GEOMATICS AND ENVIRONMENTAL ENGINEERING • Volume 20 • Number 5 • 2026

https://doi.org/10.7494/geom.2026.20.5.5

Geospatial Framework for Sustainable Land Administration for Low-Income Countries in Africa: Case study of Botswana

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Abstract: Many developing countries lack national policies and frameworks to establish how geospatial information can be incorporated into their global development agenda programs. Such policies and frameworks can help these countries to properly administer land and its resources in their national contexts. As a result, they face challenges in their efforts to achieve sustainability in properly administering land and its resources through the use of geospatial information. These issues can be addressed by a strategic geospatial framework that advocates for inclusive, participatory consensus and evidence-based decision-making initiatives. Unfortunately, such a framework does not exist in many developing countries, particularly in Sub-Saharan Africa. Thus, this study proposes a comprehensive and strategic geospatial framework for sustainable development, to provide policy and guidance to land administrators to effectively integrate geospatial information into the sustainable development agenda of Botswana as a case study. A Delphi method involving various experts in land administration was used to develop and validate the novel geospatial framework. The novelty of the proposed framework is that it provides insights on how developing countries can administer land and its resources by achieving Sustainable Development Goals 9 and 11. This study has answered the question of how and where geospatial information can contribute to achieving the outlined SDGs through proper monitoring and progress reporting of land administration issues in a developing country setup.

Keywords: land administration systems, sustainable development goals, Delphi method, evidence-based decision-making, geospatial information integration

Received: February 28, 2025; accepted: May 8, 2026

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1. Introduction

The concept of Sustainable Development Goals (SDGs) was initiated at the United Nations Conference on Sustainable Development held in Brazil in 2012. The objective was to develop a set of universally applicable goals that address the three dimensions of sustainable development, encompassing social, economic, and environmental factors. Sustainable development is defined as a development that meets the needs of the present without compromising the ability of future generations to meet their own needs [1]. It is driven by 17 SDGs, which are a universal call for action for countries to end poverty, protect the planet, and ensure that all communities enjoy peace and prosperity.

Well-functioning land administration systems (LASs) are considered good enablers for sustainable development [2]. Therefore, they are included in the United Nations' SDG 9 (industry, innovation, and infrastructure) and 11 (sustainable cities and communities). SDG 9 emphasizes the need to innovate and enable the effective and efficient use of resources, while SDG 11 advocates for inclusive, safe, resilient, and sustainable cities. For developing countries to embrace sustainable development in land-related matters, an effective, efficient, and participatory LAS is necessary. Such a LAS should empower governments to better manage the dynamic human-to-land relationship that exists due to pressures of sporadic population growth, particularly in urban and peri-urban areas. Pahl-Wostl [3] recommends a balanced and integrated approach to policy and institutional reform which considers the role of technology and public participation and addresses the dynamic relationship between humans and land. This approach is in line with SDG principles, which seek to meet the needs and aspirations of the present without compromising the needs and ambitions of future generations. Furthermore, the SDGs aim to transform the social, economic, and environmental circumstances of people, particularly in developing countries, to eliminate extreme poverty and to leave no one behind. However, Scott and Rajabifard [4] argue that there is little knowledge on the scale and dimensions of the problems experienced by developing countries, particularly their location, whom they impact, their causes, and their remedial measures.

According to Williamson et al. [2], sustainable development is a major justification for the evolution of LASs. As a result, interest in people-to-land relationships has increased because of pressures on the environment directly linked with rapid urbanization, population increase, use and misuse of resources, and technological advancements [5]. These people-to-land relationships have a crucial role in spatial enablement, which facilitates responsible land governance for governments to positively respond to national and global agendas to achieve sustainable land administration.

The United Nations Global Geospatial Information Management (UN-GGIM) committee, through its community of experts, believes that all issues related to sustainable development can be mapped, discussed, and modeled within a geographic

context UN-GGIM [6]. Furthermore, it argues that countries should develop functional geopolitical policies to provide the frameworks necessary for global collaboration and consensus-based decision-making.

The livelihoods of underprivileged families in developing countries depend on access to land and other natural resources. Therefore, this access must be secure and stable to facilitate opportunities for economic growth and incentives to invest. To achieve these goals, land should be properly planned, administered, and managed to ensure sustainable development. Similar to other developing countries, Botswana has developmental challenges such as unemployment, poverty, inequality, poor land administration, and climate change problems. The effective adoption of the SDGs can address these challenges.

Lee et al. [7] argue that the SDGs can transform the world by 2030 if appropriately implemented. However, many developing countries like South Africa, Kenya, and Zimbabwe suffered losses of land due to colonial rule, which led to social inequalities and unsustainable economic development [8–10]. As such, they might encounter underlying challenges in properly implementing the SDGs in their local contexts, caused by unequal land distributions in the past. Moreover, these countries have tenure security challenges that impede economic development, which is one of the three pillars of sustainability. The other two pillars of sustainability include social responsibility and environmental integrity. Additionally, RICS [11] stresses that there is a fourth dimension, which encompasses the legal and regulatory framework. Such a framework can help decision-makers establish systems that integrate environmental and economic accounting principles into local initiatives [12].

The study area for this research is a landlocked country located in the southern part of Africa called Botswana. It has a total land area of 581,730 km^2. Despite having a large land mass, a small population of only 2.48 million inhabitants, and being regarded as a low-income economy [13], the country still has land administration challenges that emanate from a lack of proper management and documentation of land due to limited capacities and insufficient infrastructure. The total population of the country comprises an urban population of 1.81 million and a rural population of 672,965.

Similar to other developing countries, Botswana is vulnerable to the negative effects of globalization, climate change, and other undesirable environmental conditions. Therefore, this paper answers the question of how and where geospatial information can contribute to achieving the SDGs through proper monitoring and reporting of land administration issues using a geospatial framework. Currently, there is little knowledge in Botswana of how geospatial information and activities can be used to implement most SDGs and monitor progress toward achieving sustainability in administering land and its resources.

Existing studies on geospatial information have contributed to an understanding of frameworks for effective land administration systems in support of sustainable development [2, 4, 14]. Nevertheless, there is a need for an integrated and

participatory approach that utilizes different dimensions of decision-making to accommodate and adopt geospatial knowledge in LASs in developing countries. Among the studies conducted in the past, only one study [4] proposed a strategic framework for improved land governance and the integration of geospatial information into the global development agenda, which is mostly applicable to developed nations.

Among studies focused on developing countries, to the best of the authors' knowledge, there is little research by Africans on frameworks for integrating geospatial information for effective LASs applicable to the geographic contextual factors in developing countries such as Botswana. The motivation for this study is, therefore, to fill this gap by proposing a geospatial framework for sustainable land administration applicable to developing countries, using Botswana as a case study. A geospatial framework, in this context, refers to a tool that provides a common vision, goals, and a set of actions to effectively manage and integrate geospatial and statistical information to support analysis and decision-making. The objective is to contribute to an in-depth understanding of the applicability of geospatial information in LASs that integrates empirical evidence of relevant experts in the context of developing and validating the proposed novel geospatial framework in this study.

The geospatial framework proposed in this study is consistent with the directions set out by the International Federation of Surveyors (FIG) [15] and the Sustainable Development Goals [16]. In addition, the proposed geospatial framework is a valuable research contribution for two reasons:

1) It adds to existing studies by proposing a geospatial framework for a sound and sustainable LASs that can benefit local communities to improve security of tenure in a manner that considers both implicit and explicit knowledge of relevant experts.
2) It provides new factors for effective land administration in comparison with existing studies, given the use of experts from multiple strategic levels of land administration and management across several government ministries. The latter can facilitate support for government policies in formalizing land markets, improving land and property taxation, advancing the management of land disputes, and enhancing land use planning and implementation.

In summary, the specific objectives for this study are as follows:

- to conduct a comprehensive review of previous efforts toward achieving sustainability in administering land for low-income countries;
- to design a geospatial framework for sustainable land administration for low-income countries, with Botswana as a case study;
- to use the Delphi method to validate the proposed geospatial framework through multiple rounds of questionnaires to experts in the study area.

This study is anticipated to highlight the roles that geospatial technologies can play in supporting sustainable land administration. The proposed conceptual

framework also highlights important linkages between land board management and personnel to better articulate the sustainable administration of land in rural areas. The framework proposed was validated by experts through the Delphi method.

2. Background

2.1. Land Administration in the Context of Sustainable Development

Land administration systems should evolve in developing countries to support sustainable development initiatives appropriately and speedily. One key aspect of functional LASs is proper land registers supported by practical cadastral surveys, which unfortunately are inadequate or missing altogether, particularly at district land boards [17]. For example, developing countries are characterized by mostly insecure tenure, skewed land distribution, and cumbersome land transfers. Successful LASs are measured by its ability to manage and administer land efficiently, effectively, and cheaply. The complexity of legal frameworks or sophisticated technological solutions does not determine the success of LASs. Their success lies in adopting appropriate laws, institutions, processes, and technologies designed for the specific needs of the country or jurisdiction.

Botswana has made considerable progress in establishing a sound land administration system and creating institutions at different levels, which lack uniformity in capacity and overall mandate. For example, the absence of a strong national institution that provides clear guidance and technical, legal, and financial support to both urban and rural lands in an integrated approach has resulted in tenure uncertainty and resource wastage from duplication of efforts [18]. In addition, the current LAS in Botswana lacks a basic spatial framework or a spatially referenced data capturing and maintenance system. Even though the country has existing policies and legal measures, land-related challenges like tenure insecurity, restrictions on bare land transfers, and the lack of an adequate land administration system still prevail.

Besides the absence of good land governance and management practices and outdated and rigid development plans, capacity problems still characterize both rural and urban administration systems in the country. Robust institutions are the main drivers of policy and legal frameworks in functional land administration reforms. They can help address inappropriate institutional arrangements, which are often the major bottlenecks to these endeavors. As such, governments must address institutional reform issues that include defining proper responsibilities, establishing functional intergovernmental collaboration, and promoting the decentralization of activities. To address the challenge of tenure insecurity in developing countries, UN-HABITAT [19] recommends a staged approach that can provide for more immediate security of some sort. However, there is no clear articulation of how the staged approach can be adequately implemented, considering the deficit of interoperability between existing systems in local land institutions.

In their efforts to improve and scale land administration activities in Rwanda and Ethiopia, Ho et al. [20] developed a technological innovation system (TIS) framework that provides country-specific insights into how actors, their interactions, and institutional arrangements impact the adoption and scaling of geospatial tools in government entities. Nonetheless, the framework does not sufficiently consider the processes and relationships within the local context, which plays an important role in responsive innovation. The proposed conceptual framework in this study can address the outlined challenges of previous initiatives by incorporating top-down and bottom-up approaches toward sustainably administering land and its related resources. Moreover, it could adopt the fit-for-purpose (FFP) approach by the International Federation of Surveyors (FIG) [21] which stresses that LASs in developing countries must be flexible, participatory, scalable, and able to be built within a relatively short period and at an affordable cost.

Well-functioning LASs can provide an infrastructure for implementing land policies and land management strategies to support sustainable development activities. Such an infrastructure includes standards, institutional arrangements, processes, legal frameworks, land information management, and dissemination systems. Moreover, it includes technologies required to support land markets, allocation, valuation, and any interests in land. However, no framework shows how the different strategies can be integrated such that well-functioning LASs can be achieved. Thus, this study proposes a comprehensive and strategic geospatial framework for sustainable development, to provide policy and guidance to land administrators to integrate and connect geospatial information into the sustainable development agenda of Botswana as a case study. An initial appreciation of the challenges of implementing SDGs in developing countries will be conducted to understand how the proposed geospatial framework can address these shortcomings.

2.2. Challenges of Implementing SDGs in Developing Countries

Opportunities to use geoinformation to measure and monitor targets and indicators of the SDGs bring with them a substantial expectation to deliver. There is very little understanding regarding the role of geoinformation in sustainable development processes at the governmental level. Furthermore, capacities of how geospatial information can be applied for sustainable development and how country policies can be implemented to provide coherent and integrated solutions remain a challenge in developing countries [4].

There are many positive benefits that are likely to be gained from adopting SDG principles. Nevertheless, most developing countries lack comprehensive and integrated platforms to collaborate with other stakeholders to maximize the value of fundamental geospatial data to capture the various elements of the 2030 Agenda. In agreement, Rajabifard [22] stresses that baseline data for several SDG targets remains unavailable. For example, SDG 1, Target 1.4 is concerned with ensuring that all human beings have equal rights to land and other forms of property by 2030. However,

Rajabifard [22] argues that very few countries know their baseline on the security of tenure as they do not have programs or plans for achieving the target by 2030. The 2030 Agenda calls for increased support to strengthen data collection and capacity development in member countries and to develop national baselines where they are non-existent. Many developing countries have very few or no monitoring systems to support the operations of SDG initiatives [23]. This makes it a challenge for these countries to assess and monitor progress toward achieving SDG targets through the use of indicators.

According to Gunnarsdóttir et al. [24], the task of selecting indicators and tools suitable for establishing appropriate intervention policies can be a challenge for many developing countries. Additionally, tasks of fitting different pieces of the puzzle together to combine ideas and initiatives from different disciplines into a consistent whole need thoughtful consideration. A well-crafted geoinformation framework for sustainability can be the answer for countries interested in adopting SDGs to improve the efficiency and effectiveness of their LASs.

2.3. Geoinformation as a Foundation for Incorporating SDGs into LASs

The increased interest in the use of geoinformation does not take place in isolation. Rather, it fits into general trends of innovation, big data concepts, the Internet of Things, and the re-use of free public data. New forms of cooperation can result from the effective utilization of geoinformation for advancing the Agenda 2030 initiative. For example, geoinformation can play a major role in implementing functioning land information systems (LISs) and formulating national land use development plans (NLUDMPs).

To ensure ownership of such initiatives, land professionals should be conversant with technologies and planning processes created through active citizen participation, the application of well-defined land policies, and collaboration with key stakeholders. Despite much advocacy and many global dialogues, Scott and Rajabifard [4] argue that the use of geospatial information in adding value to sustainable development processes has been limited. Many countries fail to understand that issues affecting sustainable development can be manipulated, analyzed, mapped, discussed, and disseminated within a geographic context [6].

Ideally, land authorities should be in a position to provide updated and renewed geospatial data free of charge or at an affordable fee for value-added purposes by the geospatial community. Aerial photographs and satellite images can then be used for generating high-resolution orthophotos and subsequently used to produce land-use plans. Nonetheless, Longley et al. [25] contend that geoinformation as an economic good is characterized by high production costs and low costs of reproduction, which makes it a challenge to apply classical economic pricing principles to it.

To facilitate economic growth, technologies like the Internet, Geographic Information System (GIS), and remote sensing can be significant contributors to sustainable development initiatives in developing countries. In an evolving knowledge economy, information technology is an intangible capital that places all technological

improvements at the forefront of global activities. Moreover, sufficient adaptation and use of geospatial data in a developing world context can assist in addressing current issues caused by unsustainable development. Issues like air, water, and land pollution, lack of proper waste recycling and disposal sites, and poor administration and management of land and its resources can be addressed by the application of geospatial technologies to ensure sustainability. According to Statistics Botswana [26], information underpins the development and enrichment of national policies and is a critical resource for enhancing strategic governance.

Geospatial technologies should not only be used for collecting data for decision-making and census data purposes. Rather, they consist of ideal platforms through which this information can be exploited and shared. These technologies can be implemented as information and content management systems that facilitate multiple connected organizations to apply GIS functionalities in their daily activities from a centralized resource.

Despite all the aforementioned benefits, the application of geospatial technologies in land administration faces several challenges in overcoming land governance problems. These problems include:

- limited data availability, accessibility, and quality;
- lack of connectivity and an enabling infrastructure;
- lack of necessary skills and training avenues;
- unclear legal recognition of geospatial data by relevant organizations.

In summary, there is a significant gap in the comprehensive understanding of how geospatial technologies can be used and the different contexts in which they could be utilized to facilitate improved land administration practices [27].

In the context of Africa, Botswana has produced significant results in promoting good land governance [28]. Despite being one of the least populated countries in Africa [29], land in Botswana is poorly administered and managed by the relevant authorities [9]. Good land administration and management are essential for developing countries to achieve their ambitions of transforming into food-secure and knowledge-based economies. Moreover, they can help in the sustainable management of environments and the creation of equal social conditions. However, challenges still exist as to how geospatial information can be integrated into national information systems, particularly for land administration. As such, communities in developing countries must adopt a geospatial framework to collaborate in advocating for sustainability at the local and national levels.

2.4. Partnerships for Sustainability Using a Geospatial Framework

Effective partnerships between the civil service, the private sector, and the public are necessary to create a robust cooperation model between stakeholders. They facilitate a platform in which organizations can collectively have a common vision that stimulates ownership and creativity in performing joint tasks.

Issues that can constrain coordination and collaboration efforts include a lack of harmonized legislation and overlapping administrative authorities. As noted by Hsieh et al. [30], these challenges can be mitigated by moving from a hierarchical model toward a networked mode of coordinating geospatial activities among stakeholders. Moreover, van Loenen and Grothe [31] stress that enacting strong open public sector information policies on government data can help ease access to government spatial datasets to improve efficiency and reduce duplication of effort between collaborators.

The Roles of Civil Society

Sustainable development initiatives aim to improve human lives and better manage their resources and the environment. Therefore, it is necessary to identify institutions, their compositions, and their capacities so that their roles can be identified toward achieving sustainability in a country. There are three sets of institutions – the state, the private sector, and civil society – that are key stakeholders in implementing and monitoring SDGs. According to Greyling [32], the roles of these institutions do not have to be exclusive, but the state should be a facilitator and controller of standards.

Civil societies are the voices of the people and ensure that land and property rights are not violated. In addition, they promote citizen participation by advocating for a decentralized government and countering policy distortions that may exist. In the geomatics field, citizen participation can be in the form of volunteered geographic information (VGI) to improve current land administration processes, which are mostly outdated and ineffective [21].

The Roles of the Geomatics Sector

Geomatics practitioners have significant roles to play in ensuring the sustainability of land development projects. As such, they need to be relevant and conversant with SDG issues to serve communities effectively and efficiently. A better understanding of SDG concepts by geomatics practitioners can provide a platform where they aid governments to expand their land administration systems with new tools and principles to better manage land and property rights, restrictions, and responsibilities. Subsequently, these expansions can assist in achieving sustainable development objectives [33]. To achieve an environmentally responsible service in the geomatics sector, practitioners must commit, adopt new ideas and practices, and integrate environmentally friendly systems with normal work processes.

3. Botswana's Efforts Toward Sustainable Land Administration

The adoption of the 2030 Agenda for Sustainable Development coincides with two key national development frameworks of Botswana: Vision 2036 and the National Development Plan 11 (NDP 11). Vision 2036 aims to transform Botswana from a low-income country into an upper-middle-income country by 2036 [34, 35].

It is made up of four pillars:

1) Sustainable Economic Development;
2) Human Social Development;
3) Sustainable Environment;
4) Governance, Peace, and Security.

Pillar 3 advocates for the sustainable and optimal use of land, human settlements, and natural resources. NDP 11 is a medium-term plan for the implementation of Vision 2036 and ran from April 1, 2017, to March 31, 2023.

According to the Vision 2036 Presidential Task Team [35], the plan took into consideration the development challenges of the country and the need to align its focus with global, continental, and regional initiatives such as the UN's SDGs, African Union Agenda 2063 [36] and the Revised SADC Regional Indicative Strategic Development Plan [37]. These development frameworks are the main vehicles through which the country has adopted, domesticated, and mainstreamed the SDGs. They are based on the four thematic areas of social upliftment, sustainable environment, economy and employment, and safety and security. These thematic areas are consistent with the three pillars of the SDGs: social, economic, and environmental.

The Government of Botswana, through the SDGs Roadmap of 2018 [38], is committed to ensuring that an enabling environment is created for the efficient implementation and monitoring of the SDGs for all sectors. To facilitate the domestication and implementation processes, the 17 SDGs and their corresponding indicators have been localized to the country's context. However, there exists a challenge at district land boards regarding how geographic information can be properly utilized for improved land administration. Therefore, this study proposes a geospatial framework to highlight and demonstrate how geographic information can be used to administer land and its resources. district land boards are government organizations responsible for tribal land allocation, management, and its overall administration in the country. Botswana has 12 districts, with each managed by a land board. As such, there are 12 land boards in total.

4. Materials and Methods

4.1. Methodological Overview

A snowball sampling technique was used to identify relevant participants from participating organizations around the country for six weeks. However, the technique can suffer challenges of network bias related to choosing similar participants to the initial contracts or embedded in the same networks. To address this problem, participants were purposefully selected from varied subgroups, settings, and geographic locations to maximize coverage and encourage diversity. In addition, participants were required to possess a relevant academic qualification in land-related matters and a minimum of ten years actively engaged in the public sector. It was believed that they

could provide reliable and valid insights for the study regarding challenges and how they could be addressed. Questionnaire surveys [39, 40] were developed based on literature about geospatial frameworks for land administration [14, 41–43] as starting points regarding the contents of the framework to be developed.

4.2. Literature Review and Preliminary Framework Elements

The literature review methodology used in this study was the PICO approach. The methodology is traditionally used in medical studies. However, it was adapted in this study to structure expert inquiry and consensus development within a Delphi methodology. In this instance:

- **P** represented a panel of experts in land administration;
- **I** was for the innovation and framework element, which was the subject being evaluated;
- **C** embodied comparison, where the study compared existing frameworks with current practices in the country;
- **O** was for outcome, on the consensus of experts on key framework components.

Apart from the literature as the first source of evidence to justify the framework, a second source of evidence was obtained through a Delphi method from a group of land experts identified across nine organizations within the country.

4.3. Delphi Expert Sampling and Rationale

A Delphi method is a structured technique for communication designed to achieve consensus among experts through an iterative feedback process. According to Seboni and Moreri [44], the method is suitable for refining criteria and subcriteria, as it enables a systematic convergence of expert opinions while accommodating diverse perspectives.

The Delphi method [45–47] was used to obtain opinions from a panel of 29 experts at two different levels of land administration (management and personnel). These experts included:

- 15 land surveyors from five district land boards (three from each land board);
- eight land use managers from the Ministry of Lands and Housing;
- six mapping specialists from the Department of Surveys and Mapping.

The Delphi approach was made up of two panels of experts:

1) Expert Panel 1 (management) comprised of 16 participants (from the 29) who were engaged to provide insights about the possible structure, contents and potential benefits of the geospatial framework from a management point of view.
2) Expert Panel 2 (ordinary personnel) comprised of 13 participants who were engaged to provide insights on components that could constitute a geospatial framework and its potential benefits from an ordinary personnel point of view.

Before discussing the modalities of the Delphi method, it is necessary to acknowledge some potential limitations it may have, such that they can adequately be addressed to achieve trustworthy and insightful results. These include the following [47–49]:

- time-consuming – the process can be lengthy, particularly if multiple rounds of feedback are required to achieve consensus;
- cost – there may be costs associated with organizing and managing it, especially if it requires specialized software or facilitation;
- potential for bias – even though participants are anonymous, some participants may be influenced by personal biases in the way the questions have been framed;
- expert selection – the effectiveness of the method is dependent on the selection of appropriate experts in terms of their expertise in the subject matter and willingness to participate; moreover, poor selection of experts may lead to biased or inaccurate results;
- lack of interaction – this can limit the richness of discussions and the ability to clarify complex issues in real time.

These potential challenges were adequately addressed, and the modalities of their achievement are outlined in the following sections.

4.4. Analytical Procedures for Developing Framework Components Using Delphi Method

The model for using the Delphi method to develop components of the geospatial framework included the following steps:

1. Selection of a panel of experts (Expert Panel 1) to work on the research problem.
2. Appointment of a facilitator, who was the lead researcher.
3. Administration of three rounds of questionnaires (six questions per round) [40], which were sent to the participants via email:
   - The first round asked for their input and ideas using a top-down approach such that a broad understanding of the topic could be obtained.
   - The second-round questionnaires were constructed from the insights collected from round-one responses to delve deeper into the topic and clarify issues through the use of a Likert scale.
   - The final round of questionnaires aimed to support decision-making and agreement. It focused on the responses that the experts agreed on, which provided an initial basis for the geospatial framework components.

   For best results, it was ensured that the questions in the questionnaire were clear and free of ambiguity and vagueness. All participants were sent the same questions for consistency and to reduce bias.
4. Achievement of consensus after receipt and analysis of the third round of questionnaires.

For each round of questions, responses from the questionnaires were summarized and recirculated to the participants for further comment. The objective of this activity was to ask the participants to re-evaluate their initial responses so that consensus could ultimately be achieved. The overall aim of the Delphi method is to clarify and expand on issues and reach a consensus. In this instance, consensus from experts about the components from a management point of view is necessary to develop the framework.

The same procedure described above was used in administering the questionnaires for Expert Panel 2, who provided insights on the contents and structure of the framework from a bottom-up approach.

4.5. Ethical Considerations and Bias Mitigation

The two groups of experts were asked the same questions. However, they represent different data sources as part of the design to address common method bias [50–52]. For example, Expert Panel 1 provided their perspective (management) about the structure and contents that could constitute a geospatial framework, while Expert Panel 2 viewed it from an ordinary employee perspective. To encourage honest responses concerning the contents and potential benefits of the framework, the participant information sheets and the consent forms provided to the participants assured them of both anonymity and confidentiality. These forms also indicated to the participants that there were no wrong or right responses, but the goal was rather to seek honest responses.

Besides both the context and sources of measurements, other remedies to address the issue of common method bias were:

- avoiding complex question wording within the questionnaire surveys;
- avoiding compound questions that contained more than two distinct issues;
- defining terms that could be considered vague in the context of the different expert panel members.

Moreover, two procedures were used to address the above three points relating to countermeasures for common method bias in the context of feedback on the measurements. The first procedure involved a rigorous ethical review process that provided an opportunity to address measurement error. The second procedure involved pilot testing of the questionnaires to address measurement error that could affect the reliability of the responses due to the inability to clarify seemingly unclear questions [50, 52].

4.6. Quality Assurance Measures Using the Content Validity Index

To ensure the credibility, reliability, and stability of expert consensus, the questionnaire results from the Delphi study were validated using a content validity index (CVI) measure methodology [53, 54]. The process involved interviewing

a different group of land experts (seven in total) individually to verify whether the findings obtained were meaningful and could be applicable in practice. These experts are registered land surveyors from the private sector with experience in land administration. The CVI process involved having experts rate the consensus results obtained on a 1–4 scale. The CVI formula is as follows:

$$CVI = \frac{Number\ of\ experts\ rating\ item\ as\ relevant}{Total\ number\ of\ experts} \quad (1)$$

The four-point scale used represented the following values and interpretations: 1 – not relevant, 2 – somewhat relevant, 3 – quite relevant, and 4 – highly relevant. The validation results of the Delphi study were dichotomized, whereby scores of 1 and 2 were converted to "irrelevant" (0), and scores 3 and 4 to "relevant" (1). The objective of the process was to determine the proportion of items rated as either relevant "1" (3 or 4) or irrelevant "0" (1 or 2). Responses that obtained averaged sums of these scores that were greater than or equal to 0.8 were considered acceptable.

Overall, the Delphi method was beneficial to this study as it was successful in seeking and establishing consensus from the diverse experts in this study. For example, it managed to provide a platform where participants were able to reconsider their views, considering the contributions of others, which provided space for an element of reflection usually missing from studies based on single interviews or focus groups. Nonetheless, this flexibility to allow participants to alter their responses can also be a double-edged sword, as it can introduce bias with them altering their responses to comply with the majority view – the bandwagon effect [49].

In instances where opinions differed, the facilitator analyzed the range of responses and presented the information back to the participants in subsequent rounds. The objective of the feedback was to help participants appreciate how their views compared to others, thus encouraging them to refine their opinions based on the collective expertise. This process iteratively narrows the range of opinions until a consensus or a high level of agreement is reached. As outlined earlier, this study answers the question of how and where geospatial information can contribute to achieving SDGs 9 and 11 through proper monitoring and progress reporting of land administration issues in a developing country setup.

4.7. Detailed Description of How the Geospatial Framework Was Developed

The first step in developing the geospatial framework was to establish what it was intended for. As per Objective 2 of this study, it was developed for sustainable land administration in low-income countries. This includes improved land tenure security, proper support for land use planning and development control, and enabling efficient land registration and cadastre. A review of the existing land administration system was then conducted for a baseline assessment and understanding of

the current system to identify gaps, overlaps, and inefficiencies. The Delphi method provided valuable insights into the current issues, which further facilitated the development of framework components. In addition, the method helped in exposing existing institutional arrangements between organizations that deal with land issues and in identifying key stakeholders within the country, which included national mapping agencies, district land boards, district councils, planning authorities, private survey companies and academic institutions.

Other steps engaged in the development of the framework from the Delphi study included:

1. Defining clear roles, responsibilities, and a coordination mechanism to ensure collaboration and ease of data sharing with other stakeholders.
2. efining fundamental geospatial datasets for land administration, such as cadastral land parcels, land use data, administrative boundaries, infrastructure (roads and utilities), and topography.
3. Establishing data standards to facilitate effective data sharing between different institutions, where the framework is able to define data standards, establish metadata standards, data exchange formats, and coordinate reference systems.
4. Specifying the technical architecture of the framework, which considers the spatial databases, GIS platforms, and web-based portals.
5. Ensuring that the framework can support the main functions of land administration, such as land tenure registration, land value determination, and land use and land development parameters.
6. Establishing the need to develop policies and legal support, which include national geospatial policies, geospatial data sharing agreements, and privacy and data protection regulations.
7. Determining the need for capacity building and skills development since human capacity is important for implementing the framework.
8. Supporting consideration for implementation strategies, which can be through pilot studies and proper monitoring and evaluation.

Proper mechanisms for feedback can help ensure the framework evolves with technological and institutional changes.

5. Results and Analysis

As mentioned earlier, the geospatial framework proposed in this study is consistent with the directions set out by FIG and the Sustainable Development Goals. It is a result of implementing the methods described in the methodology section in terms of the review of existing literature and the insights provided by the two expert panel groups. A mixed-methods approach was used to analyze the results obtained from the expert panel groups. The approach proved valuable, as strengths from both

qualitative and quantitative methods were satisfactorily integrated to produce information beneficial to the study. To maintain rigor in this study, a response rate of 70% or more per round was deemed successful, as depicted in Table 1.

Table 1. Delphi rounds and response rates for the study

Study group	Round	Response rate [%]	Notes
Expert Panel 1 (16 participants)	Round 1	93.8	15 out of 16 participants responded
	Round 2	81.3	13 out of 16 participants responded
	Round 3	75.0	12 out of 16 participants responded
Expert Panel 2 (13 participants)	Round 1	92.3	12 out of 13 participants responded
	Round 2	84.6	11 out of 13 participants responded
	Round 3	76.9	10 out of 13 participants responded

The results of the study provide an understanding of the perceptions of the experts regarding the status of land administration in the country and its efforts toward sustainability. A high proportion (86%) of Expert Panel 1 believe that current land administration initiatives at land boards could be greatly improved by a geospatial framework that clearly outlines how geospatial data can effectively be integrated into daily administration functions (Table 2).

Table 2. Expert Panel 1, round 3 consensus results

Number	Question	Consensus [%]
1	Do you believe that current land administration initiatives at land boards can be greatly improved by a geospatial framework to effectively integrate geospatial data into daily administration functions?	86
2	Do you desire a well-informed, capacitated, and proper implementation of the geospatial framework?	83
3	Based on your experience in the profession, is it important to include lower management in the decision-making at the land boards?	74
4	According to your knowledge, is it necessary to develop indicators to assess the achievement of goals and objectives set out to achieve sustainable land administration?	69
5	Do you think it is important to embrace and utilize new technologies to improve current work processes?	65

To measure the respondents' attitudes toward parameters identified from the literature review, a five-point Likert scale (strongly agree, agree, neutral, disagree, and strongly disagree) was used. Figure 1 shows responses from one parameter that gauges their agreements or disagreements toward establishing clear goals and objectives for sustainability: a large proportion of respondents (69%) strongly agreed, followed by agree (25%) and lastly neutral (6%). Interestingly, the other scale measures (strongly disagree and disagree) received no votes at all. Such a response demonstrates that a majority of participants are aware of the significance of setting clear goals and objectives whenever sustainability in LASs is desired.

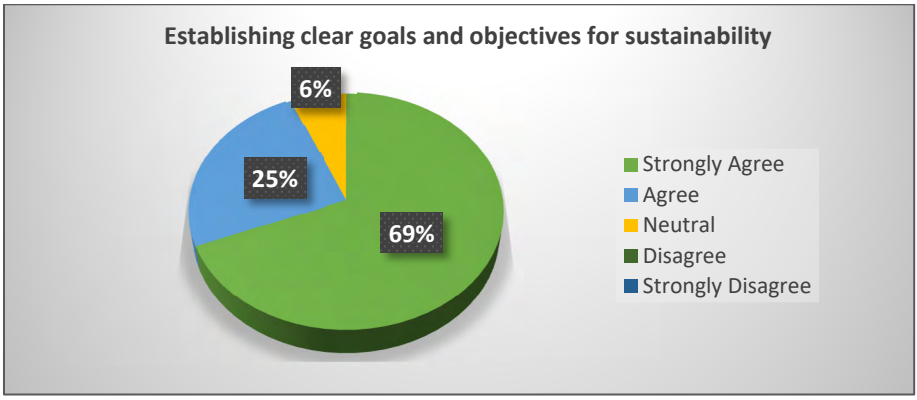


Fig. 1. Participants' responses toward establishing clear goals and objectives for sustainability

A large proportion of respondents (77%) in Expert Panel 2 stressed their unhappiness about the benefits derived from the current state of LASs in the study area (Table 3). Their concerns were that the current systems and procedures were outdated and did not meet most societal needs in terms of social gains, economic empowerment, and environmental protection of land and its resources. Furthermore, they suggested practices that could improve service delivery at land boards that could lead to sustainable land administration. Their suggestions included:

- recognition and respect for indigenous intellectual property rights;
- acceptance and implementation of free, prior, and informed consent in land issues;
- increased return on investment through improved management, use and reuse of geospatial data;
- reduced duplication of effort in the acquisition, management, and dissemination of geospatial data;
- improved administration and management of the environment and land resources;
- reduced environmental degradation and resource wastage.

Most participants in both groups (83% in Expert Panel 1) and (71% in Expert Panel 2) expressed their desire for a well-informed, capacitated, and proper implementation of the geospatial framework. Their frustrations were based on the notion that previous experiences with similar implementations had not provided any tangible benefits to improve the current ineffective land administration (LA) processes.

Table 3. Expert Panel 2, round 3 consensus results

Number	Question	Consensus [%]
1	To what extent are you satisfied with the benefits derived from the current state of LAS in the study area?	77
2	Do you believe that current land administration initiatives at land boards can be greatly improved by a geospatial framework to effectively integrate geospatial data into daily administration functions?	87
3	Do you desire a well-informed, capacitated, and proper implementation of the geospatial framework?	71
4	Do you think it is important for all employees, even those in lower management, to actively participate in skills and capacity-building toward achieving sustainability in land administration?	68
5	According to your knowledge, is it necessary to develop indicators and checklists to assess the achievement of goals and objectives set out to achieve sustainable land administration?	81
6	Do you think the adoption of geospatial standards and the use of new technologies, both hardware and software, can enhance efforts toward sustainability in administering land in rural areas?	85

Responses from both panels were similar and aimed at the same goal of providing insights toward developing a geospatial framework proposed in this study. Nonetheless, they provided varying perspectives from different angles – top-down (management) and bottom-up (personnel).

5.1. A Geospatial Framework to Support Land Administration Systems for Sustainable Development

An appropriate geospatial framework ensures effective coordination and proper implementation of the SDGs. Through this framework, a roadmap for SDGs in collaboration with geomatics can be designed to guide the implementation of the goals and indicators at both the national and local levels. The geospatial framework proposed in this study is presented in Figure 2.

It provides an understanding that implementing SDGs targeted at land issues, measuring and monitoring their progress, requires inclusive top-down and bottom-up approaches [55]. It does not claim to address all issues regarding sustainable development in land administration in developing countries. Rather, it highlights

important linkages between land board management and personnel better, to articulate the sustainable administration of land in rural areas. The framework has adopted the semi-hybrid model introduced by Budhathoki [56], where junior land board personnel are executors of the initiative at the operational level, and senior staff represent implementers and team leaders at the managerial level.

The framework consists of two sections: A and B.

Section A comprises ten stages, with half belonging to a top-down approach and the other half to a bottom-up approach. These stages are outcomes of both the interviews and literature as key components necessary for an effective geospatial framework. The top-down approach consists of:

- establishing goals and objectives for sustainability;
- providing clear definitions of assessment methods;
- developing indicators to assess goal achievement;
- developing a conducive environment;
- establishing functional systems to incentivize innovation.

The latter is made up of the following steps:

1. Execute the goals and objectives for sustainability.
2. Design checklists as assessment tools.
3. Embrace and utilize new technologies to improve current work processes.
4. Apply agreed standards, methods, and frameworks.
5. Actively participate in skills and capacity-building programs.

The top-down approach emphasizes that implementing sustainability and measuring and monitoring its progress requires a conducive environment with clear goals and objectives. This is true even though Burns et al. [57] argue that there is little discussion of what constitutes effectiveness in land administration. Proper goal setting and establishment of appropriate indicators and measures can help strengthen tenure security and improve land service delivery. Previously, it has been reported [58, 59] that SDGs do not have clear assessment methods to properly measure progress toward sustainability. Therefore, it is crucial to have proper indicators and clear evaluation elements to outline the extent to which the goals and objectives have been met.

The top-down approach of the framework has adapted four elements suggested by Steudler [14] in evaluating the performance of an organization. These elements are:

1) establishing well-defined objectives – knowing where to go by defining targets for the whole system;
2) defining clear strategies – knowing how to reach and satisfy the objectives;
3) developing outcomes and monitorable indicators – knowing how to track progress;
4) evaluating results – assessing the inputs from the processes, outcomes and indicators for future improvements.

In addition to the four elements outlined, the framework argues that there should be a conducive environment for ensuring that all activities are conducted as set out in the objectives, which can be facilitated by capacities in the personnel, technological, and administrative resources within land boards. Lastly, the top-down approach advocates for functional environments to incentivize innovation to promote creativity and problem-solving avenues.

The bottom-up approach stresses the need to embrace cultural norms and activities in the community of interest. Land administration is not just the science of measuring and recording land data; it involves the proper management and a better appreciation of cultural values and cognitive meanings of land as a whole. Modern LASs should make use of new technologies like smartphones, GNSS/GPS devices, tablets, satellite imageries, and global basemaps to solve major hardware issues that governments face regularly [60]. The adoption of geospatial standards and the use of new technologies, both hardware and software, can enhance efforts toward sustainability in administering land in rural areas. Furthermore, the bottom-up approach stresses that these technologies should embrace the FFP concept, which emphasizes the need to be flexible, participatory [61], scalable, and affordable.

For interoperability and scalability purposes, personnel at land boards should utilize agreed standards, methods, and frameworks when conducting their daily activities. In line with the strategy cascading principles outlined by Levin and Gottlieb [62], with the assistance of supervisors, supervisees are further expected to develop functional checklists and assessment tools for their specific roles and activities to ensure that they feed directly into the main goals and objectives of sustainable land administration in the organization. The colors in the proposed geospatial framework in Figure 2 represent similar themes in both approaches. For example, dark green represents community and stakeholder engagements, gray depicts policy and governance mechanisms, while light green is for assessment processes and technological systems. Lastly, light brown represents operational processes in both approaches.

Section B of the framework represents the anticipated benefits of sustainability in land administration. According to Chehrehbargh et al. [63], Steudler et al. [64], and Silva et al. [65], sustainability in land administration is measured by assessing the performance of the social, environmental, and economic principles. The assessments are usually done by assessing a program against existing best practices. The use of sustainability as a metric to properly administer land and its resources does not only involve support for land market operations. Rather, it involves broader land information structures that support economic growth, environmental management, and social stability, as highlighted in Section B of the geospatial framework.

As mentioned in Section 4.6, the Delphi study results were validated using the CVI measure. For an overall index, the average CVI obtained was 0.82, which signified that there was a high level of agreement between the seven private sector experts.

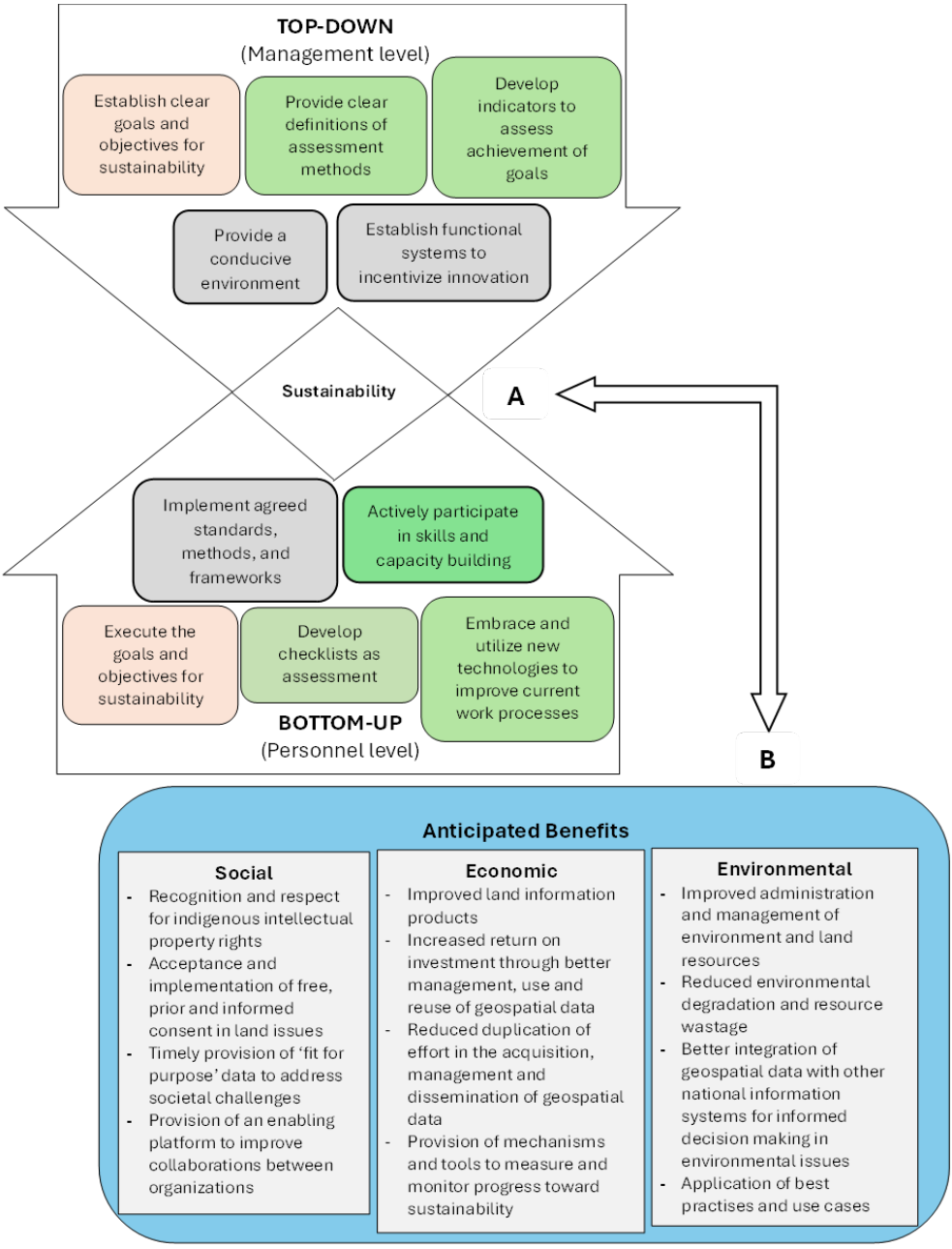


Fig. 2. Geospatial framework for sustainable land administration for developing countries

Overall, the geospatial framework stresses that sustainable development initiatives, particularly for land administration, require consistent demographic, statistical, geospatial, and earth observation data as the core information inputs, supported by informed science, robust methodologies, enabling technologies, and sound policies.

Several gaps have been identified in the review of the literature from past initiatives, such as, implementation issues of the staged approach by UN-HABITAT [19], and the inability to consider processes and relationships in the local context by the framework developed by Ho et al. [20]. The top-down and bottom-up approaches emphasized by the proposed framework aim to address the challenges outlined above. The framework requires governments to embrace transparency and democratic governance, since it facilitates two-way communication channels for the effective and efficient administration of land and its resources. In short, it provides a comprehensive overview and understanding of the complexities and interconnections of the management and personnel levels of decision-making at land boards necessary to incorporate geospatial data for sustainable land administration.

5.2. Implementation Strategies for the Geospatial Framework in Botswana

The proposed framework leverages the IGIF Implementation Guide [43] as a reference source, which provides information for developing countries to design, plan, implement, and maintain effective, transformational, and sustainable LASs. The IGIF provides reference information that governments can use to design, plan, establish, implement, and maintain integrated frameworks in their respective environments to facilitate sustainable and transformational change [66].

A review conducted in 2008 by the Auditor General in Botswana has highlighted some challenges regarding the acquisition, allocation, and recording of land rights in the country [67]. These include:

- lack of capacity to conduct efficient recording and management of land;
- lack of proper monitoring activities, such as acquisition registers and development covenant checks;
- poor service delivery resulting from a lack of a proper land information system (LIS) to integrate textual and spatial allocation information;
- lack of public education, engagement and consultation in land-related issues to create awareness and minimize conflicts.

It is believed that these challenges can be addressed by the framework for a flexible, inclusive, participatory, efficient, and effective LAS advanced in this study. In brief, the proposed framework is not aimed at modifying any specific regulations in Botswana regarding the use of geographic information in land institutions, since none exist. Rather, it aims to provide functional solutions to assist land boards in effectively and efficiently administering land properly.

According to de Zeeuw et al. [41] and Klimach [68], geospatial information is an important foundation for an effective and efficient land information system to support the administration of customary land rights, land policy frameworks, security of tenure, property rights, and sustainable development. The proposed framework is designed on the basis and insights from the Framework for Effective Land Administration (FELA) initiative, whose objective is to support global policy adherence to land administration [43]. FELA has nine pathways [66] which could guide how the framework can be implemented, monitored, and evaluated to achieve the targeted SDGs. In comparison to FELA, the proposed framework, through its two approaches, considers both provider and user communities. It stresses that if both approaches work together, countries stand to benefit more regarding the use of geospatial information for sustainable land administration. A suggestion by Siriba and Dalyot [69] is that the framework could be implemented in a complementary and accommodative approach to ensure its eventual use and acceptance by governments in official systems. For financially constrained countries, Dawidowicz et al. [70] and Moreri et al. [71], recommend a fit-for-purpose approach that advocates flexibility and adaptability to specific local needs while being affordable and efficient. The anticipation is that these strategies could reduce land-related problems through increased transparency, legitimacy, and security of tenure. The two recommendations outlined by Siriba and Dalyot [69], and Moreri et al. [71], clearly demonstrate that the proposed framework does consider implementation mechanisms in low-resource settings, which unfortunately are lacking in both the IGIF and FELA frameworks. Moreover, the existing frameworks are silent on incentivizing innovation at the local level. Nonetheless, the proposed frameworks stresses that it encourages local experts to be innovative by seeking improved practical ways of addressing land administration challenges in the societies they live in, with incentives attached to achievable solutions. Unlike existing frameworks, for example IGIF and FELA, which do not have clear policies for open data or provisions to accommodate artificial intelligence (AI) systems, the proposed framework stresses the need to embrace new technologies as they emerge for improved management and administration of land and its resources. Moreover, when further compared to the proposed framework, they are too generic regarding sustainability. For example, they do not have mechanisms for low-income countries interested in implementing their frameworks to measure and monitor progress toward sustainability, which are explicitly stated in the proposed framework. The proposed geospatial framework aims to address gaps overlooked by existing frameworks for the effective and sustainable administration of land in low-income communities.

5.3. The Geospatial Framework as an Indicator for Sustainable Land Administration

An indicator system involves a set of metrics on social and economic indicators used to track progress toward achieving sustainable land administration [14]. Social indicators in this instance include the provision of measures to quantify the

proportion of land parcels with registered titles for increased tenure security, the ability to analyze the distribution of land ownership between genders, and the provision of systems to effectively address land disputes and monitor indigenous people's rights. In contrast, economic indicators include the ability to assess the ease and transparency of land transactions and the capacity to analyze trends in land prices over time [42]. In addition, indicator systems must be tailored to specific conditions and priorities for a particular region and should ensure that there is easy access to reliable data and develop systems that facilitate regular data collection, analysis, and reporting to relevant stakeholders. Lastly, an indicator system should involve all stakeholders in all the design and implementation stages for buy-in and acceptance.

The proposed framework advocates for the indicators advanced here to ensure sustainability in administering land in the context of developing countries. It stresses that to improve the efficiency and effectiveness of LASs, its processes must be evaluated. As lamented by Kaplan and Norton [72], what cannot be measured cannot be managed sufficiently. The outlined indicators can help developing countries effectively measure progress toward achieving effective and sustainable LASs. Moreover, decision-makers can utilize the indicators to evaluate the performance of LASs to ensure that they guarantee secure land tenure and ownership while promoting sustainable development. Nonetheless, this study acknowledges that the identified indicators do not encompass all aspects identified in other global initiatives, as the focus is on developing countries. As a result of this limitation, future studies should explore additional indicators that can be incorporated into the performance assessment of LASs such that they align with broader global goals and priorities.

6. Discussion

The success of sustainable LASs lies in their ability to manage and administer land effectively, efficiently, and at an affordable cost. It is not determined by complex legal frameworks or sophisticated technological solutions. Rather, it depends on the adoption of appropriate land laws, the establishment of functional institutions and processes, and the use of appropriate technologies designed for the specific needs of a country. For issues relating to land governance and administration, it has been realized that developing countries tend to overlook the spatial dimensions in favor of social dimensions [27]. These countries fail to understand that to successfully administer land in order to reap its rewards economically and socially for sustainable development, it is essential to properly manage and store geospatial information. For example, the accurate and timely management of geospatial data for land administration can enable greater recognition of tenure security and reduction in land conflicts [27]. According to Du [73], countries such as China use geospatial tools to guard against private plot encroachments on agricultural land, such that they do not invade them illegally.

According to Williamson et al. [74], LASs need to shift from the focus on just technical tools and concentrate on land governance and capacity building and reflect on a broad cognitive understanding of the role that land plays in the society and economy at large. This statement is in line with the framework proposed in this study, that it is important to capacitate both sides of the civil community (bottom-up and top-down) if a functional and sustainable LAS is to be achieved.

The geospatial framework proposed in this study highlights key aspects necessary for land authorities to adequately administer land in line with the 2030 Agenda for Sustainable Development. Furthermore, it provides a significant and strategic contribution toward guiding developing countries like Botswana to collectively manage land and its resources using the three pillars of the SDGs: the social, environmental, and economic factors.

The geospatial framework further provides a platform in which developing countries can be empowered with evidence-based decision-making by using geospatial data as an enabler for the SDGs. The driving force of the SDGs is geospatial data that is accurate, timely, and readily available to managers, policymakers, and the public. The geospatial framework could benefit greatly from adapting the four-step method by Chen et al. [75], particularly the SDG indicators to assess and monitor the achievement of the framework components. Similarly, UN-GGIM [43] developed an Integrated Geospatial Information Framework (IGIF) that integrated place-based information with other meaningful data to solve societal and environmental problems and act as a catalyst for economic growth and opportunity. Insights from the implementation guide of the IGIF have been incorporated into the geospatial framework proposed here as a reference resource on how governments can design, plan, establish, implement, and maintain geospatial data in their establishments.

Developing countries should invest in real-time reporting systems to produce reliable datasets with at most a yearly time lag. This can be achieved through the use and adoption of technological solutions like the Internet, smartphones, remote sensing, and GIS. Such investments can strengthen the SDG initiative in terms of advocacy, real-time data management, feedback, inclusivity, and public input and buy-in. Policymakers can strategically incorporate the geospatial framework into land management and administration practices, streamlining processes and enhancing efficiency at both local and national levels. Furthermore, the framework provides a practical roadmap to leverage geospatial data to achieve SDGs, which can provide actionable and measurable strategies for policymakers and organizations to improve their land management and administration policies.

SDGs 11 and 15 cannot be achieved without good land governance in place: an operational component of land administration. Therefore, the framework proposed is an enabler for implementing and achieving these goals and their objectives. For example, SDG 11, Indicator 3.1 stresses the need for "inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement by 2030."

Moreover, the framework embraces transformative changes and collaborative approaches to properly link different datasets, which include statistical, demographic, and earth observation data, to name but a few. These datasets are core information system inputs to better measure and monitor progress toward sustainability in land administration. Expert Panel 1 argues that implementers must establish conducive environments with sound policies, enabling technologies, and robust methodological approaches to foster sustainability in administering land and its resources.

Despite the three broad categories of the SDGs (social, economic, and environmental sustainability), their success depends on a fourth condition: good governance at all levels of local, national, regional, and global setup [76]. Sustainability requires good leadership and responsibility within the public sector, private sector, and civil society. In contrast to developing countries, the private sector in Western countries is the main productive sector and an innovator of advanced technologies and management systems crucial for the success of the SDGs. Therefore, governments in developing countries should facilitate conducive environments for the private sector to support the SDGs in practical and measurable ways in their production processes, policies, and engagement with stakeholders.

Land authorities in developing countries further need to acknowledge that creating sustainable built environments requires a different approach from that adopted by the developed world. For example, the problems and their scale, priorities, capacities of local industries, and skillsets in developing countries are often a fraction of those in developed countries. Other issues to be cognizant of are the cultural differences between developed and developing countries, which can greatly impact the understanding and proper implementation of sustainable development initiatives.

The overall belief of Expert Panel 2 is that land boards need a transformational change in terms of thought processes to effectively measure and monitor progress toward achieving the SDGs. Moreover, the group acknowledges that leveraging new and existing sources of data can improve current processes for properly administering land and its resources at land boards, which is crucial for sustainability. Even though most developed countries have an abundance of data and connectivity to technology, a digital divide still exists due to the complexities and lack of understanding of how they could easily be transferred to the technology- and data-poor developing countries. Therefore, the framework provides a better understanding of how developing countries can incorporate geospatial information into their sustainable development agenda to better administer land for the benefit of local communities and the environment.

This study has adequately addressed its research objectives to demonstrate how a sustainable land administration initiative could be achieved in a developing country setup. A review of the literature on past and similar initiatives has provided the study with critical gaps to focus on for designing a functional conceptual framework to administer land sustainably in developing countries. Further research and scrutiny of current land administration activities in the study area have provided an

overview and indication that sustainable land administration is indeed necessary in the country. Moreover, it has provided insights that there was a need for a framework that could assist local authorities, both management and personnel, to address land administration challenges in their local environments. A CVI measure was then used to validate the proposed geospatial framework through interviewing experts from the private sector within the study area.

7. Conclusions

Developing countries are vulnerable to the negative impacts of globalization, climate change, and other uncontrollable conditions. Therefore, this study has answered the question of how and where geospatial information can contribute to achieving SDGs through proper monitoring and progress reporting of land administration issues.

The outcomes of this study represent a valuable contribution for the following reasons:

- They add to existing studies by proposing a geospatial framework for sound and sustainable LASs that can help local communities to improve security of tenure in a manner that considers both the implicit and explicit knowledge of relevant experts.
- They provide additional new factors for effective land administration in comparison with existing studies, given the use of several experts from multiple strategic levels of land administration and management across several government ministries.

These outcomes have implications for practice, as they provide an in-depth understanding of the applicability of geospatial information in LASs that integrate the empirical evidence of relevant experts in the context of validating the proposed novel geospatial framework.

Unlike the IGIF and FELA, which are generic in nature, the proposed geospatial framework specifies how developing countries can actively involve land administrators to properly engage stakeholders, effectively utilize geospatial technologies, and build transparent processes to promote sustainable land management and administration. Furthermore, they do not provide tailored capacity-building initiatives and enabling frameworks to advance the effective integration of geospatial information, which are advocated for in this study. The methodological use of Delphi in this study adds novelty compared to prior conceptual frameworks. Moreover, it provides a framework applicable beyond Botswana. In particular, components of the framework that are universally applicable to other countries include the development of indicators to assess the achievement of goals, the provision of clear assessment methods, and the embracing of new technologies like AI to improve current

processes. In contrast, some components of the framework are context-dependent, such as the execution of goals and objectives for sustainability and the development of functional systems to incentivize innovation. Low-income countries suffer from low employee morale due to financial constraints and disparities in pay structures, which subsequently results in very few innovations, if any.

Nonetheless, the framework proposed here can facilitate support for adequate capture, analysis, and dissemination of location-based information to implement sustainable development policies. Moreover, it provides building blocks for the country to link global policy demands to local implementation needs to facilitate the development of specific national information and data flow frameworks. Nonetheless, achieving this outcome requires collective leadership and a better understanding of the significance and potential benefits of the proposed framework to all stakeholders involved.

The increase in the recognition of geospatial data and technology as being fundamental to policymaking and monitoring can help address societal pressures of growing populations and limited resources with timely and comprehensive land information for evidence-based decision-making. The implementation and adherence to the framework principles can lead to consistent geospatial data production, improved data management methodologies, and buy-in of all stakeholders for an open, responsive, accountable, and effective land administration. The framework advocates for the regular and consistent tracking of the goals, targets, and indicators of the SDGs against localized goals and objectives for sustainability set by different countries.

Other developing countries can benefit from the outcomes presented in this study, subject to geographic context. Future work will include applying the proposed framework in practice to test its functionality and potential to be scaled to other parts of the country.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

CRediT Author Contribution

K.M.: methodology, conceptualization, software, validation, analysis, investigation, resources, data curation, writing – original draft preparation, visualization.

M.S.: methodology, validation, conceptualization.

L.M.: conceptualization, supervision, review, and editing.

L.S.: validation, review, and editing.

Declaration of Competing Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

No data.

Use of AI-Assisted Technologies

During the preparation of this manuscript, the authors used AI-assisted tools, specifically Grammarly, to improve the clarity, grammar, and overall language quality of the English text. This tool was not used to generate scientific content, perform data analysis, or interpret results. All scientific content and interpretations were solely developed and verified by the authors.

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