in its effectiveness. The key components of an SDI are:

- Data: The heart of any SDI is its data. This includes geospatial information about locations, their attributes, and information describing the data's source, quality, and currency.
- Metadata: Metadata provides essential information about data, making it discoverable and understandable. Metadata includes details about the data's ownership, accuracy, and usage restrictions.
- Standards: To ensure compatibility and consistency, SDI relies on data and service standards. These standards define the structure and format of data and the protocols for accessing it. Examples include ISO 19100 series for geospatial standards and OGC (Open Geospatial Consortium) standards for web services.
- Software and Tools: Various software and tools are essential for data collection, management, and dissemination within the SDI. Geographic Information Systems (GIS) software, web mapping tools, and data visualization applications are common examples.
- Policies and Governance: Clear policies and governance structures are crucial for ensuring data quality, privacy, security, accessibility, and usability. Government agencies or organizations often play a central role in defining these policies.
- Human Resources: Skilled personnel are essential for the implementation and maintenance of SDI. This includes data managers, GIS professionals, and policy experts.
- User Community: A user community is vital to ensure the geospatial data is used effectively. This includes government agencies, businesses, researchers, and the broader public.

- Network Infrastructure: SDI requires a robust network infrastructure to ensure that data can be accessed and shared efficiently. This often involves the use of the internet, intranets, and other communication technologies.

2.1.1 Benefits of Spatial Data Infrastructure

The implementation of SDI offers many benefits to society, governments, businesses, and individuals. SDI provides decision-makers with a wealth of geospatial information, enabling them to make more informed and evidence-based decisions (McDougall et al., 2009). This is particularly valuable in fields, such as urban planning, disaster management, and environmental protection. Governments and organizations can efficiently manage resources to optimize infrastructure development and reduce costs by leveraging geospatial data within SDI (Masser et al., 2008). By doing so transparency is increased in government operations making it easier for citizens to access information and participate in governance. Also, SDI can lead to better public services, including improved transportation systems, healthcare facilities, and education services (Rajabifard et al., 2002). This is beneficial for the business sector that gains insights into market trends, optimizing logistics, and facilitating location-based marketing. As the effect of climate change has been increasing rapidly, geospatial information within SDI helps in disaster preparedness and response, from flooding events to earthquake prediction (Delgado & Crompvoets, 2008). Not only does SDI play a crucial role in disaster management but also in environmental conservation as natural resources can be better managed by monitoring environmental changes for the preservation of biodiversity and cultural heritage (Turkstra et al., 2003).

2.1.2 Challenges of Spatial Data Infrastructure

Despite SDI's myriad benefits, several challenges must be addressed to realize its full potential. One of these challenges is ensuring data quality and availability. This remains a persistent challenge because data may be outdated, incomplete, or inaccessible due to copyright and privacy concerns (Ali & Imran, 2020). Another challenge is achieving interoperability between diverse data sources, and systems. This is often a complex process because geospatial data is stored in different formats and is used by different systems (European Commission, 2017). Therefore, it is essential to have common standards and data-sharing protocols for the efficient flow of information. Developing and maintaining an effective SDI is also a challenge because it requires significant financial and human resources. This is a hurdle for many governments and organizations if there is not enough financial budget allocated for the development and management of the SDI and when there is a shortage of skilled personnel in the field of geospatial data management and analysis for the SDI implementation (Hadi et al., 2012). When it comes to data privacy and security, data accessibility and sharing, which is the main functionality of an SDI, becomes quite complex especially when dealing with sensitive information (Ramirez-Gomez et al., 2013). Furthermore, legal and policy challenges may arise, especially when sharing data across national borders, as data may be subject to different regulations and licensing agreements (Euopean Commission, 2017).

2.1.3 Levels of Spatial Data Infrastructure

Spatial Data Infrastructures can be categorized into various levels or stages based on their scope, complexity, and the extent of data sharing and integration. It is important to note that these tiers represent a continuum, and many SDIs may fall somewhere between these levels, depending on their specific goals and capabilities (Rajabifard et al., 2002). The choice of the SDI level depends on factors such as the geographic area of interest, the number of stakeholders involved, the scale of data integration, and the resources available for implementation. In practice, the development and evolution of SDIs often involve starting at lower levels and gradually progressing toward higher levels as data infrastructure and coordination mature (van Loenen, 2006). The goal is to achieve a more interconnected and interoperable global geospatial data ecosystem that benefits various sectors, from urban planning to disaster management to environmental conservation (Masser et al., 2008).

The specific terminology and criteria for these levels can vary, but generally, they include the following:

Table 1: Overview of SDI categories with their scope and examples.

SDI category	Scope	Example
Organizational SDI	Within an organization or governmental agency	Processes of data management, analysis, and dissemination within a specific organization.
Local SDI	Primarily focuses on a local or municipal level.	A city's GIS (Geographic Information System) system manages local data like property records, zoning, and utility infrastructure.
Regional SDI	Expands beyond the local level to cover a larger region, such as a county or a group of municipalities.	A regional planning agency that integrates data from various cities within a county for coordinated land-use planning and emergency response. European Space Agency's geohazards Exploitation Platform (GEP).
National SDI	Covers an entire nation and typically involves coordination among various government agencies.	Brazilian National Spatial Data Infrastructure (INDE) includes federal, state, and local agencies collaborating to provide geospatial data and services.
Global SDI	It encompasses the entire planet and involves international collaboration.	The Group on Earth Observations (GEO) is a global effort to coordinate Earth observation data from various countries and organizations for a range of applications, including climate monitoring and disaster management.

2.2 Suriname National Spatial Data Infrastructure

This section gives a summary of the National Spatial Data Infrastructure of Suriname. Before discussing the NSDI a description is given of Suriname and its administration as this is important to understand the context.

2.2.1 Suriname

History

Suriname, located on the northern coast of South America, is a small independent country that received its independence in 1975. Before its independence, Suriname was a colony of the Netherlands and the British who first colonized Suriname in the late 15th century. During this period other European explorers from Spain and Portugal also came to the region to occupy land. However, it was the Dutch who established a permanent presence in the region with the formation of the Dutch West India Company in the early 17th century (Höfte & Meel, 2022). Under Dutch rule, Suriname became a major producer of sugar cane, relying heavily on enslaved Africans to grow the lucrative crop. This period of Dutch colonialism was marked by exploitation, brutality, and resistance from the enslaved peoples (Emmer, 2011). Some of these people could escape the harsh environment and run away into the dense forests of Suriname far away from the plantations as possible. These runaway slaves, who were called Maroons, went back to the plantations to take food and weapons, and free other enslaved people. As these Maroons became a growing threat to the colonizers, several treaties were signed with three groups of Maroons in the 17th and 18th centuries which eventually led to the abolition of slavery. The abolition of slavery in the 19th century brought significant changes to Suriname's social and economic landscape. Indentured laborers from the Dutch East Indies (now Indonesia) and British India were brought in to replace the freed slaves on the plantations. This influx of diverse cultural groups contributed to Suriname's unique ethnic mosaic, which includes Creoles, Hindus, Javanese, Maroons, and indigenous peoples (IsGeschiedenis, 2022). In 1954, Suriname gained autonomy within the Kingdom of the Netherlands, followed by full independence on November 25, 1975. Independence brought both opportunities and challenges, as Suriname grappled with building a national identity while navigating economic development and political stability (Ramsoedh, 2018). One of the defining moments in Suriname's post-independence history was the 1980 military coup led by Sergeant Desi Bouterse. The coup ushered in a period of political instability and authoritarian rule, marked by human rights abuses and economic mismanagement. Despite this tumultuous period, Suriname has made strides toward democratic governance, with several elections and peaceful transitions of power in recent decades.

Resources

Suriname, with its abundant natural resources and diverse ecosystems, has significant potential for economic development. However, the exploitation of these resources presents both opportunities and challenges for the country and its people. From mining to forestry to sustainable energy, Suriname's journey to harness its natural wealth has been marked by a delicate balance between economic growth, environmental protection, and social equity (Ungar, 2018). The mining sector has been a key driver of economic growth, attracting foreign investment and generating revenue for the government. Bauxite mining, which was a major industry in Suriname, has a long history dating back to the colonial period. While bauxite mining

has contributed to economic development and infrastructure investment, it has also left a legacy of environmental degradation and social inequality (Lobach, 2023). The closure of bauxite mines in recent decades has led to unemployment and economic downturns in affected regions, highlighting the vulnerability of resource-dependent communities. Gold mining has boomed in recent years, with both large-scale operations and artisanal miners seeking their fortunes in the country's interior as can be seen in Figure 2.But mining also poses significant challenges, particularly in terms of environmental degradation (Quash et al., 2024) and social conflict. Deforestation, mercury pollution, and habitat destruction are among the environmental problems associated with gold mining in Suriname (Ottenbros et al., 2019). In addition, conflicts often arise between mining companies, indigenous communities, and residents over land rights, resource ownership, and the impact of mining activities on traditional livelihoods (Haalboom, 2011). In addition to mining, forestry is another important sector in Suriname, with vast tracts of pristine rainforest covering much of the country's interior. Sustainable forestry practices hold the promise of economic growth while preserving biodiversity and ecosystem services. However, illegal logging and deforestation for agriculture pose serious threats to Suriname's forests (The Guardian, 2023) and undermine efforts to achieve long-term sustainability and conservation goals.

Nowadays, Suriname faces several socioeconomic challenges, including poverty, unemployment, and environmental degradation. However, the country also has a rich cultural heritage, biodiversity, and potential for sustainable development. Efforts are underway to diversify the economy by promoting ecotourism, large-scale agriculture, and the extraction of natural resources such as logging, mining, and the oil and gas industry. Through these efforts, Suriname hopes to invest in education and infrastructure to ensure a better future for its people.

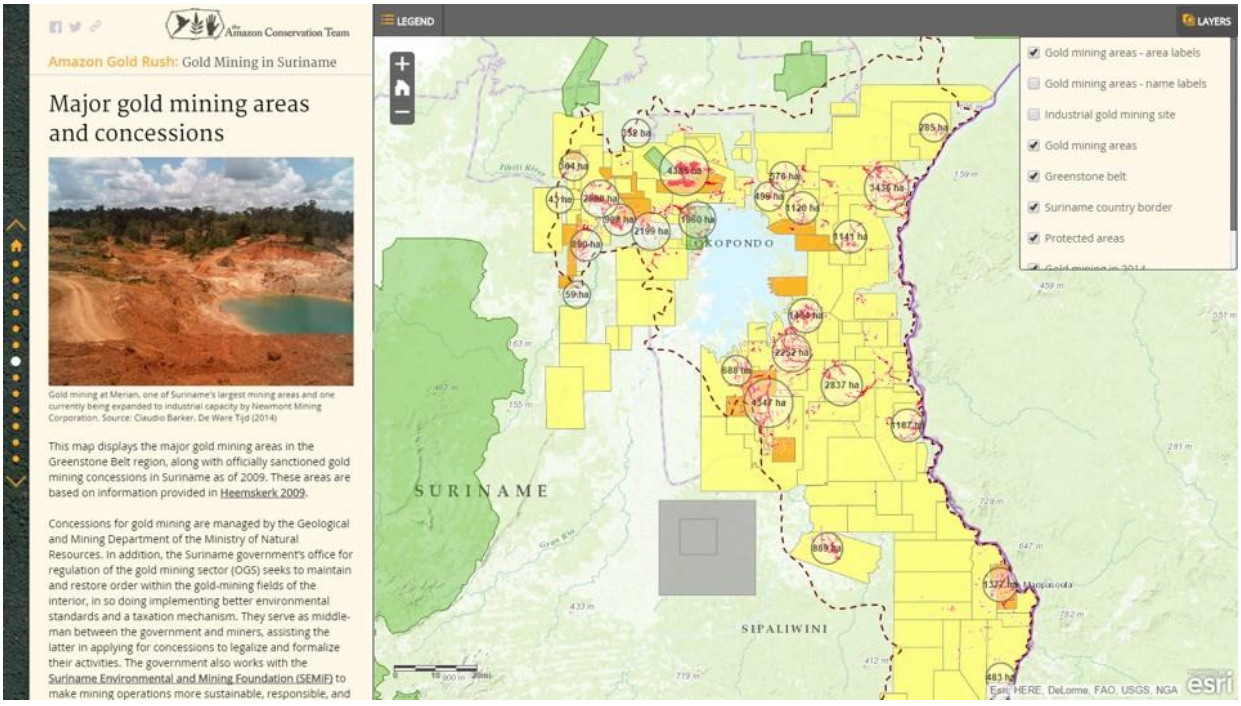

Figure 2: Map of East Suriname indicating the goldmining concessions. (Source: https://www.amazonteam.org/maps/suriname-gold/, Amazon Conservation Team)

2.2.2 National Spatial Data Infrastructure

The National Spatial Data Infrastructure (NSDI) is a crucial framework that plays a pivotal role in the effective management, sharing, and utilization of geospatial data within a country. NSDIs are essential for the efficient management and utilization of geospatial data for various purposes, including urban planning, resource management, disaster response, and economic development (Hadi et al., 2012). Suriname, like many countries, is in the process of developing its NSDI (Merodio Gómez et al., 2019).

Since 2009, Suriname has actively been participating in conferences held by the United Nations Group of Experts on Geographical Names (UNGEGN), United Nations Global Geospatial Information Management (UN- GGIM), and UN Spider in Switzerland regarding capacity building and institutional strengthening of geographical information management (Raghoebar, 2009). During the Ninth Regional Cartographic Conferences for the Americas held in New York, Suriname presented a model of their SDI. The main aim of this was to bridge the gap between the Surinamese public and modern technology (Raghoebar, 2013).

Today, the National SDI is still under development and is not operational. The Management Institute for Land Registration and Land Information System (MI-GLIS) wants to fulfill that role and by Surinamese law is the lead organization responsible for developing and maintaining the NSDI. The MI-GLIS is a member organization of UN-GGIM: Americas (MI-GLIS, 2017). This division promotes the creation of regional and national SDIs on decision-making based on spatial data, namely for the Americas and the Caribbean. In 2017 MI-GLIS conducted a geospatial data survey with 14 organizations. However, only six responses were obtained. Based on the results of that survey the organizations that responded indicated there is a need for an NSDI, which should support the accessibility and dissemination of geospatial data (MI-GLIS, 2017).

In 2019, Merodio Gómez et al. assessed the status of SDIs in the Americas. The results of this study were acquired by conducting a survey in which the questions were categorized according to five components of an SDI: institutional aspects, human resources, geographic information, technology, and financial resources. Each country was represented by a specific institution that coordinates the SDI development in the specific country. To assess the status of SDI in each country of the member states in the Americas, performance indicators were developed for comparison between the countries as well as standardization on a regional level (Merodio Gómez et al., 2019). The performance indicators were categorized as follows:

- Initial Level: Represents the initial state of implementation and development of an SDI.
- In Action Level: Projects are being implemented and ways to implement each component of the SDI are being sought.
- Defined Level: The SDI has a mature development and the guidelines of the work to be done are defined.
- Operational Level: High level of maturity of the SDI; however, there are still some components to improve and develop.
- Optimizing Level: All components are developed and correspond to a high level of maturity of the SDI.

Table 2: Score of indicators of SDI assessment done by Merodio Gómez et al. (2016)

Country	Institutional Aspects	Human Resources	Information and Standards	Technology	Total score	Level
Jamaica	8	3	14	4	29	Defined Level
Paraguay	9	2	14	3	28	Defined Level
Trinidad y Tobago	9	2	11	6	28	Defined Level
Antigua and Barbuda	8	4	10	5	27	Defined Level
Belize	8	3	11	5	27	Defined Level
Bahamas	10	2	10	4	26	Defined Level
St. Lucia	9	3	10	4	26	Defined Level
Haiti	7	2	11	5	25	In Action Level
Suriname	9	2	10	4	25	In Action Level
Granada	8	2	10	4	24	In Action Level
Nicaragua	6	2	10	6	24	In Action Level
El Salvador	6	3	10	4	23	In Action Level
Guatemala	6	2	11	4	23	In Action Level
St. Vincent and the Grenadines	5	4	12	2	23	In Action Level
Guyana	6	3	10	3	22	In Action Level
Dominica	5	3	11	2	21	In Action Level
Sint Maarten	6	2	10	3	21	In Action Level
Barbados	6	1	10	2	19	Initial Level

For Suriname, this was the MI-GLIS organization. MI-GLIS is also working with other government agencies and private sector organizations to develop and implement new geospatial data products and services. In 2018, MI-GLIS signed a Memorandum of Understanding with the United Nations Economic Commission for Latin America and the Caribbean (ECLAC) to collaborate on the development of the NSDI. Also, a geospatial workshop was held to bring together various organizations and institutions regarding the creation of a national geospatial framework. However, this has not been realized yet (MAS, 2020). Although these efforts have been made for the development of the NSDI, it is currently not being implemented. A National Base Map was developed but has not been published due to the lack of financial resources and political will. However, there have been efforts made by the Ministry of Spatial Planning and Environment to develop a Geospatial Intelligence hub for Suriname. In October 2023, the Ministry presented to various organizations consisting of governmental agencies, research institutions, and non-profit organizations to discuss its development (GOV.SR, 2023).

2.3 Local SDI for Kwamalasamutu

2.3.1 Kwamalasamutu

Located in the southernmost region of the country, in district Sipaliwini lies the village of Kwamalasamutu. With a population of 1300 people, most of the community consists of the Trio indigenous peoples and to a lesser extent approximately eleven other subtribes. The village is characterized by its traditional houses constructed from local materials such as palm leaves, wood, and vines. Among these traditional houses, there are also some non-traditional houses

built from wood and zinc plates. The latter came to be through the influence of people outside the community, mainly from the coastal area. Central to Kwamalasamutu's cultural identity is its connection to the natural environment as can be seen in Figure 3. The village is surrounded by lush, biodiverse rainforests that provide food, medicine, and materials for crafts and construction. Hunting, fishing, and gathering remain vital aspects of daily life, reflecting a deep respect for nature and traditional knowledge passed down through generations.

The people of Kwamalasamutu practice subsistence agriculture, growing crops such as cassava, plantains, and some fruits and vegetables in small family gardens. Traditional farming techniques, including slash-and-burn agriculture, are used to ensure sustainable land use and minimal ecological impact. This intimate relationship with the land reflects the indigenous worldview of reciprocity and stewardship, where people are seen as stewards of the earth rather than masters of it. Despite its remote location, Kwamalasamutu is not immune to the challenges of the modern world. Rapid environmental change through external pressures from logging, mining, and land development threatens the delicate balance of traditional life in the village. In response, community leaders and activists are working tirelessly to protect their ancestral lands, assert their rights, and promote sustainable development initiatives that respect indigenous sovereignty and cultural integrity. However, this process is challenging as Suriname has not officially recognized the land rights of indigenous and maroon peoples.

In recent years, there have been significant efforts to address the long-standing issue of land rights and territorial autonomy for indigenous communities in Suriname. One notable development is Suriname's signing and ratification of the International Labor Organization Convention 169 (ILO 169) in 1993. This convention recognizes the rights of indigenous and tribal people to control their lands, territories, and resources. There have also been other instances of progress in the recognition of indigenous land rights. For example, the government of Suriname has established land rights commissions to address land claims and has made efforts to demarcate and title indigenous lands. There have also been initiatives to strengthen the legal framework for the protection of indigenous rights, including the development of a draft law on the rights of indigenous peoples. Despite these efforts, indigenous communities in Suriname continue to advocate for stronger legal protections, greater participation in decision-making processes related to land and natural resource management, and meaningful consultation and consent for development projects that affect their territories. Ongoing dialogue and cooperation between the government, indigenous organizations, civil society groups, and the private sector are essential to advancing the recognition and protection of indigenous land rights in Suriname.

As Suriname continues to navigate the complexities of development and conservation, the village of Kwamalasamutu serves as a shining example of indigenous wisdom and cultural diversity in the heart of the Amazon rainforest. Through their deep connection to the land, rich cultural heritage, and commitment to sustainable living, the people of Kwamalasamutu offer valuable lessons in coexistence, harmony, and stewardship for the benefit of present and future generations.

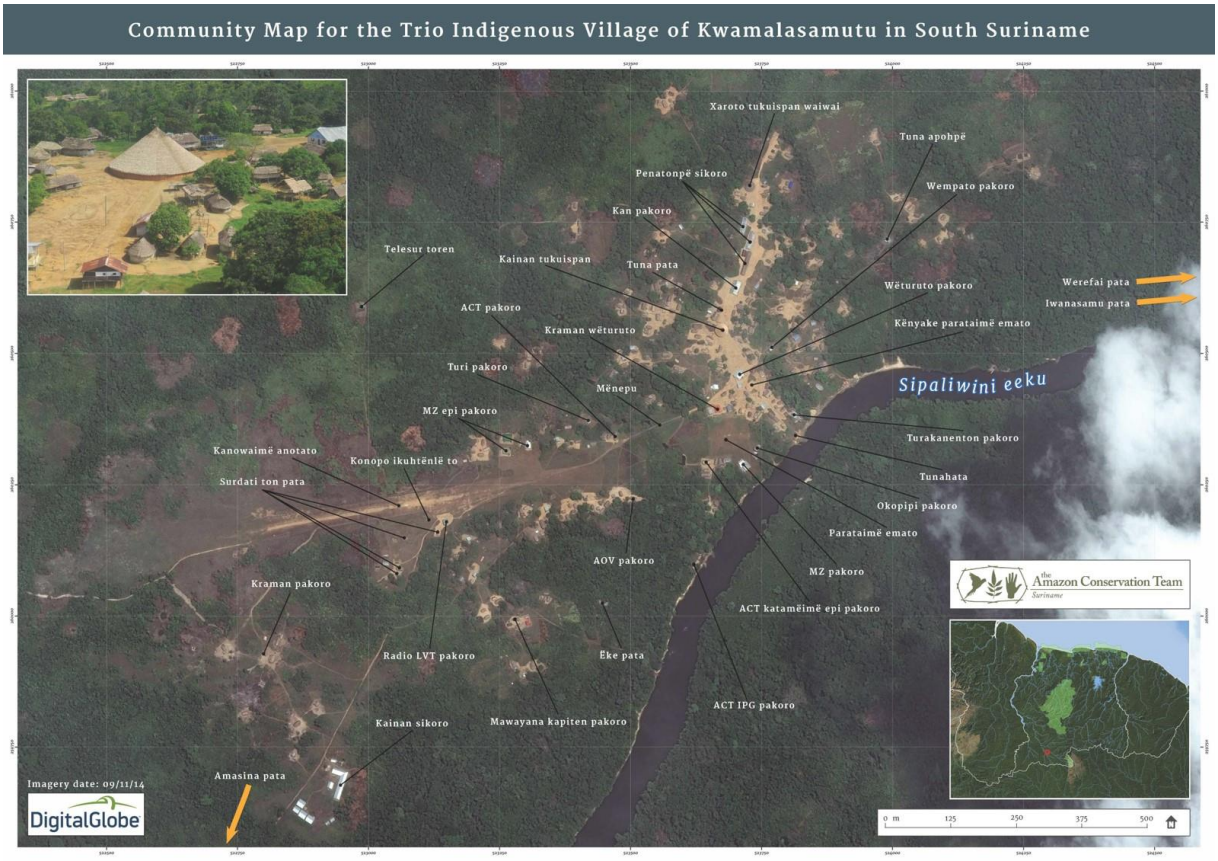

Figure 3: Map of Kwamalasamutu village with areas of interest indicated in the Trio language. (Source: Amazon Conservation Team)

2.3.2 Local SDI

Compared to a National SDI a Local Spatial Data Infrastructure (LSDI) is a framework for managing and sharing geospatial data and information at the local or municipal level. It is a subset of a larger National Spatial Data Infrastructure (NSDI) or Regional SDI, which focuses on geospatial data and services specific to a particular local authority, such as a city, county, municipality, or even a smaller administrative unit (Rajabifard, 2001). The primary purpose of an LSDI is to facilitate the use and exchange of geospatial data within the defined geographical area. According to McDougall et al., (2009), the LSDI framework helps streamline data management, making it more accessible and usable for decision-makers, planners, and the public For Kwamalasamutu a local SDI would strengthen their geospatial data management and support their decision-making process when it comes to their spatial data being used by other organizations. Local SDIs are, in theory, a critical component of a broader spatial data winfrastructure that spans from local to national and even international levels. They contribute to the effective governance, development, and overall well-being of local communities by harnessing the power of geospatial information (Yu & Cai, 2009). Examples of data typically managed by an LSDI may include property records, zoning information, transportation networks, utilities, public health data, land use data, and more.

For an indigenous community such as Kwamalasamutu, an LSDI tailored to the needs and preferences of the community can empower them to manage their lands, resources, culture, and

environment effectively (Turkstra et al., 2003). It promotes community engagement, decision-making, and self-determination, while also fostering collaboration with external partners for common goals (Yu & Cai, 2009). An LSDI can be beneficial to a community in various ways. The LSDI can serve as a centralized repository for geospatial data related to the community's traditional lands, including land use, land ownership, and natural resources. This helps in maintaining a comprehensive record of the land. Community members can easily access geospatial data related to land and resource management, allowing them to make informed decisions about sustainable land use and resource conservation (Bruhn, 2014). Geospatial data can be shared within the community, ensuring that traditional knowledge and practices are passed down and preserved. This data can also be shared with external partners and agencies involved in conservation efforts (Gómez & Inés, 2019).

According to Yu & Cai (2009), another way that geospatial data can be used is to map and document culturally significant sites, traditional territories, and historical landmarks, preserving the community's cultural heritage. Indigenous community members can access maps and data representing their cultural and historical sites, which is essential for cultural education and heritage preservation. Sharing such data can help raise awareness about the cultural significance of certain areas and can be used in educational programs for younger generations (Saab, 2009). The storage of geospatial data related to the environment, such as wildlife habitats, water sources, and ecological zones, helps in monitoring environmental changes and potential threats as can be seen in Figure 4. Community members can access this data to understand how environmental conditions are evolving and to identify areas that need protection. Collaboration with environmental organizations and government agencies can enable the sharing of data for conservation initiatives and help advocate for environmental protection (Williamson et al., 2023). Geospatial data can be used to store community-generated data, traditional ecological knowledge, and local expertise, empowering the community to have control over their information. The Local SDI ensures that community members have easy access to geospatial tools and information, enabling them to actively participate in decision-making processes. Sharing data with external partners, such as NGOs or researchers, can facilitate collaboration and resource access that benefits the community (Group, 2011). The storage of geospatial data can include risk assessment maps, evacuation routes, and emergency contact information, which is essential for disaster preparedness. The community can access this data to prepare for and respond to natural disasters or emergencies effectively. Sharing data with emergency services and government agencies ensures that the community receives the necessary support during crises (Molina & Bayarri, 2011). Local SDIs can be designed to prioritize data sovereignty and protect the privacy of the community's geospatial data, ensuring that the community maintains control over its information (Williamson et al., 2023).

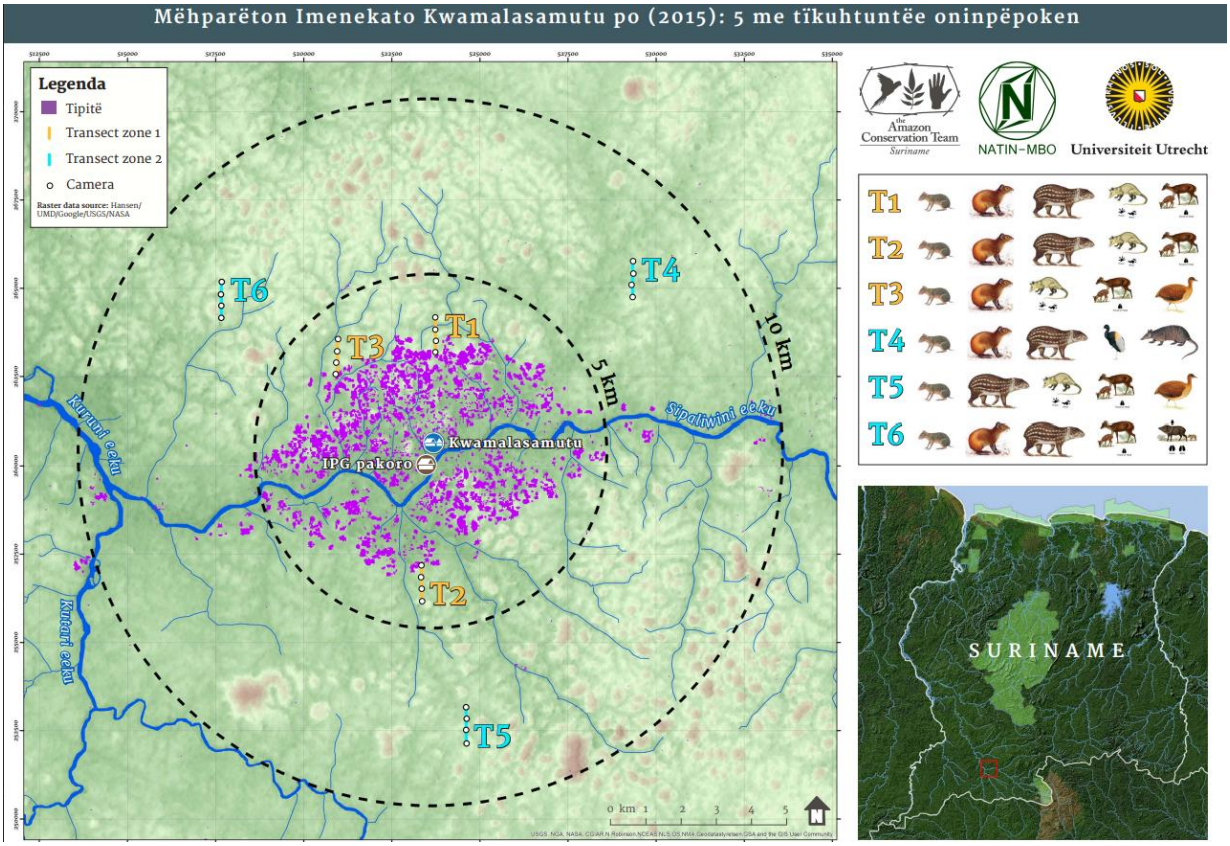

Figure 4: Map of Kwamalasamutu area indicating species distribution in relation to agricultural plots. (Source: The Amazon Conservation Team Suriname)

A community LSDI is essential for effective governance, sustainable development, public safety, and overall quality of life within the community. It empowers local decision-makers, fosters public engagement, and promotes the responsible use of resources, all of which are fundamental to the well-being and growth of the community. However, several challenges may occur. One major challenge is ensuring that the development of the SDI respects and aligns with indigenous knowledge systems, cultural practices, and governance structures (Williamson et al., 2023). Therefore, it is crucial to involve the community from the beginning and prioritize their perspectives and needs. Another challenge is the integration of traditional ecological knowledge with modern geospatial data. Bridging the gap between indigenous wisdom passed down through generations and contemporary scientific data requires careful consideration and collaboration (Bruhn, 2014). A more practical challenge is the availability and the use of technical infrastructure for which resources and capacity building will be needed for the creation and maintenance of the SDI. Indigenous communities may need support in developing the necessary skills to collect, manage, and analyze spatial data (Group, 2011).

Another significant issue is data sovereignty. Indigenous communities need to have control over their data, ensuring that it is used ethically, and respecting their rights and privacy. This involves addressing legal and ethical concerns surrounding data ownership, access, and sharing (Jennings et al., 2023). Establishing clear protocols or principles for data sharing and collaboration can help navigate potential conflicts and ensure that the SDI benefits everyone involved (Carroll et

al., 2022). An example of such principles could be the CARE principles developed by the International Indigenous Data Sovereignty Interest Group which is part of the Research Data Alliance (Kukutai & Taylor, 2016). These principles are a set of guidelines that aim to ensure that Indigenous communities have control over their data and that it is used in a way that benefits them. The principles consist of four concepts: Collective benefit, Authority to control, Responsibility, and Ethics (CARE).

Figure 5: Field data collection by the Kwamalasamutu rangers investigating health of crops.

In this chapter, background information on SDI, their benefits, challenges, and the different levels have been discussed. Also, it provided information about Suriname and Kwamalasamutu and discussed the NSDI which answered the first sub-question regarding the status of the NSDI in Suriname. To provide answers for the other two sub-questions regarding the users, their needs, and the requirements to develop a local SDI a practical approach is required to acquire the necessary information for answering those questions. This practical approach is discussed in the following chapter which elaborates on this research's methodology.

3 Methodology

3.1 Introduction

An effective SDI is not merely a collection of geospatial data such as maps, satellite imagery geospatial databases, and technologies, but is a tailored solution that aligns seamlessly with the diverse requirements of its end users (Corcoran, 2012). Developing a robust SDI involves not only assembling this wealth of data but also ensuring that it caters to the specific needs and preferences of the end users. Users of geospatial data range from government agencies and environmental researchers to urban planners, businesses, and the general public or groups within the public such as a community. Each of these users has distinct needs and requirements which makes it difficult to give all the users the same level of satisfaction (van Loenen, 2018). However, for the development of the SDI, it is important to know who the specific users are and how the SDI could be beneficial for them. This can be achieved through a user needs assessment that serves as the compass guiding the development of an SDI (Zwirowicz-Rutkowska & Michalik, 2016). It involves systematically identifying and understanding the requirements, preferences, and challenges faced by the end users. This process not only ensures that the SDI is relevant but also enhances its usability and effectiveness.

In this chapter, the focus will be on the methodological approach to gathering information from the users for who will benefit from the local SDI. This will be done according to the following structure. Section 3.2 discusses the users who will benefit from the local SDI which provides answers to sub-question three. Section 3.3 discusses the methodology applied to acquire information for sub-questions two, three and four as shown in Figure 6. The data collection methodology will be done through a user needs assessment which will focus on the challenges and needs of the Kwamalasamutu user group and through a questionnaire focused on the challenges and requirements of the organization's user group. For both questionnaires a combination of open and closed questions was developed. After this, Section 3.4 discusses the analysis of the information obtained which will be done through a quantitative and qualitative approach.

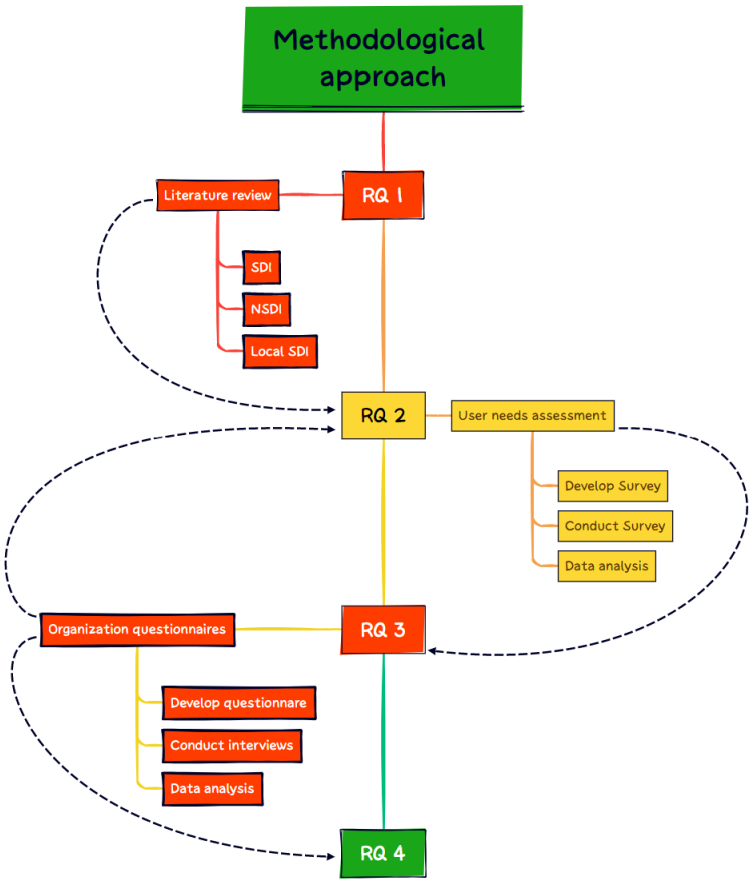

Figure 6: The methodological approach of the research.

3.2 The users of the local spatial data infrastructure

As the main users of the SDI will be the villagers of Kwamalasamutu, a user needs assessment will be carried out with the community. For this user needs assessment specific groups of people within the community will be interviewed. These groups consist of community members, which have been formed during a yearlong intensive workshop to develop their community-based management plan called Life Plan, for Kwamalasamutu . Out of this process, seven key components were identified which can be seen in Figure 7. Representatives of the community helped to develop the needs and actions that are needed to develop and manage those seven components which are: Governance, Sustainable Income Generation, Land Management, Food, Health, Education and Connection. The user needs assessment will be carried out with the representatives of these seven components regarding geospatial data collection. Per component, at least two representatives were asked to partake in the questionnaire, which would be at least 14 respondents. However, only ten responses were acquired out of the 14. Unfortunately for the education component, no respondent was available and for the governance and food component, only one respondent was available. Key individuals such as the grand chief of Kwamalasmutu and his assistant, were not available during the time of the interviews. Having them conduct the interview questionnaires would also provide valuable information as they are the highest decision-making body within the village authority of Kwamalasamutu.

For the community-based management plan's development, other stakeholders such as governmental institutions and organizations were also involved to help guide the actions within the plan to governmental plans on subnational and national levels. Representatives of various organizations and governmental institutions, referred to as the working group collaborated and gave their input to help guide the actions and align them with governmental plans on subnational and national levels (De Boodschap, 2023). As the stakeholders were part of the process, interviews will be conducted with them regarding the geospatial data collection and management that occurs in the seven identified topics. Except for the working group other important stakeholders are identified who may provide valuable information for the creation of the local SDI. One of these other stakeholders is the MI-GLIS, which is working towards an NSDI and is by Surinamese law the institution that needs to develop and maintain the NDSI. A list of all the stakeholders, governmental and non-governmental, can be viewed in Table three. Most of these organizations and government institutions conduct projects by themselves or in partnership with other national and international organizations. Table tree gives an overview of some of the key governmental and non-governmental organizations which will be approached for the interview.

Figure 7: Picture indicating the topics identified by Kwamalasamutu for their community development plan. (Source: Kwamalsamutu Tareno plan, Amazon Conservation Team)

3.3 Data collection

3.3.1 Kwamalasamutu user needs assessment.

For the user needs assessment, a questionnaire was developed to assess the knowledge of the community about the current situation and the challenges how geospatial data is managed. Also, what the needs of the community are for strengthening their geospatial data management. The questionnaire, can be found in appendix I, consists of questions grouped into seven categories which are: general information, technology use, spatial data collection, spatial data storage, spatial data access, spatial data distribution, and governance of spatial data. With the use of a translator, the survey questions were translated into the local indigenous language for some of the community members. These will help to identify the needs and challenges when it comes to their resources' geospatial data management. The questions will be formulated according to the CARE principles for indigenous data governance that are based on collective benefits, authority to control, responsibility, and ethics.

3.3.2 Organizations requirements

To acquire the information regarding the requirements to develop the LSDI the organizations were given the choice if they wanted to have physical meetings for interviews or if they would want the interview questions to be sent to them, and they could answer the questions on their own time. All the organizations chose to have the interview questions sent to them as it was difficult to set up personal meetings. Also, the respondents from the organization wanted to discuss the questions with colleagues within their organization before providing the information. The questionnaire, which can be found in Appendix II, was developed for the organizations based on the questions intended for the in-person interviews. As an assessment of the user needs, this questionnaire consisted of eight categories: general information, technology, data management, standards & metadata, data access from third parties, data sharing with third parties, collaboration & governance, and spatial data infrastructure. This questionnaire was sent to sixteen organizations to provide information regarding the requirements to develop the LSDI. However, of these sixteen only ten organizations responded.

3.4 Data analysis of the user needs assessment and the questionnaire

The user needs assessment will provide information regarding the users of the local SDI, as well identify the challenges, and needs of the Kwamalasamutu community regarding spatial data management. The questionnaires developed for the organizations will acquire information regarding the challenges and requirements for the development of the local SDI. The analysis will be done through a quantitative and qualitative approach. The quantitative analysis will provide the main challenges, needs and requirements and the qualitative analysis will result in the importance of the identified challenges, needs and requirements.

Having discussed the users and the methodological approach of this research, the following chapter will discuss the information acquired from both user groups through survey

questionnaires. As mentioned in the methodological approach two different surveys were developed, one for the Kwamalsamutu user group and the other for the organization's user group. The following chapter, Chapter four, presents the results of each user group separately.

Table 3: List of organizations to be interviewed.

	Type of organization	**Name of the organization**	**Sector**
1	Government	Foundation for Forest Management and Production Control	Forestry
2	Government	Meteorological Services Suriname	Research
3	Semi-government	Natuur Instituut voor Milieu en Ontwikkeling in Suriname (NIMOS)	Environment
4	Semi-government	National Planning Office Suriname	National & Regional Planning
5	Non-government	Management Instituut GLIS	Cadaster
6	Non-government	Medische Zending Primary Health Care Suriname	Public Health
7	Non-government	Department NARENA of the Centre for Agricultural Research in Suriname (CELOS) Research	Agriculture, Community development, Education, Environment, Forestry
8	Non-government	Conservation International Suriname	Community development, Conservation, Environment, Forestry, Fisheries
9	Non-government	The Amazon Conservation Team	Community development, Conservation, Environment
10	Business	Gissat n.v.	GIS technology and solution provider

4 Results of the user needs assessment and requirement questionnaires.

In this chapter, the results of the methodological approach will be provided. Section 4.1 discusses the results of the user needs analysis carried out in Kwamalasamutu. This section is further divided into subsections as mentioned in the methodology chapter based on the categories of the user needs assessment: general information, technology use, data collection, data storage, data access, data sharing, and governance. In Section 4.2, the results of the questionnaire filled in by the organizations are presented. As with the previous section, this section is also divided into topics that are part of the questionnaire filled in by the organizations: technology, data management, standards & metadata, data access from third parties, data sharing with third parties, collaboration and governance, and spatial data infrastructure.

4.1 Kwamalasamutu user needs assessment.

4.1.1 General information

For the user needs assessment ten villagers filled in the survey questionnaire. As the questionnaire was made in English a community translator assisted in translating the questions to the respondents. The ten respondents from the community can be categorized as follows: three community rangers, two traditional healers, two beekeepers, two national government administration workers, and a government health worker. Of these respondents eight are males and two are females as can be seen in Figure 8. The age range of the respondents is between 25 and 70 years old. Four of the respondents are between the ages of 25 and 35 years, whereas two of the respondents are between 35 and 45 years and two other respondents were between 55 and 65 years old. One respondent was between 45 and 55 years old, and the oldest one is over 65 years old as indicated in Figure 9.

Figure 8: Pie chart indicating the number of respondents according to gender.

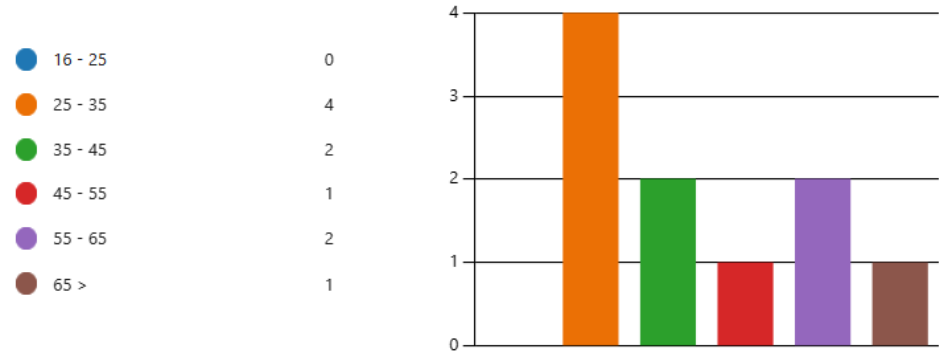

Figure 9: Histogram giving an overview of the respondents according to their age group.

4.1.2 Technology

When it comes to technology, all ten respondents mentioned using smartphones. One uses a phablet and six of them can use computers as illustrated in Figure 10. These devices are also used to access the internet and from all the respondents six find it easy to access the internet. Two of the respondents, who are community rangers, also mentioned that they use GPS devices for data collection.

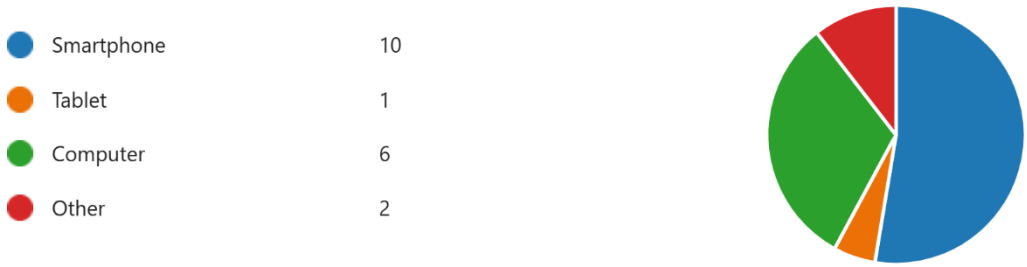

Figure 10: Pie chart visualizing the use of technological devices by the respondents.

All the respondents confirmed that they have used spatial data mainly in the form of paper maps or hand-drawn maps on which spatial data is visualized. Seven of the respondents have used maps in a digital format such as PDF files, photos, or web-based platforms such as Google Maps which can be seen in Figure 11. Two of the respondents who are community rangers have also mentioned having used GPS coordinates for making maps or visualizing these on Garmin Basecamp and Google Earth Pro software.

Figure 11: Pie chart indicating the current use of spatial data by the respondents.

Furthermore, all ten respondents mentioned they would like to have spatial data visualized on paper maps and digital maps and all of them also prefer to use spatial data in their local

language, which is the Trio language as illustrated in Figure 12. Other languages that were mentioned were Dutch by nine of the respondents and English by eight of them. One of the respondents also mentioned Portuguese and Sranan Tongo which is the lingua franca in Suriname.

Figure 12: Pie chart giving an overview of languages the respondents are comfortable with when using spatial data.

Of all the respondents six would like to have further training in the use of computers, smartphones, and other devices to view and use spatial data. They would also like to have training in effective internet browsing, mainly to search for spatial data. Four of the respondents mentioned specifically wanting training in the use of computers or laptops as shown in Figure 13.

Figure 13: Pie chart indicating training needed per technology use of the respondents.

4.1.3 Spatial data collection

Eight of the ten respondents mentioned that they are aware of data collection activities in the village and two answered that they do not know. Eight mentioned that most of the spatial data collection activities are carried out by non-governmental organizations. The Amazon Conservation Team Suriname organization is mentioned by eight of all the respondents. Four of them also mentioned four also mentioned Conservation International organization and one answered the Ministry of Land Policy and Forest Management. Most of the spatial data collected consists of environmental data which was mentioned by nine of the respondents. Eight respondents mentioned land use data, seven mentioned data regarding traditional knowledge and one specifically mentioned wildlife data as indicated in Figure 14.

Figure 14: Pie chart indicating the main topics of data collection.

Nine of the respondents mentioned that the reason why there are data collection activities in the village and its surroundings is because the community wants to know what resources are in their area and where these are located. Such resources are the availability of water, the abundance of wildlife, how these migrate, and how these can be protected and managed. Also, to know what resources there are in the forest for income generation projects. Eventually, when they know where these resources are and their abundance, they will be able to protect and manage them better for the community's development. Regarding the procedures for spatial data collection, five of the respondents mentioned that there are procedures in place to collect spatial data of which two answered no and three didn't know as shown in Figure 15.

Figure 15: Pie chart indicating the number of respondents who are aware of procedures for spatial data collection.

According to the respondents the procedures regarding spatial data collection are that spatial data collectors and other outsiders need to respect the village rules. Data may not be collected without the consent of the village authority and the village authority always needs to know when outsiders come to collect spatial data within the community and its surroundings. Also, outsiders need to be accompanied by the rangers of the village when collecting spatial data. Eight of the respondents mentioned that the village authority permits the collection of spatial data. However, when it comes to the decision making what needs to happen after the spatial data is collected four answered that nobody makes this decision. Three mentioned the rangers and two others individually answered the village authority and the Indigenous organization TRIJANA. One of the respondents did not know. The respondents also mentioned the challenges they face when it comes to collecting spatial data. Four of the villagers answered that the availability of fuel is one of the biggest challenges because this is needed to go to faraway places to collect spatial data. In addition, the rangers mentioned that there is limited equipment such as GPS devices and cameras. Also, limited mobile connection in case of an emergency. There is also a lack of communication between organizations and the community when spatial data activities need to be conducted, which results in village rules not always being followed. To overcome these challenges certain aspects are needed. Approval should be given by the village authority before any data spatial data is collected within the village and its surroundings. Also, technical

equipment and a good internet connection are needed. Fuel should be available to collect spatial data in faraway places and importantly a good communication structure and strong protocols need to be in place for spatial data collection. For example, data collectors must communicate with the village authority what kind of data will be collected and what the purpose is. This should further be communicated or presented to the community, so they are aware of the activities.

4.1.4 Spatial data storage

Regarding the storage of spatial data in the community, four of the ten respondents mentioned that this is not stored within the community. Three answered yes and the other three did not know. The three who answered yes, were the rangers and they all mentioned that this is currently stored at the ranger station and that they are responsible for this. The formats in which the spatial data is stored are GPS coordinates, digital maps and paper maps as seen in Figure 16.

Figure 16: Pie chart indicating the spatial data formats stored within the village.

However, there are some challenges when it comes to the storage of spatial data. The respondents mentioned that there is no person responsible for storing this data and managing the data after it is collected. Also, there is a lack of technical hardware such as hard drives and laptops to store spatial data and there is limited electricity to charge laptops and other devices. Regarding spatial data being stored outside the village, six of the respondents did not know and three mentioned that this does happen as indicated in Figure 17. One of the respondents mentioned this does not happen. According to the three the spatial data is stored in Paramaribo, at the office of the Amazon Conservation Team, and probably in other countries such as the Netherlands and the United States. The decision to store spatial data outside of the community according to three respondents, the Amazon Conservation Team, the village authority, and one of the respondents mentioned that nobody makes this decision.

To overcome these challenges, the respondents mentioned several needs such as 24-hour electricity for the available technology and the need for more technological equipment such as laptops, external hard drives, and printers. Also, more training for the rangers and maybe other youngsters on how to store and manage spatial data according to agreements and protocols with organizations and other outsiders for storing spatial data in the community after spatial data has been collected. Next to the above-mentioned aspects, most respondents also mentioned that there should be one or more responsible persons who ensure that spatial data is stored locally after data collection activities have taken place.

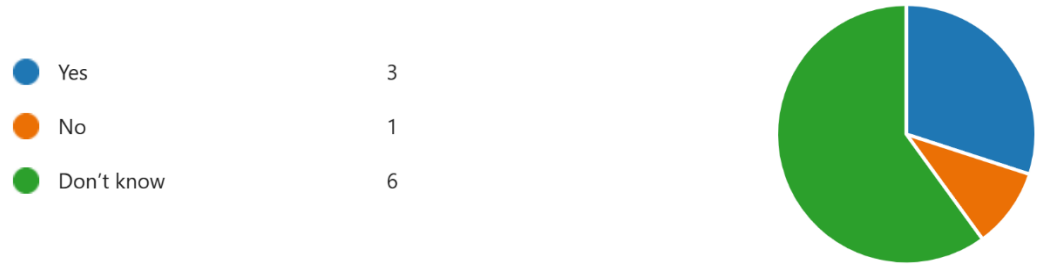

Figure 17: Pie chart indicating the number of respondents who are aware that their spatial data is stored outside the community.

Finally, all ten respondents mentioned that they would like the spatial data stored in the village because it is their data, and they should decide how this is stored. Also, they mentioned that the community needs to know what spatial data is collected so they and future generations know what resources they have. Nine of the respondents mentioned that they want the spatial data to be stored at the ranger station because they are local villagers who assist in research and monitoring activities. The ranger station is also already equipped with some technology such as laptops and the rangers have received some training in the use of this. However, the rangers should present the data to the village authority and the rest of the community, so they are aware of what spatial data is available. Some other locations mentioned for storing spatial data are at the village authority because they are the decision-makers, the local school so that youngsters can also learn about the spatial data, and the medical clinic. Furthermore, all ten respondents mentioned wanting to have the spatial data stored as paper and digital maps, and as GPS coordinates in GPX files or Excel to a lesser extent as shown in Figure 18.

Figure 18: Pie chart indicating the formats of how spatial data should be stored in the community.

4.1.5 Spatial data access

Of the ten respondents seven answered that they do not have access to their spatial data stored outside the village and three do not know as indicated in Figure 19. Because of this, they could not answer what type of spatial data they have access to, from which organizations and if there are procedures to do so. According to them, there are several challenges when it comes to having access to spatial data stored at the organizations. There is a lack of procedures on how to access spatial data outside of the community because there are no village meetings to discuss how spatial data should be organized and how this can be accessed. Also, there is no communication from organizations towards the community where their spatial data is stored. So, the community is not aware of where the spatial data is stored and how this can be accessed. In addition, the organizations decide what happens to the spatial data and if this can be accessed. Finally, there is no training in accessing spatial data stored at organizations. To overcome these challenges several actions are needed. After the spatial data has been collected, the organizations should let

the community know where the spatial data is stored. When this is known, procedures need to be in place to know how the spatial data can be accessed. Also, there is good internet and technological equipment needed to be able to access spatial data. Furthermore, a local responsible person is needed who knows how to access the data and can present this to the community. Most importantly a good collaboration is needed and there should be a relationship built on trust and procedures between the organizations and the Kwamalasamutu community. Eventually, all ten respondents agreed that the community should decide how their spatial data can be accessed because it is their data, and they should be able to manage and have control over this.

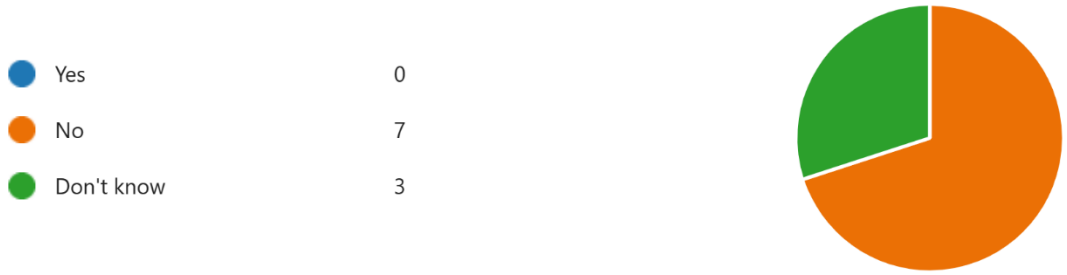

Figure 19: Pie chart indicating the number of respondents familiar with how to access their spatial data stored outside the community.

4.1.6 Data Sharing

Five out of ten respondents mentioned that they are not aware of their spatial data being shared between organizations. Four answered no, and one mentioned being aware of this. However, nine of the respondents do not know if procedures are in place for spatial data sharing between organizations and one respondent answered that there is not. Although the respondents are not aware of this, two of the respondents mentioned that some of the challenges they assume regarding spatial data sharing are that the organizations do not communicate with the rangers or the village about sharing spatial data. Also, that the organizations do not always work with each other, which makes it difficult for sharing spatial data with themselves or with other third parties. To overcome these challenges the organizations, need to ask permission from the community or rangers to share spatial data. Also, the organizations should have a good collaboration with each other. Eventually, all the respondents mentioned that they would want the Kwamalasamutu community to decide when spatial data can be shared between organizations because the spatial data belongs to the community. The village authority must be informed, and they should decide who may use the spatial data, its purpose, and why this is being shared and how it will be used. The spatial data can only be shared with their consent.

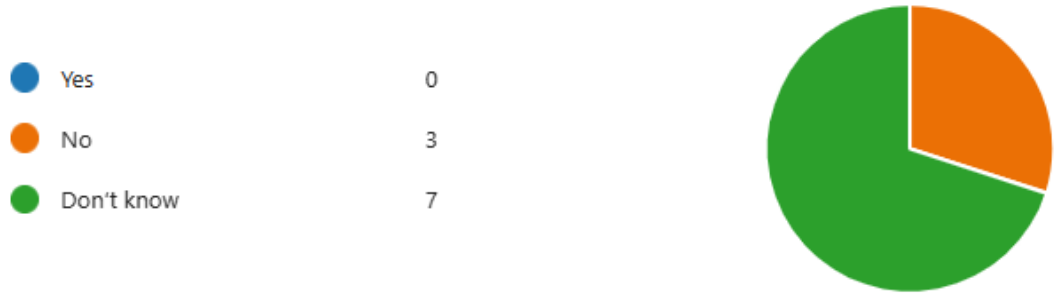

Figure 20: Pie chart indicating the number of respondents aware of their spatial data being shared between organizations.

4.1.7 Governance

Regarding the governance component, seven of the ten respondents mentioned that they do not know if formal agreements or protocols are in place for managing spatial data. The other three specifically mentioned are not in place as shown in Figure 20. On the contrary seven mentioned that informal agreements and protocols are in place, and the other three mentioned not to know as indicated in Figure 21. According to the seven respondents the informal agreements are that before collecting spatial data, the village authority must give consent. However, after the data is collected there are no informal agreements that they know of. Also, when organizations and outsiders go to the forest, they are not allowed to collect items physically from the forest, such as plants, stones, or small animals without consent. Another informal agreement is that if there is a certain need in the village to collect spatial data or do monitoring activities, they can ask the organizations for help. Finally, they mentioned that the rangers need to accompany outsiders when they go to the forest to collect data.

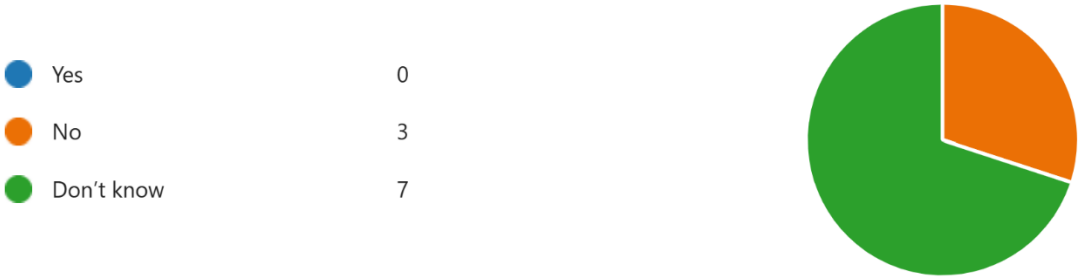

Figure 21: Pie chart indicating the number of respondents aware of formal agreements in place regarding spatial data management.

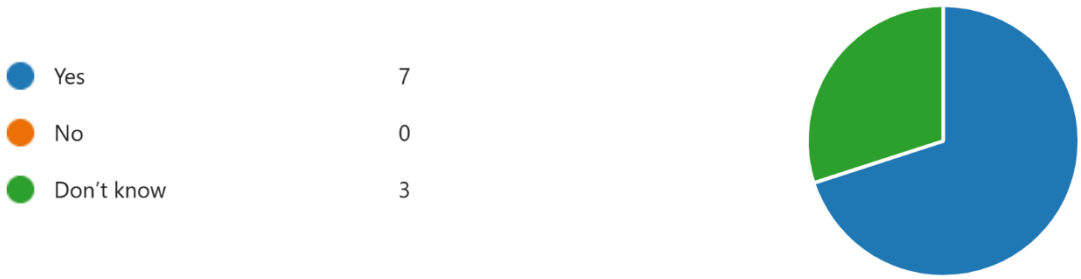

Figure 22: Pie chart indicating the number of respondents aware of informal agreements in place regarding spatial data management.

The respondents mentioned several ways they would like the spatial data from Kwamalasamutu to be managed. The majority answered that the location where the spatial data should be stored, is at the ranger station. Five respondents mentioned that the rangers should be responsible for managing the spatial data. Three respondents mentioned this should be the village authority's responsibility, and two other respondents mentioned that the government workers should do this. In addition, to the answers above three of them also mentioned that this should be their own responsibility so that they can teach youngsters. Furthermore, the spatial data should be stored as paper maps that are plasticized, and digital maps should be available on laptops and external hard drives and managed by trained persons. Also, protocols and rules are needed for data collection,

data use after collection, who has access to the spatial data, and when this data can be used. Possibly the rangers need to give permission when to use spatial data.

Furthermore, the respondents mentioned that they would like to be involved in decisions about their spatial data by being invited to village meetings organized by the village authority. In these meetings, the spatial data must be presented to the rest of the community by the organizations or by the rangers who collected or have it. Also, the purpose of the data collection, where it will be stored, who has access to it, and with whom the spatial data will be shared, must be discussed. Five of the ten respondents mentioned that the final decision about spatial data collection, storage, access, and sharing should be made by the village authority. Three mentioned this should be done by the rangers. From the other two one mentioned the Indigenous organization TRIJANA, and the other one mentioned not to know.

Finally, the ten respondents mentioned that for communities, organizations, and other outsiders, certain principles need to be considered when it comes to spatial data management. Specifically, regarding spatial data collection and the use of spatial data that is respectful to the community's values and beliefs.

4.2 Stakeholder interviews

4.2.1 General information

For the stakeholder interviews, the questionnaires developed were sent to sixteen organizations. However, only eleven responses were received. Unfortunately, one of the respondents of an organization filled out the form twice, so one of the responses was not valid. This makes ten responses obtained from ten organizations, of which four were from non-governmental organizations, two from governmental organizations, two semi-governmental organizations, one business, and one from a research institute that is part of the Anton de Kom University in Suriname. Most of these organizations mentioned that they are working in the environmental, forestry, and community development sectors. Other sectors mentioned are conservation, agriculture, education, health, cadaster, fisheries, and national planning. Of the ten organizations, nine of them use spatial data in their operations and one does not. The most used spatial data used by these organizations is satellite imagery, followed by land use data and environmental data as shown in Figure 23.

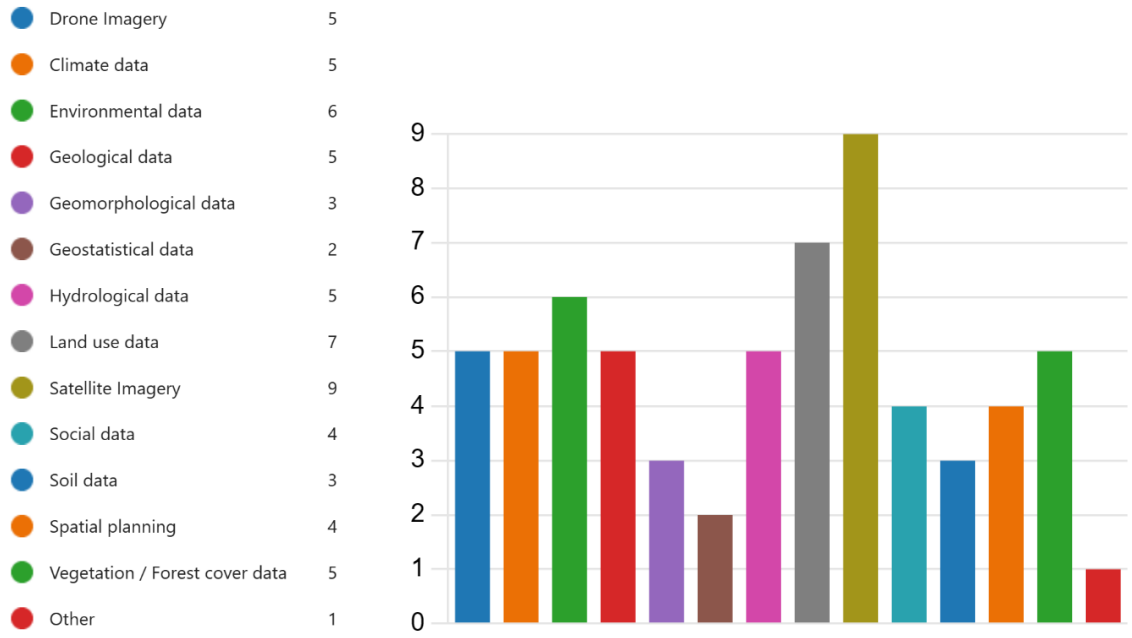

Figure 23: Histogram visualizing the type of spatial data used by the organizations.

4.2.2 Technology

Of the ten organizations, nine organizations mentioned using spatial data in their operations and are using geographical information systems for managing spatial data. The most used GIS software for this is the ArcGIS software, to a lesser extent the QGIS software as can be seen in Figure 23. Other software programs that are being used individually by the organizations are AutoCAD, MapInfo, Google Earth Engine, R-Instat, R, GRASS GIS, and IDRISI.

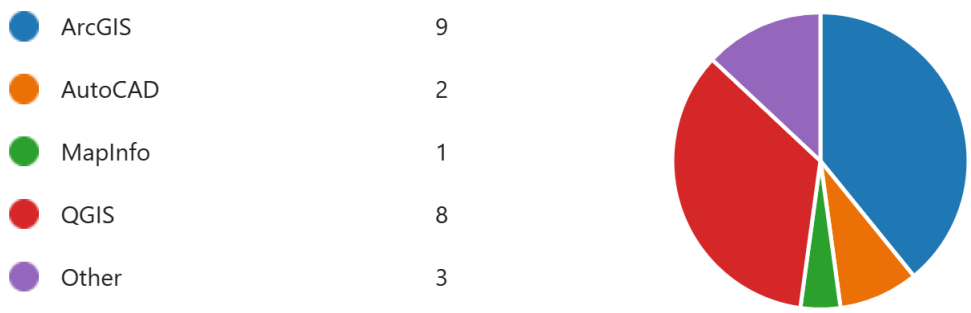

Figure 24: Pie chart indicating the number of respondents using a certain spatial data software.

According to the organizations some of the benefits would be that the community would be able to make better spatial planning of their environment, by mapping all the areas of interest and monitoring their livelihoods. Also, they would be able to preserve their heritage and lifestyle and have knowledge about the property boundaries, land rights and the location of resources for sustainable development activities. Through GIS Technology, the current situation can be better mapped. This includes identifying where individuals or families currently reside, the locations of their agricultural plots, hunting grounds, as well as other areas significance for culture and traditional purposes. With an overview of the current situation, they can plan better how to manage their resources. This together with their Life Plan, GIS Technology is also a valuable tool in the process of recognizing land rights.

However, according to the organizations, there are some challenges when implementing GIS technology within Kwamalasamutu. These are the lack of technical equipment such as laptops and other hardware for spatial data management. Also, to have this technological equipment functional there will be the challenge of maintenance. Another challenge is the lack of technical skills and basic ICT skills of the Kwamalasamutu community. This could be due to the language barrier because they mainly speak their local language, which is the Trio, and have limited educational opportunities. Finally, there are insufficient financial resources, so the community must develop its spatial data management.

Regarding technical requirements that are needed in Kwamalasamutu for managing spatial data, the organizations mentioned that there is a reliable electricity system and stable internet connection to support a robust GIS infrastructure. This consists of all necessary hardware (computers, tablets, smartphones, external hard drives, GPS devices and servers) to store spatial data as well as GIS software and tools such as QGIS, Mapeo, Cadasta or EpiCollect5 for collecting spatial data. Also, training and capacity buildings are needed to have skilled personnel equipped with basic GIS knowledge in analyzing spatial data. This could be achieved by offering digital literacy programs and training materials that are accessible, inclusive, and interactive for spatial data management and maintenance of the technology.

4.2.3 Spatial data management

Of the ten organizations five mentioned manage spatial data from Kwamalasamutu whereas the other five did not. The spatial data is stored in various ways, from which the most are GPS coordinates or GPX files, Shapefiles, and digital maps as shown in Figure 24. Some other forms

in which spatial data is stored are paper maps, KML files, GeoJSON, ArcGIS online services, and geodatabases.

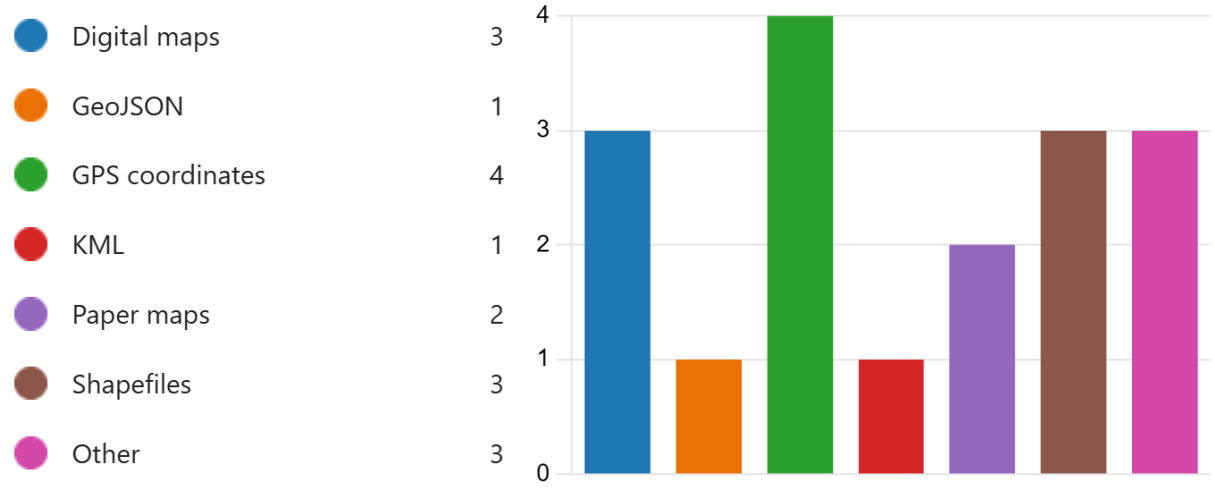

Figure 25: Histogram visualizing the type of spatial data formats from Kwamalasamutu managed by the organizations.

Of the five organizations that manage spatial data from Kwamalasamutu, three mentioned not knowing if the community is involved in the decision-making process to have their spatial data managed by their organization as shown in Figure 25. The other two organizations mentioned individually that the communities are involved whereas the other one mentioned that they are not. However, three organizations responded that the community is involved through the VIDS, which is an indigenous organization representing indigenous rights. Another way that the community is involved in the decision-making process regarding their spatial data is through technical workshops of the GIS community in Suriname whereafter the outcomes are shared with the community. In some cases, oral agreements are made with the community, or letters of approval are given by the village authority through written letters regarding agreements for spatial data management. The reasons for them not being involved, as mentioned by two of the organizations, is because it is not the responsibility of the community and that there is no structure in place to involve them in the decision-making process.

Figure 26: Pie chart indicating the number of respondents mentioning the community involvement in the decision-making regarding spatial data management.

It is remarkable that nine of the ten organizations have mentioned that they are in favor of Kwamalasamutu managing their spatial data because they have a better understanding of their area and know their specific needs. Being in the area indicates events that occurred, and it would

make it possible for them to analyze past, present, and future trends based on their perception. Carrying out an assessment of their resources can lead to better management of the resources. This will also give them ownership of the data, which increases the management of the data, and they can update it regularly, increasing its quality. ensure quick access to their data if there is a need for this by providing a copy of that data to the organizations. Also, spatial data requires a certain level of knowledge to monitor the data, it is best that someone or an organization manages the data and someone from the village can start learning and know what to look for when validation is needed in the field. The MI-GLIS organization specifically mentioned that they oversee the registration of parcel data and rights. Any other data can be managed by Kwamalasamutu itself.

Also, the organizations have mentioned some requirements needed for an effective data management system in Kwamalasamutu. There should be centralized data storage and management of the spatial data. Also, good agreements should be made on how to manage the spatial data and who would be in charge according to guidelines (standards, skills, hardware, software, procedures, data) by the responsible parties in Kwamalasamutu. Sustainable funding and resources should be made available through collaboration and partnerships. Furthermore, community involvement and capacity building need to be facilitated for infrastructure development. One organization specifically mentioned a local spatial data infrastructure.

4.2.4 Spatial standards & Metadata

Of the ten organizations seven are familiar with geospatial data standards, two do not know of this concept and one is not sure. Of these seven, four mentioned using geospatial standards in their work, while three did not use these and the remaining one did not know. Regarding the type of geospatial standards being used by the organizations, the following is mentioned:

- Quality Assessment and Quality Control measurements and stakeholder inclusion for data validation.
- For the parcel data we have our own, listed in the surveyor instructor's manual (by law). Our Projected CRS is WGS 1984 UTM Zone 21N.
- ArcGIS Online uses standards like WMS, WFS, WMTS, KML/KMZ, GeoJSON, GML, Shapefile, CSV/Excel, and OGC Standards for geospatial data sharing and interoperability.
- Tabular data, shapefiles.
- We do not completely adhere to any officially established (top tier) document (standard), but we do implement several rules and guidelines.
- Geospatial Metadata.

For managing the spatial data within the organization, the most used formats are shapefiles as mentioned by five of the organizations. Another format is Geo TIFF files which is mentioned by one of the organizations as indicated in Figure 26. One of the other respondents mentioned using specifically enterprise geodatabases and individual shapefiles. Also, ArcGIS Online standards like WMS, WFS, WMTS, KML/KMZ, Geo JSON, GML, CSV/Excel, and OGC Standards for geospatial data sharing and interoperability are used by one of the respondents which is a business focused on GIS services.

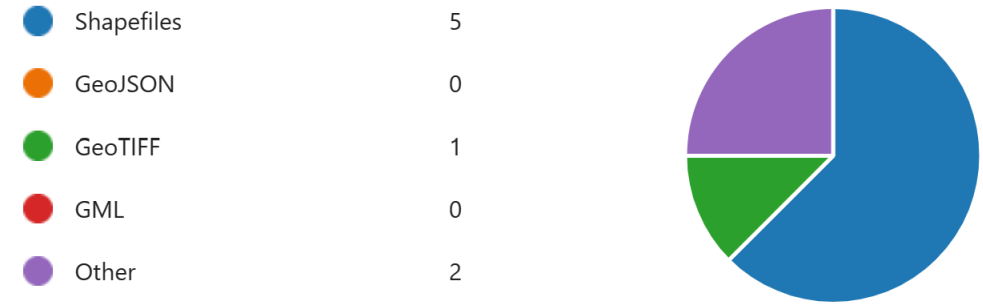

Figure 27: Pie chart indicating the number of spatial data formats being used by the respondents.

Of the ten organizations, six are familiar with metadata standards, whereas four are not familiar with such standards. Of those six only one mentioned using metadata standards for describing geospatial data. Three of them do not use metadata standards and the other two do not know if the organization they represent uses metadata standards as can be seen in Figure 27. One respondent mentioned using ArcGIS Online and the Living Atlas of the World which primarily use the following metadata standards:

1. ISO 19115: The international standard for geographic information metadata.
2. FGDC/CSDGM (Federal Geographic Data Committee/Content Standard for Digital Geospatial Metadata): Commonly used in the United States.

Figure 28 : Pie chart indicating the number of respondents being familiar with metadata standards.

Six of the organizations, five rated an eight up to ten when asked about the importance of having clear and understandable information (metadata) about maps and other geographic information. Regarding the information that is included in the metadata that is relevant for Kwamalasamutu five mentioned the following:

- Traditional names, and dates.
- Place names, resort, and district names.
- Traditional Place Name, Cultural Significance, Language, Land Use History, Environmental Data, Resource Management Practices, Socioeconomic Data, Legal or Governance Structures, Community Projects and Initiatives, Contact Information
- Not particularly relevant for Kwamalasumutu, but generally if available Source, Date, Authors, Spatial scale, Accuracy, and processing steps when derived products are created.
- Traditional place names.

Furthermore, six of the organizations mentioned several suggestions on how maps and geographic information can be made more accessible and understandable for the Kwamalasamutu community which are:

- Good leadership, for continued training/improvement in the use of GIS data. For example, the assignment of a monthly GIS hero in the community, a Platform for sharing GIS achievements and how they helped the community.
- First, make a P3DM with the community and then teach them how to collect all the information they need in Mapeo.
- Publishing online in map format
- Training and information sessions, use local language and everyday cases to explain how it works and provide examples of how it can work for them, have the local community come up with a problem that could be solved using GIS and the availability of this SDI; An optimal level of local involvement during the creation and processing of information; Provide printed maps to familiarize with the maps and with mapping to demonstrate how reality is represented in maps.
- Through Participatory GIS (PGIS)

4.2.5 Data Access from third parties

Six of the ten organizations mentioned that they do not have access to spatial data from Kwamalasamutu stored at other organizations. Also, when it comes to the community requesting access to spatial data stored at their organization three answered that there is no involvement whereas the other three answered that they are not aware of this which is shown in Figure 28. However, four of the organizations have responded that there are some procedures in place within the organization when requesting access to spatial data stored at other organizations such as sending a formal letter to request if specific spatial data might be shared. If permission is needed from Kwamalsamutu, then that permission is also requested through a letter. Also, formal request letters to the District Commissioners and Resort Office of the District of Sipaliwini, and the Public and Private organizations involved with community activities in Kwamalasamutu. Also, there are several challenges mentioned by the four organizations when it comes to having access to spatial data stored at other organizations. One challenge is the availability of the information that is needed. Another challenge is that there are inaccurate spatial data formats. Also, there is poor or informal responsibility.

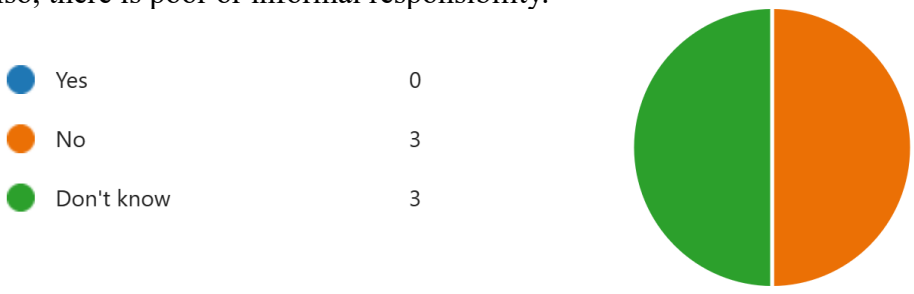

Figure 29: Pie chart indicating the number of respondents familiar with the community requesting spatial data from their specific organization.

4.2.6 Data Sharing with third parties

Regarding the sharing of spatial data of Kwamalasamutu from the organization with other organizations, three answered that this does happen and the other three did not know if this takes

place. The type of spatial data that is most shared with the organizations are shapefiles and to a lesser extent other formats such as digital maps, Geo JSON, GPS coordinates, KML, paper maps, and map services via ArcGIS Living Atlas as shown in Figure 29. However, only one agreed that the community is involved when sharing their spatial data with others. Two of the organizations answered that this does not happen and three mentioned that they do not know as can be seen in Figure 30.

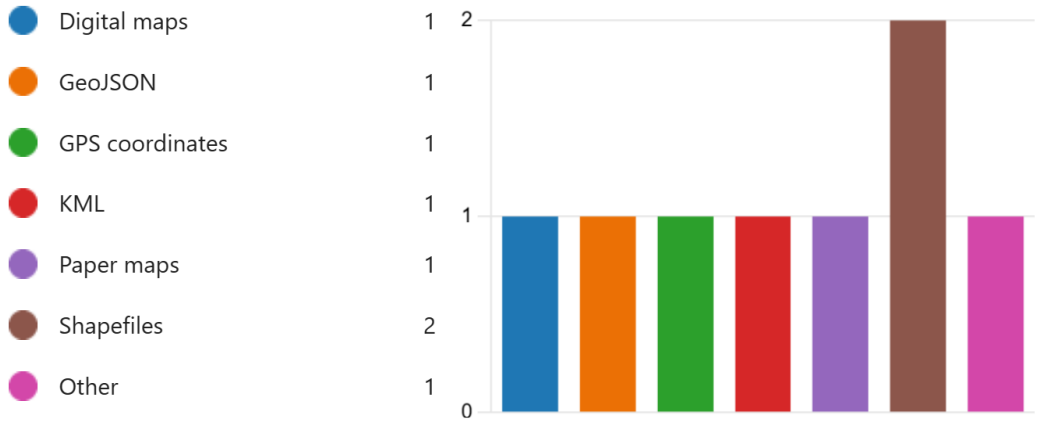

Figure 30: Histogram visualizing the spatial data formats from Kwamalasamutu shared with other organizations.

Figure 31: Pie chart indicating the number of respondents familiar with the community being involved when their spatial data is shared between organizations.

Four of these organizations have mentioned the following regarding the procedures for spatial distribution.

- All national data is shared on www.gonini.org and kopi.sbb.sr
- If we have data from Kwamalasamutu whereby the community was closely involved in creating the data, we will ask for consent first of the community before sharing the data with other organizations.
- Not applicable up to now
- Currently the organization does not distribute spatial data with others.

Regarding the challenges when sharing spatial data from Kwamalasamutu with others two organizations mentioned that there are no challenges yet, the other two organizations mentioned

individually that one challenge is the incorrect use of spatial data and the other answered that when permission is needed from Kwamalasamutu, then that permission will be requested, or the other party will be redirected to the Kwamalasamutu community.

4.2.7 Collaboration and Governance

Five of the organizations responded that there are no formal agreements in place between the organization and the community regarding spatial data management as shown in Figure 31. One mentioned not to know of this, and four other organizations were not applicable to answer this question. Regarding informal agreements, four answered that these are also not in place and two did not know as seen in Figure 32.

Figure 32: Pie chart indicating the number of respondents familiar with formal agreements being in place between the community requesting spatial data management.

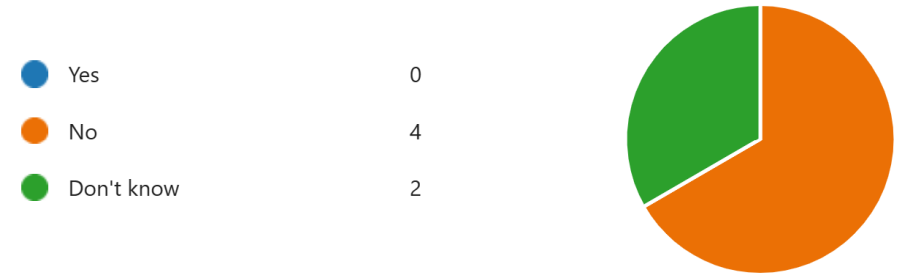

Figure 33: Pie chart indicating the number of respondents familiar with informal agreements being in place between the community requesting spatial data management.

Also, when it comes to having access to and sharing spatial data from Kwamalasamutu between organizations four answered that there are no agreements and two did not know as shown in Figure 33.

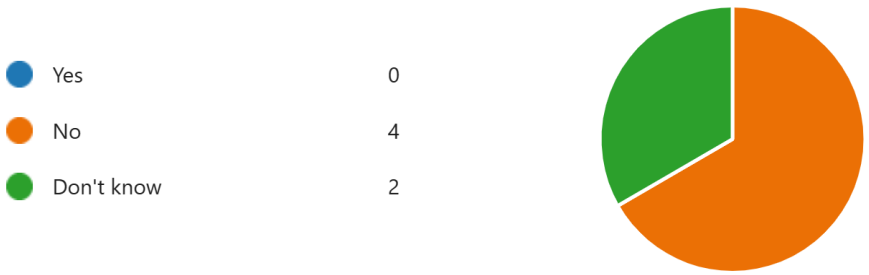

Figure 34: Pie chart indicating the number of respondents familiar with agreements for having access and sharing spatial data with other organizations.

Of the six organizations, five would like Kwamalasamutu to decide how and when their data can be accessed and shared because of the following reasons:

- Detailed data can introduce a threat to the community (e.g. hunters can have better access).
- If they were closely involved in creating and validating the data, it would be very polite to ask for permission as it is their area.
- If it is their data, then they best understand what the purpose is, and with that knowledge, the way of sharing can be best determined by them.
- Imagery data and derived vector data are mostly open data.
- Kwamalasumutu should decide which data they want to share with whom.
- Due to the area's preservation status and the risk that data can be applied for adverse activities by third parties.

Furthermore, the organizations mentioned for having an effective data governance system in Kwamalasamutu the following requirements are needed:

- Centralized data storage and management, a clear vision of how geo data can improve livelihoods.
- A good agreement on how to manage the data and who would be in charge according to a written SOP.
- Guidelines (standards, skills, hardware, software, procedures, data) by the responsible parties in Kwamalasamutu
- Community Involvement, Clear Policies and Standards, Cultural Sensitivity, Capacity Building, Infrastructure Development, Data Quality and Reliability, Legal and Regulatory Framework, Transparency and Accountability, Sustainable Funding and Resources, Collaboration and Partnerships.
- GIS data management expertise in-house; training and long-term support; Regularly syncing to an external backup database.
- Local Spatial Data Infrastructure

4.2.8 Spatial Data Infrastructure

Six of the ten organizations mentioned that they are familiar with spatial data infrastructure. Of these six, five agreed that a local SDI would be useful for the Kwamalasamutu community for

their spatial data management, however, one organization mentioned that this would not be useful as shown in Figure 34. The five organizations mentioned that for developing an SDI that is culturally appropriate and relevant to the needs of the Kwamalasamutu community there are some key requirements such as a census of the community and an assessment of how they can use spatial data. The needs of the community should be determined according to guiding questions; why is this data being collected, what will it be used for, and what is the benefit for my community and others? Also, the organizations mentioned to support the development of an SDI for Kwamalasamutu, government institutions, and NGOs need to collaborate effectively according to the following ways such as providing training to a GIS team to manage the SDI. Training can be tailored to how to access publicly available data and the collection of spatial data in the future. Eventually, the local SDI can be integrated with existing spatial data initiatives and frameworks in Suriname by linking access to the spatial data via existing spatial data initiatives. Also, by contributing spatial data to a national SDI when one is established or through the Spatial hub that the Ministry of Spatial Planning and Environment ROM is planning to launch.

Figure 35: Pie chart indicating the usefulness of a local SDI according to the number of respondents.

5 Discussion

5.1 Introduction

This research investigated how developing a local SDI could benefit the Kwamalasamutu community to strengthen their geospatial data management. Also, it assessed the status of the National Spatial Data Infrastructure of Suriname. While studies have been done on SDI development on local and national levels, limited research has been conducted in Suriname to assess the NSDI, and on a local level, no research has been carried out for SDI development. To assess the status of the NSDI and conduct research for the development of a local SDI four sub-questions were created as guidance to acquire the needed information for this research. Each of the following paragraphs discusses the information obtained through this research for each of the sub-questions.

1. What is the status of the National Spatial Data Infrastructure (NSDI) in Suriname?
2. What are the challenges for the development of a local SDI to enhance geospatial data management?
3. Who are the users of the local SDI, and what are their needs for the development of a local SDI for Kwamalasamutu?
4. What are the requirements for the development of a local SDI to enhance collaboration with other organizations?

5.2 Status of the NSDI

Regarding the first research sub-question to assess the status of the NSDI in Suriname, the information was acquired through literature research. Although Suriname has an NSDI, this is currently not performing due to the lack of financial resources and political will. The MI-GLIS institution is by Surinamese law the organization that has the authority to develop and maintain the NSDI. Although there is a National Base Map developed by the MI-GLIS with input from governmental organizations, this has not been published until now. Also, for the development of the National Base Map information from non-governmental organizations such as conservation and environmental organizations, which work with communities were not considered. However, there are efforts from the government to develop a Geospatial Intelligence Hub. The aim of the Geospatial Intelligence Hub is to have an effective centralized spatial data system that provides access to spatial data and promotes collaboration between stakeholders working with spatial data in Suriname. Unfortunately, it is unclear if efforts will be made to develop and implement the NSDI of Suriname, if this will be merged with the Geospatial Intelligence Hub, or if the NSDI will be replaced by it. In the case of the latter, it is important to note that by law the MI-GLIS is the only organization that has the authority to develop and manage an NSDI for Suriname. Although the MI-GLIS did partake in the workshop regarding the development of the Geospatial Intelligence Hub, it is unclear what the role of MI-GLIS will be in the development and management of this as the Ministry of Spatial Planning and Environment is coordinating this.

5.3 Challenges local SDI development

Regarding the development of the local SDI there are several challenges that the community of Kwamalasamutu and the organizations have mentioned. This information was acquired through questionnaires carried out in the Kwamalasamutu community and questionnaires sent to the organizations identified. The user groups within this research have several differences between them such as the different languages, levels of education, cultural beliefs, technical capacity, and financial resources. These challenges are not unique to Kwamalasamutu as there are also other indigenous groups facing these same challenges (Turkstra et al., 2003). An important factor that is crucial to minimize these differences is the recognition of indigenous peoples and their rights to self-determination by the government. Because Suriname has not officially recognized the land rights of indigenous communities (IWGIA, 2023), this is a big challenge when it comes to these communities having control over their spatial data (Gómez & Inés, 2019). The authority to control their spatial data is a key pillar of the CARE principles, and this has also been expressed by respondents of Kwamalasamutu and the organizations.

The challenges mentioned by the Kwamalasamutu community, and the organizations were mainly focused on technology, data management, standards and metadata, and governance. Specific to the stakeholder user group information was also acquired for the local SDI development. The availability of electricity and the internet is one of the important challenges as this is a condition for technological equipment to function. The lack of technical equipment when it comes to hardware and software is a challenge as this is needed to work with spatial data. Also, another component is human resources because the community has limited people who are skilled in using computers and especially GIS infrastructure and spatial data management. This could be due to the linguistic barriers and insufficient educational opportunities for the community to develop their digital literacy. Another challenge is the environmental conditions because of Kwamalasamutu being in the forest of Suriname the humidity is higher which results in adequate monitoring and maintenance of the equipment. As these are most of the challenges the community faces, one main challenge is the availability of financial resources. Because of Kwamalasamutu being remote in the far south of the country and there is no road infrastructure to the village, the only means of transportation is by small airplanes. What makes this issue worse is that there are no regular flights to the village. The small airplanes need to be chartered, which is very costly. As technological equipment needs to be flown in and a continuous training program to train specific people within the community, the transportation costs alone might be equal to other costs for implementing an activity in the village. The organizations have expressed in this sense to be willing to support technical capacity building and advocate raising awareness to policymakers, funding agencies, and other stakeholders to ensure Kwamalasamutu has control over their spatial data according to the requirements regarding technology, spatial data, and standards.

As mentioned in the data management section, the community does not know how to access their spatial data and with which organization it is shared. As mentioned by them there should be good communication between the village authority and the stakeholders, and the community should be made aware if there are any agreements made. Also, most of the stakeholder's user group mentioned not being aware that there are specific procedures when it comes to spatial data access and sharing. Some organizations have signed contracts with each other with clear procedures, but

such procedures and agreements are not established with Kwamalasamutu. Although there are sometimes informal agreements between a specific organization and the village authority, this is not an ideal situation when it comes to accessing and sharing spatial data with others. Also, although the community is sometimes made aware of data sharing, they are not the ones deciding when and with whom this can be shared.

5.4 Users and needs local SDI development.

For the third sub-question, the results of this study have identified the users of the local SDI which are the community of Kwamalasamutu and stakeholder organizations consisting mainly of governmental and non-governmental organizations. For the Kwamalasamutu community specific people who utilize spatial data were asked to be interviewed for the user needs assessment. This selection is due to some of the challenges mentioned earlier, which is the limited number of villagers who can understand Dutch compared to most of the community who speak their local language which is Trio. Another factor that limited the size of the respondents is the understanding of technical knowledge and their experience with spatial data. This resulted in a small group of villagers being identified to partake in the interviews. However, due to the cultural lifestyle and their position in the community the group of respondents was smaller than expected. Account needs to be taken with regards to their daily lifestyle which consists of going to the forest to hunt and going to their agricultural plots to harvest food. Also, the paramount chief who was a key person for the interviews, was unfortunately out of the country at the time of fieldwork. Regarding the other user group which are the organizations, not all the organizations had responded to partake in the questionnaire. Although a limited number of organizations have provided information for the development of the LSDI, it is important to mention that the LSDI will also be beneficial for other organizations and communities who use the spatial data from Kwamalasamutu. However, it is difficult to satisfy all user groups because of their different needs (van Loenen, 2018).

For the development of the local SDI, the local community's needs have been identified to have this operational locally. The needs for the development of the local SDI were assessed in the following components: technology, spatial data collection, spatial data storage, spatial data access, spatial data sharing, and governance. As the needs closely relate to the challenges, the importance of reliable electricity and internet has been mentioned in this section again. Without these main conditions, technology would not be able to function, which would make managing spatial data not possible. These conditions are also mentioned by the stakeholder user group before providing technical resources and capacity-building sessions to use certain technologies. Although now Kwamalasamutu has electricity through a diesel generator, this often does not function the whole day or certain periods due to the lack of fuel that needs to be flown in from the capital city of Paramaribo to Kwamalasamutu. Fortunately, the ranger station which is mentioned by the Kwamalasamutu respondents as the place to manage their spatial data has solar-powered electricity the whole year long. Also, access to the internet is possible from this location due to a Starlink system. According to the Suriname National Digital Strategy, more effort will be put into giving remote communities such as Kwamalasamutu electricity and internet access to stimulate communication, education, health, and other governmental services (National Digital Strategy, 2023).

The Kwamalasamutu user group mentioned that there is a specific location which is the ranger station where spatial data can be stored, there is a need for more technological resources and capacity building in how to use such technology which is mentioned in the technology section. However, having the technical resources and trained technical people only partially solves the need for a strengthened data management system. There is also a set of training needed focusing specifically on the management of spatial data. One of the needs for these trainings is that the spatial data should be made available to the community by the organizations. According to the responses, this is not the case as the community mentioned that most spatial data is stored outside of the community, and they do not know how to access their spatial data and do not have any say in when and how this data can be shared. This is contradictory to the CARE principles of indigenous data governance that state that the Indigenous Community, has the authority and right to control how indigenous data is collected, accessed, used, and shared. Recognizing and respecting this authority is fundamental to Indigenous Data Governance principles, as it ensures that decisions about data management and use are consistent with the values, needs, and aspirations of the community (Carroll et al., 2020). By asserting authority over the collection, use, and dissemination of data, Kwamalasamutu can ensure that their knowledge, experiences, and perspectives are accurately represented and used in decision-making processes.

Although several needs were mentioned in the user needs assessment, an important need that was expressed was regarding the governance component. The main concern regarding the collection, storage, access, and distribution of Kwamalasamutu's spatial data was the decision-making process. Throughout the answers provided by the Kwamalasamutu user group, it was noticeable that there is a need for a strengthened local governance system and adequate agreements within the community and with other stakeholders. The majority of the Kwamalasamutu user group made known that they are unaware of informal and formal agreements when it comes to their spatial data. Agreements should be made regarding all the four above-mentioned topics starting with the spatial data collection, the storage, accessibility, and the distribution of the spatial data. Although there are sometimes informal agreements between a specific organization and the village authority, this is not an ideal situation. Within the village, these informal agreements are not optimally communicated with villagers, which leads to community members not being aware of any activity regarding their spatial data. Also, informal agreements between the village and the stakeholders lead to complex situations when other organizations want to access certain spatial data. This decision is then often made by the organization with whom the informal agreement is made, not by the village authority, which owns the spatial data.

5.5 Requirements for local SDI development

For the development of the local SDI, the requirements from the organizations have been obtained to have this operational on a national level. The requirements for the local SDI development were assessed in the following components: technology, data management, standards and metadata, and governance. Specific to the stakeholder user group information was also acquired regarding their knowledge of SDIs. Two of the main requirements are electricity availability to power technological equipment and devices and the internet, especially when having access and sharing spatial data outside of the community. As the needs of the Kwamalasamutu user group, the organizations have also mentioned as requirements to have technical equipment in place for Kwamalasamutu to be able to manage their spatial data.

Another requirement for spatial data management is not only having the technology in place, but also skilled people who know how to use that technology. For the latter training and capacity-building sessions are needed for which some of the organizations have mentioned to be willing to train the local community in the use and management of their spatial data. According to the Kwamalasamutu respondents, the group that is favored for such training are the rangers who already have received some training in the use of technology and are also involved in some data management practices.

The standards component was focused more on the stakeholder user group as this is more related to technical requirements that are needed for the LSDI. However, from the responses, it was noticed that most organizations do not use geospatial standards within their work. The most common standard mentioned by the organizations was specific to certain data formats. This is important to consider when developing the LSDI which should be interoperable with other systems used by the organizations and on a local and national level. The data format standard most used by organizations is shapefiles. This is a technical term that the community of Kwamalasamutu is not familiar with. Therefore, when training the rangers and other community members regarding spatial data management as expressed in the previous section, they need to learn about shapefiles and other commonly used data formats. As the organizations are aware of this issue, they mentioned that a way for the community to be able to understand and use spatial data would be to include metadata information in their language and levels of understanding. Within this regard, the respondents of Kwamalasamutu have also mentioned the need to have the maps and other data translated into their language. Also, the involvement of the community in spatial data collection should be mentioned as this would give them more ownership of the process.

Also, the organizations have mentioned that spatial data plays a central role in maintaining ethical standards in Indigenous data management. According to Walter & Suina (2019), requirements regarding ethical considerations include obtaining informed consent, protecting the privacy and confidentiality of individuals and communities, and ensuring that data use respects Indigenous rights, protocols, and cultural sensitivities. Ethical data practices help build trust, reciprocity, and mutual respect within and among Indigenous communities. However, these ethical considerations need to be considered when developing the LSDI for the community, it should adhere to certain standards as mentioned by the organizations. Therefore, to support the development of an SDI for Kwamalasamutu, government institutions, and NGOs need to collaborate effectively according to the following ways, such as providing training to a GIS team to manage the SDI. Training can be tailored to how to access publicly available data and the collection of spatial data in the future. Eventually, the local SDI can be integrated with existing spatial data initiatives and frameworks in Suriname by linking access to the spatial data via existing spatial data initiatives. Also, by contributing spatial data to a national SDI when one is established or through the Geospatial Intelligence Hub that the Ministry of Spatial Planning and Environment is planning to develop.

5.6 Reflection

This research identified several caveats for developing a local SDI. Firstly, although valuable information was provided by the Kwamalasamutu community, it is possible that there were some misinterpretations of questions because these needed to be translated from Dutch to the local language by an interpreter. Also, some of the respondents provided answers in the Trio language which again needed to be translated into Dutch, which might cause a second misinterpretation of each question in the interview process. Another way misinterpretation might have taken place is in describing some of the technical terms which are difficult to describe in the local context. Because of these multiple interpretations valuable or detailed information might be overlooked when understanding the questions of the questionnaire and providing answers to those questions.

Secondly, another caveat regarding the data collection process was the number of responses obtained was limited. For the Kwamalasamutu user group, key persons such as the paramount chief, the village leader, and teachers were not available in the village during the interviews. Having conducted an interview with especially the paramount chief would provide valuable information as he is the person who is the highest authority in the village and for the whole Trio community who live in smaller villages around Kwamalasamutu as indicated in figure 1. Also, the governmental and non-governmental organizations need his approval before carrying out any activity within Kwamalasamutu or the other villages in which the Trio community reside. Having conducted the user needs assessment questionnaire with him would give more depth to the research especially regarding the governance component regarding the formal and informal agreements with the organizations. Also, regarding spatial data management, he is the highest decision maker to appoint responsible persons accordingly. Finally, regarding the fieldwork conducted for the user needs assessment, more time is required so that the research topic could be introduced adequately to the interviewees which would give them a more detailed understanding to answer the questions more effectively.

Thirdly, regarding the stakeholder user group, the responses received were limited. Responses from the Ministry of Spatial Planning and Environment and the indigenous organization VIDS were not obtained. Information obtained from the Ministry of Spatial Planning would be valuable as they are the authority when it comes to spatial planning and environment issues on a local and national level. Also, regarding the Geospatial Intelligence Hub this Ministry is coordinating, their views on the development of the local SDI and how this might be integrated in that system would give more depth to this research. Obtaining information of the VIDS would also give more depth to this research as they focus on human- and especially indigenous rights. Their input would be valuable regarding the governance component and standards and metadata component regarding according to the indigenous worldview.

Therefore, more research may be needed to gather more information on both the local and national level. The additional research on local level could focus on obtaining more information from key persons in the village, such as the paramount chief and the teachers and on national level to obtain information from the Ministry of Spatial Planning and the VIDS. Also, on national level additional research could give insight whether the NSDI, the Geospatial Intelligence Hub or a combination of both can support the LSDI and vice versa. Also, long-term studies could explore further how the challenges mentioned can be addressed for the implementation and performance of an effective local SDI.

6 Conclusion

Suriname does not currently have formal recognition of the collective and land rights of Amerindians and Maroons, making it one of the few countries on the continent without such legislation. While discussions on formal recognition continue at the national level, several organizations are working at the local community level to educate and empower these communities in order to increase their capacity for territorial governance and sustainable resource management. However, when it comes to data management, these communities have a complex relationship with national and local organizations and government institutions. One of the main problems is that although the community is actively involved in the data collection projects coordinated by the organizations and the government, they have only limited control over the way in which their geospatial data is stored, used, accessed, and shared. Despite being the primary users and owners of geospatial data, communities lack the technical knowledge, skills, and resources to manage their geospatial data. A Spatial Data Infrastructure (SDI), which could provide a framework of agreements and procedures according to the needs of its users, is an essential tool for effective geospatial data management and decision making. Given that communities are actively collecting geospatial data, a local SDI for indigenous communities, based on their needs and priorities for managing geospatial data, would strengthen community initiatives related to territorial governance and sustainable resource management.

Therefore, the main research question of this study is: How can the development of a local SDI strengthen the spatial data management of the Kwamalasamutu community and improve collaboration with other organizations? This question was further divided into four sub-questions.

1. What is the status of the National Spatial Data Infrastructure (NSDI) in Suriname?
2. What are the challenges for the development of a local SDI to enhance geospatial data management?
3. Who are the users of the local SDI, and what are their needs for the development of a local SDI for Kwamalasamutu?
4. What are the requirements for the development of a local SDI to enhance collaboration with other organizations?

To answer this question a literature review was conducted to assess the status of the NSDI as well as survey questionnaires were conducted with two user groups: the Kwamalasamutu community and stakeholder organizations. The existing NSDI is currently not performing, however there are efforts from the government to develop a Geospatial Intelligence Hub for Suriname. Having either the NSDI or the Geospatial Intelligence Hub in place would support the development of a local SDI. The main challenges that have been identified throughout this research are the availability of electrical and internet infrastructure, the lack of hardware and software, limited technical capacities, weak governance structure and insufficient financial resources. Regarding the needs of the Kwamalasamutu user group and the requirements of the organization's user group, these were closely related to the challenges mentioned. However several needs and requirements have been mentioned, the needs and the requirements that stood out the most were the availability of electricity and reliable internet, strengthened capacities of the local community and a strong governance regarding formal agreements for spatial data

management. To address the challenges, needs and requirements from the Kwamalasamutu community and the organizations, some recommendations are provided in the following chapter.

7 Recommendations

For the development of the local spatial data infrastructure for Kwamalsamutu according to their needs, these users should be involved from the beginning of the process. Also, the organizations should be involved from the beginning because the LSDI will have to comply with the requirements mentioned by them. The LSDI will strengthen decision-making and collaboration on various levels, the local level within the community, the stakeholder level between the community and organizations, and the national level with government agencies and institutions. Therefore, it is important that also on these different level's efforts should be made for the development and eventually the implementation of the LSDI. On all these levels there are efforts that can be made in the short and long term. Therefore, a distinguishment between short-term and long-term actions is made on the three levels mentioned.

1. Local community level
    - Short term: capacity building sessions could be facilitated to have the community gain more understanding regarding the spatial data management challenges and how these can be addressed in an interactive way. This could lead to the formalization of agreements within the community and with the organizations. Also, it would provide the space and time to appoint people such as the rangers responsible for coordinating the specific components of spatial data management such as the collection, storage, access, and distribution.
    - Long-term: Kwamalasmutu needs to strengthen their govenance structure according to their development plans they have created, Also, for the next development plan of Kwamalasamutu they can include digital inclusion activities and reach out to the government and other organizations to seek funding or other kind of resources and capacity building trainings.

2. Stakeholder level
    - Short term: On this level, the efforts of the different organizations will have to be combined for the development of the local SDI for Kwamalasamutu. Collaboration between each organization and the community will need to be effective through formal agreements such as signed partnerships or Memorandum of Understanding (MOU) according to the needs of the community and their established protocols and guidelines. Also, for the development and effective implementation of the LSDI, adequate agreements and protocols need to be made between the organizations when it comes to the use and sharing of spatial data from the community between each other and other third parties.
    - Long-term: The organizations can contribute by providing technical resources and training sessions to strengthen the spatial data management capacity of the community or the identified persons, such as the rangers within the community. In addition, the organizations can advocate for effective policies and legislation on the national level according to ethical considerations when it comes to using spatial data from Indigenous Communities. To develop the LSDI, financial resources will be needed to which the organizations can reach out to their project donors or search for funders for projects such as the digital inclusion of Indigenous communities. Finally, more research will be needed

regarding this topic, thus the organizations can play an important role in facilitating researchers or students regarding local SDI development.

3. National level
   - Short term: One of the first and the most important actions that the government can take to support the development of the LSDI is the formal recognition of the land rights which since the independence of Surname have not been established until now. Formal recognition of the rights of Indigenous and Maroon communities will pave the road for strong policies and legislation for spatial data management on national and local levels. Also, according to the National Digital Strategy, the government is planning to provide electrification and improve telecommunication in rural areas where this is currently not available. For the development and implementation of the LSDI 24-hour electricity and internet are two conditions that are needed.
   - Long-term: It should be made clear if the NSDI will continue to be developed or if the Geospatial Intelligence Hub will replace this. The authorized organization, which currently is the MI-GLIS, should take the lead in developing a framework for LSDIs. Also, the implementation of digital inclusion programs as part of the educational system for remote communities could be something for the government to investigate. Finally, as the only transportation to Kwamalasamutu is by chartering a small airplane which is very costly, other means of transportation networks need to be developed with the inclusion of the communities who live in and of the forest.

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Appendix I. User Needs Assessment

A. BACKGROUND INFORMATION

1. What is your name?

2. Gender:
   - Male
   - Female
   - Prefer not to say.

3. What is your age?
   - ❑ 16 - 25
   - ❑ 25 - 35
   - ❑ 35 - 45
   - ❑ 45 - 55
   - ❑ 55 - 65
   - ❑ 65 >

4. Role, or position in the community?

B. TECHNOLOGY

5. Which technology do you use?
   - ❑ Smartphone
   - ❑ Tablet
   - ❑ Computer
   - ❑ Other

6. How would you rate your level of comfort with using technology?

Very easy Easy Medium Difficult Most Difficult

7. Smartphone use
8. Computer use
9. Internet access
10. Other

11. Have you ever used spatial data of Kwamalasamutu?
    - Yes
    - No
    - Maybe

12. Which spatial data have you used?
    - ❑ Paper maps
    - ❑ Digital maps
    - ❑ GPS coordinates
    - ❑ Other

13. In what format would you prefer to see or use spatial data?
    - ❑ Paper maps
    - ❑ Digital maps
    - ❑ GPS coordinates

- ❑ Other

14. What language would you prefer to use when using spatial data?
- ❑ English
- ❑ Dutch
- ❑ Trio
- ❑ Portuguese
- ❑ Other

15. In what technology do you need training?
- ❑ Smartphone use
- ❑ Computer use
- ❑ Internet browsing
- ❑ All

C. DATA COLLECTION

16. Are you aware of spatial data collection activities in the village?
- o Yes
- o No
- o Maybe

17. Can you name the organizations (governmental and non-governmental) that conduct spatial data collection in the village?
18. What types of spatial data does your community currently collect?
- ❑ Traditional Knowledge
- ❑ Environmental data
- ❑ Land use.
- ❑ Other

19. Are there procedures to collect spatial data?
- o Yes
- o No
- o Don't know.

20. What are the procedures?
21. Who in the village gives authority for the collection of spatial data?
22. Who decides what happens to the spatial data after it is collected?
23. What are the challenges when it comes to spatial data collection activities in Kwamalasamutu?
24. What do you think is needed to overcome these challenges?
25. How would you like to know if spatial data collection activities will happen in the village?

D. DATA STORAGE

26. Is the collected spatial data stored within the village?
- o Yes
- o No
- o Don’t know.

27. Where in the village is spatial data currently stored and who is responsible?
28. How is the spatial data stored in Kwamalasamutu?
- ❑ Paper maps

- ❑ Digital maps
- ❑ GPS Coordinates
- ❑ Excel files
- ❑ Other

29. What are the challenges when it comes to the storage of spatial data in Kwamalasamutu?
30. What is needed to overcome these challenges?
31. Is the collected spatial data stored outside the village?
    - o Yes
    - o No
    - o Don't know.

32. Where outside the village is spatial data stored and who makes this decision?
33. Would you like to have the collected spatial data stored in the village?
    - o Yes
    - o No
    - o Don't know.

34. How do you want this data to be stored?

- ❑ Paper maps
- ❑ Digital maps
- ❑ GPS coordinates
- ❑ Excel files
- ❑ Other

E. DATA ACCESS

35. Do you have access to spatial data stored outside the village? (e.g. Organizations, Government, Others)
    - o Yes
    - o No
    - o Don't know.

36. From which organizations do you have access to the data?
37. To what type of spatial data do you have access to?

- ❑ Paper maps
- ❑ Digital maps
- ❑ GPS coordinates
- ❑ Excel files
- ❑ Other

38. Are there procedures to get access to the data?
    - o Yes
    - o No
    - o Don't know.

39. What are the procedures?
40. What are the challenges when it comes to having access to spatial data from Kwamalasamutu stored in organizations?
41. What do you think is needed to overcome these challenges?
42. Would you like Kwamalasamutu to decide how their spatial data can be accessed?
    - o Yes

- No
- Don’t know.

F. DATA SHARING

43. Are you aware if spatial data from Kwamalasamutu is shared between organizations?
- Yes
- No
- Don’t know.

44. Are there procedures to share data requested between organizations?
- Yes
- No
- Don't know.

45. What are the procedures?
46. What are the challenges when it comes to sharing spatial data from Kwamalasamutu with organizations?
47. What do you think is needed to overcome these challenges?
48. Do you want Kwamalasamutu to decide when spatial data can be shared between organizations?
- Yes
- No
- Don’t know.

49. Why?

G. DATA GOVERNANCE

50. Are there formal agreements or protocols in place between Kwamalasamutu and organizations regarding spatial data management?
- Yes
- No
- Don’t know.

51. What formal agreements are in place and with which organizations?
52. Are there informal agreements or protocols in place between Kwamalasamutu and organizations regarding geospatial data management?
- Yes
- No
- Don’t know.

53. What informal agreements or protocols are in place and with which organizations?
54. How would you want the spatial data from Kwamalasamutu to be managed?
55. Who should be responsible for managing spatial data?
56. How do you want to be involved in decisions about what happens to your spatial data?
57. Who should decide if spatial data can be collected, and where it should be stored, accessed, and shared?
58. What ethical principles are important to your community when it comes to spatial data collection, storage, and use?
59. How can outsiders ensure that spatial data is collected and used in a respectful way that honors your community's values and beliefs?

Appendix II. Stakeholder Interviews

A. GENERAL INFORMATION

1. Name of the Organization:

2. Which category best describes the organization?
- o Business
- o Government
- o Non-government
- o Semi-government
- o Other

3. In which field or sector does the organization work?
- ❑ Agriculture
- ❑ Community development
- ❑ Conservation
- ❑ Education
- ❑ Electrification
- ❑ Environment
- ❑ Fisheries
- ❑ Forestry
- ❑ Mining
- ❑ Telecommunication
- ❑ Water management
- ❑ Other

4. Does your organization use spatial data in its operations?
- o Yes
- o No
- o Don't know.

5. Which spatial data does the organization use?
- ❑ Drone Imagery
- ❑ Climate data
- ❑ Environmental data
- ❑ Geological data
- ❑ Geomorphological data
- ❑ Geostatistical data
- ❑ Hydrological data
- ❑ Land use data
- ❑ Satellite Imagery
- ❑ Social data
- ❑ Soil data
- ❑ Spatial planning
- ❑ Vegetation / Forest cover data
- ❑ Other

B. TECHNOLOGY

6. Does the organization use a Geographical Information System (GIS) or any other type of geographical infrastructure or software for managing spatial data?
- o Yes
- o No
- o Don't know.

7. Which Geographical Information System or software do you use?
- ❑ ArcGIS
- ❑ AutoCAD
- ❑ MapInfo
- ❑ QGIS
- ❑ Other

8. How would you rate the benefit of GIS technology to strengthen an indigenous community such as Kwamalasamutu in managing their resources?
Not at all likely Extremely likely

9. What would be the benefits for Kwamalasamutu?
10. What barriers or challenges do you anticipate in implementing GIS technology within Kwamalasamutu?
11. What technological requirements are needed in Kwamalasamutu for managing spatial data?
12. Would you support training locals to strengthen their efforts in GIS technology?
- o Yes
- o No
- o Don't know.

C. DATA MANAGEMENT

13. Does the organization use or manage spatial data from Kwamalasamutu?
- o Yes
- o No
- o Don't know.

14. How is the spatial data stored within the organization?
- ❑ Digital maps
- ❑ Geo JSON
- ❑ GPS coordinates
- ❑ KML
- ❑ Paper maps
- ❑ Shapefiles
- ❑ Other

15. Is the community involved in the decision-making regarding the management of their spatial data?
- o Yes
- o No
- o Don't know.

16. How are they involved?
17. Why are they not involved?
18. Would you like Kwamalasamutu to manage their spatial data?
- o Yes

- o No
- o Don't know.

19. Why would you want that?
20. What barriers or challenges do you anticipate having Kwamalasamutu manage their spatial data?

D. STANDARDS & METADATA

21. Are you familiar with geospatial data standards?
- o Yes
- o No
- o Not really

22. Do you use any geospatial data standards in your work?
- o Yes
- o No
- o Don't know.

23. What geospatial data standards does your organization currently use?
24. What data formats are most used within the organization for managing spatial data?
- ❑ Shapefiles
- ❑ Geo JSON
- ❑ Geo TIFF
- ❑ GML
- ❑ Other

25. Are you familiar with metadata standards in relation to geographic information?
- o Yes
- o No
- o Not really

26. Does the organization use metadata standards for describing geospatial data?
- o Yes
- o No
- o Don't know.

27. What metadata standards do you use?
28. How important do you think it is to have clear and understandable information (metadata) about maps and geographic information?
    Not at all likely Extremely likely
29. What information do you include in your metadata that is particularly relevant for the community of Kwamalasamutu (e.g., cultural significance, traditional place names)?
30. Do you have any suggestions or preferences for how maps and other geographic information could be made more accessible and understandable for a community such as Kwamalsamutu?

E. DATA ACCESS FROM THIRD PARTIES

31. Does the organization have access to spatial data from Kwamalasamutu stored at other organizations?
- o Yes
- o No
- o Don’t know.

32. To what type of spatial data or spatial data formats does the organization have access?

- ❑ Digital maps
- ❑ GeoJSON
- ❑ GPS coordinates
- ❑ KML
- ❑ Paper maps
- ❑ Shapefiles
- ❑ Other

33. Is the community involved when requesting access to their spatial data?
- o Yes
- o No
- o Don't know.

34. What are the procedures within the organization to have access to spatial data from Kwamalasamutu stored at others?
35. What are the challenges when accessing spatial data from Kwamalasamutu from third parties?

F. DATA SHARING WITH THIRD PARTIES

36. Does the organization share spatial data from Kwamalasamutu with other organizations?
- o Yes
- o No
- o Don’t know.

37. What type of spatial data is shared with these organizations?
- ❑ Digital maps
- ❑ GeoJSON
- ❑ GPS coordinates
- ❑ KML
- ❑ Paper maps
- ❑ Shapefiles
- ❑ Other

38. Is the community involved when sharing their spatial data?
- o Yes
- o No
- o Don't know.

39. What are the procedures within the organization for the distribution of spatial data from Kwamalasamutu with others?
40. What are the challenges when sharing spatial data from Kwamalasamutu with third parties?

G. COLLABORATION & GOVERNANCE

41. Are there formal agreements in place between the organization and Kwamalasamutu regarding spatial data management?
- o Yes
- o No
- o Don't know.

42. Regarding which of the following activities are there formal agreements in place?
- ❑ Spatial data collection
- ❑ Spatial data storage

- ❑ Spatial data access
- ❑ Spatial data sharing
- ❑ Other

43. Are there informal agreements in place between the organization and Kwamalasamutu regarding spatial data management?
- o Yes
- o No
- o Don't know.

44. Regarding which of the following activities are there informal agreements in place?
- ❑ Spatial data collection
- ❑ Spatial data storage
- ❑ Spatial data access
- ❑ Spatial data sharing
- ❑ Other

45. Are there formal agreements in place with other organizations when accessing or sharing spatial data from Kwamalasamutu?
- o Yes
- o No
- o Don't know.

46. Would you like Kwamalasumutu to decide how and when their data can be accessed and shared?
- o Yes
- o No
- o Don't know.

47. What requirements do you think are needed for an effective data governance system in Kwamalasamutu?

H. SPATIAL DATA INFRASTRUCTURE

48. Are you familiar with the term Spatial Data Infrastructure?
- o Yes
- o No
- o Not really

49. Do you think a local SDI would be useful for the indigenous community of Kwamalasamutu for its spatial data management?
- o Yes
- o No
- o Don't know.

50. How do you perceive the potential benefits of a local SDI for the indigenous community of Kwamalasamutu?
51. Not at all likely Extremely likely
52. What are some key requirements for developing an SDI that is culturally appropriate and relevant to the needs of the Kwamalasamutu community?
53. What are the potential challenges and opportunities for implementing and maintaining an SDI in a remote rural community like Kwamalasamutu?

54. How can government institutions and NGOs collaborate effectively to support the development of an SDI for Kwamalasamutu?
55. How can the local SDI be integrated with existing spatial data initiatives and frameworks in Suriname?