Compilation Report on the Integration of Terrestrial and Maritime Domains

United Nations Committee of Experts on Global Geospatial Information Management

Jointly developed by the Expert Group on Land Administration and Management (EG-LAM) and the Working Group on Marine Geospatial Information (WG-MGI)

Table of Contents

Contents

Acknowledgements

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Foreword

The United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM), at its thirteenth session, noted the intended considerations on the integration of terrestrial, maritime, built and cadastral domains and encouraged the Expert Group on Land Administration and Management (EG-LAM) and Working Group on Marine Geospatial Information (WG-MGI) to collaborate with relevant international organizations as well as functional groups of the Committee of Experts.

To advance the work set forth by the Committee of Experts, this compilation report was developed by both the EG-LAM and WG-MGI functional groups to strengthen the integration of domains into the global geospatial information ecosystem. It aims to provide Member States with a reference for integrating the terrestrial and maritime domain by leveraging the United Nations Integrated Geospatial Information Framework (UN-IGIF) to enhance the availability and accessibility of integrated geospatial information for the betterment of society, environment, and economy.

This document focuses on the integration of terrestrial and maritime domains. This scope was intentionally selected by the co-Chairs of both groups to enable a targeted and scalable approach, laying the groundwork for broader domain integration efforts over time. These two domains converge in coastal and transitional areas— spaces increasingly vulnerable to climate change and central to resilience planning, especially for small island and coastal states.

To inform this work, a questionnaire was developed by both functional groups and circulated by the UN-GGIM Secretariat to Member States and key stakeholders, seeking input on use cases in domain integration and perspectives on how the UN-IGIF can support national efforts to advance integrated geospatial information management. A total of 47 responses from 40 Member States were received, providing valuable insights that have informed the development of this compilation report.

Drawing from the contributions of Member States across the terrestrial and maritime domains, this report serves as an initial effort to raise awareness about the importance of terrestrial-maritime integration and catalyze broader discussions within the geospatial community. It examines key definitions and benefits of domain integration, before analyzing implementation approaches through the UN-IGIF strategic pathways. The report concludes with strategic insights and recommendations for the Committee of Experts' consideration. The report aims to serve as a foundation to spark conversations and inspire innovative ideas about integration approaches, encouraging Member States to exchange experiences and recommendations that can be incorporated into their respective country action plans. In doing so, it contributes to bridging geospatial gaps across domains and regions, reinforcing shared progress under the UN-GGIM vision and the broader UN principle of *leaving no one behind*.

1.0 Introduction

At its second session in August 2012, the Committee of Experts on Global Geospatial Information Management (UN-GGIM) noted the importance of the world's seas, oceans and coastal waters as a significant global resource that was neither well mapped, nor integrated with land geospatial information. The Committee also noted the disjoint between terrestrial and marine geospatial data, restricted access and fragmented collaboration between land and marine geospatial agencies (United Nations, 2013)

This led to the development of the report of the Secretariat on "Critical issues relating to the integration of land and marine geospatial information", E/C.20/2013/10/Add.1, that provides an overview of issues faced and recommendations to facilitate the integration of land and marine geospatial information. Notably, it describes:

> "… *the need for governments to place greater emphasis on the mapping of the world's seas, oceans and coastal waters; the lack of harmonized land and marine geospatial data access and policies, and the challenges of integrating land and marine geospatial information; and the common existence of non-matching geospatial data sets (topographic maps and nautical charts), resulting from differing vertical datums, symbologies and generalization issues*".

Today, these challenges and imperatives remain relevant, continuing to guide Member States' efforts and highlighting crucial areas for collaboration in integrating land and marine geospatial information.

The need for action has never been more urgent. As climate change accelerates the melting of polar ice caps, the ability to accurately monitor rising sea levels is now of paramount concern. The availability of high-quality, integrated datasets empowers policymakers to implement forward-thinking coastal protection measures and develop long-term resilience strategies. This is especially crucial for low-lying nations or Small Island Developing States (SIDS) that remain particularly vulnerable to climate change's exacerbation of rising sea levels. These datasets also facilitate more accurate climate modeling and risk assessment, enabling communities to better prepare for a range of climate change impacts.

Densely populated coastal cities face compounding pressures from rapid urban development and climate change impacts, necessitating integrated approaches towards coastal zone management. As reported by Mississippi State University (2024), recent estimates as of 2018 show that approximately 40-50% of the global population live within 100 kilometers from the coast. The seamless integration of geospatial data across terrestrial and maritime domains is therefore crucial in enabling effective coastal management.

Integrated geospatial data is critical in spaces where terrestrial and maritime domains intersect. Figure 1 from the UN-IGIF Hydro (Part 2) illustrates the range of institutional

actors and stakeholders spanning the land-sea continuum, demonstrating the necessity for integrated geospatial data management and adoption to achieve effective domain integration. Taking the example of sea level change and its impacts – while sea level measurements may typically be monitored by “marine agencies”, the impacts of sea level change would be experienced by stakeholders on land, and their corresponding “land agencies”. This can be seen, for example, in storm surges from adverse weather conditions leading to flooding events inland. Predicting and monitoring storm search events, up to the activation of contingency plans and emergency response, requires close coordination, information sharing, and collaboration by actors across land and sea.

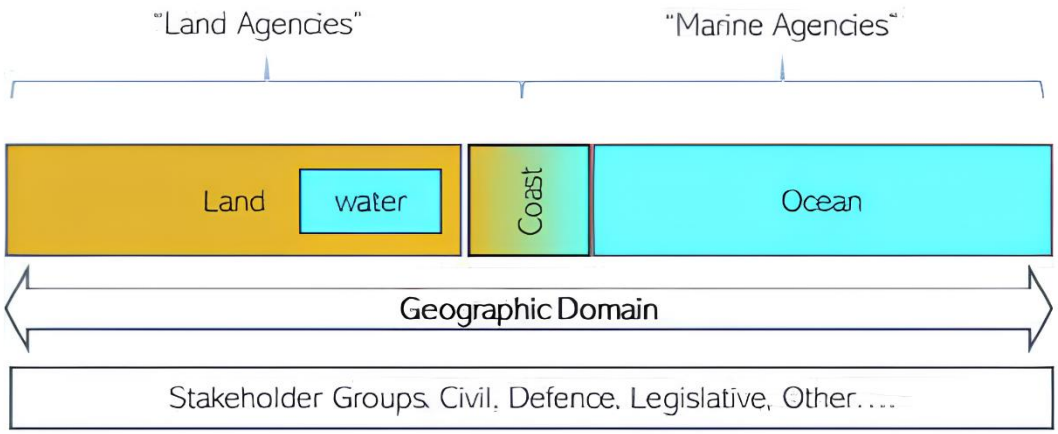

Figure 1. Potential institutional arrangements in the hydro domain.
Source: extracted from UN-IGIF-Hydro Part 2, pg 7, 2023.

From this brief example, it is evident that the integration of domains is not just about linking data—it requires holistic approaches aligned to specific needs and use-cases. As Member States confront intensifying challenges at the interface of land and sea, the potential role of integrated geospatial data becomes increasingly pertinent, and the importance of coordinated governance and stakeholder collaboration grows. These perspectives demonstrate that domain integration is not simply a technical feat, but rather a complex undertaking encompassing governance, institutional, and human capital dimensions. The report explores this theme throughout the rest of the paper.

1.1 Definitions and Frameworks

Defining and delineating the scope for the integration of terrestrial and maritime data is crucial for the success of this endeavor. As stakeholders focus on their respective responsibilities, a unified definition and scope is fundamental in ensuring that parties involved are on the same page.

While varying definitions are prevalent in various fields, this document adopts the following definitions (Table 1) in alignment with the International Organization for Standardization (ISO)[1].

Term	ISO Definitions
Domain	A defined area of knowledge or activity in geospatial data, such as land, marine, or cadastral information.
Integration	The process of combining different types of geospatial data (e.g., topographic, cadastral) to create a unified, usable dataset.
Terrestrial Domain	Refers to land-based geospatial data, including topography, built environments, land use, and environmental features.
Maritime Domain	Refers to oceanic geospatial data, including the spatial representation of water bodies, coastlines, marine ecosystems, and navigational features.

Table 1: ISO Definitions adopted in this compilation report

The integration of the terrestrial and maritime domains extends far beyond data standardization and integration. The operationalization and implementation of integrated data requires a range of efforts across institutional and legal considerations, infrastructure and technology, and stakeholder collaboration and communication. To guide this intricate process, frameworks such as the UN-IGIF and UN-IGIF-Hydro are important resources that can offer guidance to tackle the challenges associated with domain integration[2].

The UN-IGIF was established in 2018 and serves as a cornerstone for modern geospatial information management. With the aim of translating high-level concepts into actions for implementation, the UN-IGIF leverages seven underpinning principles, eight goals, and nine strategic paths. The UN-IGIF strategic pathways aim to empower nations to develop robust geospatial infrastructure aligned with their development priorities and the UN Sustainable Development Goals (SDGs).

The UN-IGIF is anchored by three areas – Governance, Technology, and People. Visualized as an interconnected puzzle comprising of nine pieces that represent the nine strategic pathways, each area has three corresponding strategic pathways that are horizontally adjacent to each other in this puzzle.

[1] Extracted from ISO 19152:1:2024, ISO 19101-1:2014, ISO 19115-1:2014, ISO 19107:2019, and ISO 19115-2:2019.

[2] For more detailed information on each of the strategic pathways, readers may refer to existing literature such as the UN-IGIF, UN-IGIF-Hydro, and the UN FELA.

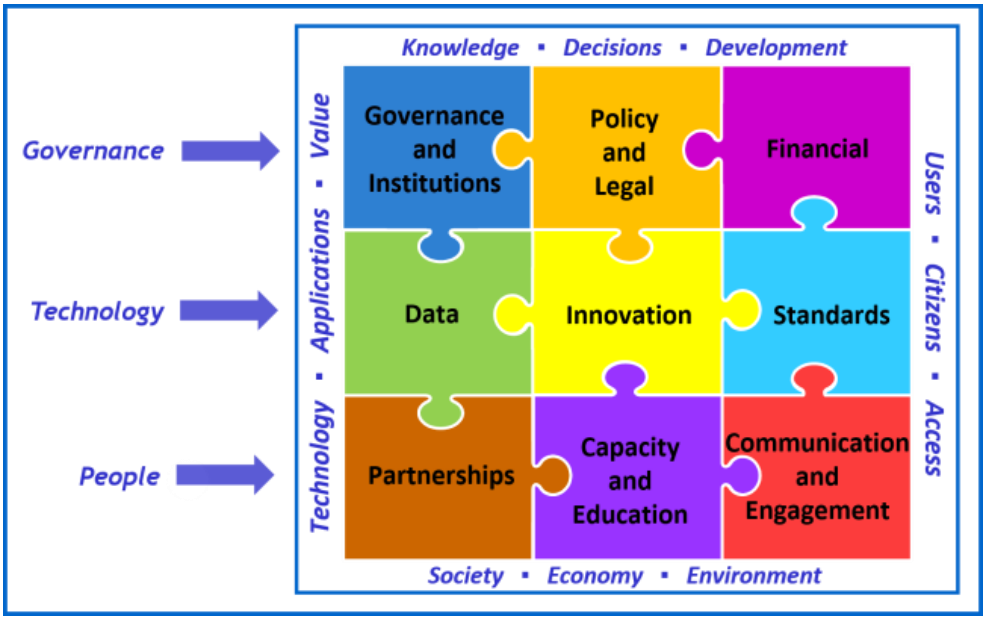

Figure 2: Strategic pathways of the UN-IGIF (Source: UNGGIM – IGIF Overview, 2025)

The integration of terrestrial and maritime domains is still in its infancy stage. The UN-IGIF will be adopted as a framework to deconstruct the complexities of domain integration.

1.2 Methodology

A questionnaire was disseminated to members of the EG-LAM, WG-MGI, and other relevant committees to gather insights on terrestrial-maritime integration practices. The survey period spanned from November 2024 to March 2025, with responses received from member states across different regions, as detailed in Table 2 and Figure 3. The questionnaire can be found in Appendix A.

Region	Responses received
Africa	Cameroon, Côte d'Ivoire, Nigeria
Americas	Canada, Brazil, Chile, Colombia, Costa Rica, Cuba, Ecuador, El Salvador, Mexico, Peru, Uruguay, United States of America, Venezuela
Arab States	Kingdom of Saudi Arabia
Asia Pacific	Bhutan, Fiji, Indonesia, Iran, Kyrgyzstan, Mongolia, Nepal, Papua New Guinea, Republic of Korea, Singapore
Europe	Cyprus, Finland, France, Germany, Greece, Italy, Kingdom of the Netherlands, Latvia, Lithuania, Montenegro, Spain, Sweden, Ukraine

Table 2: Responses categorized by region

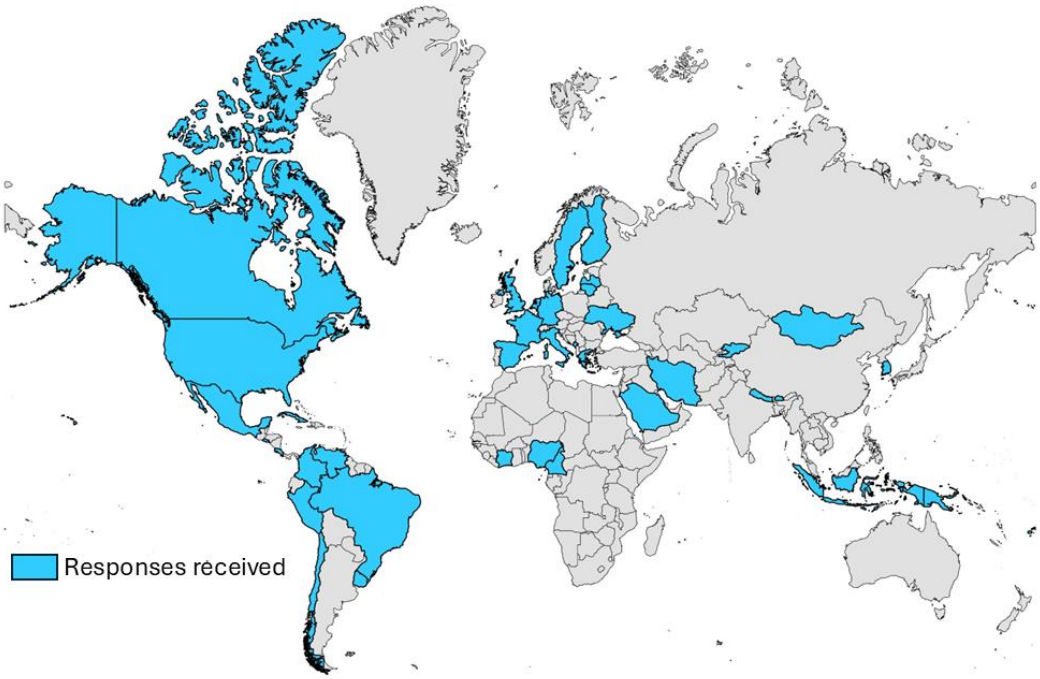

Figure 3: Member States that responded to the questionnaire.

A total of 47 responses from 40 Member States were received, noting that some Member States submitted more than one response through various agencies. Multiple submissions from a single Member State were consolidated into one response, reflecting that state's overall position. Seven survey responses were received in languages other than English. To maintain accuracy and prevent potential misinterpretation, these responses have been excluded from the analysis, as professional translation services were not available. Nevertheless, we would like to thank these Member States for their contribution. Therefore, the aggregated statistics mentioned in subsequent sections of this report only account for the remaining 33 Member State responses that were in English or translated into English.

The questionnaire was structured in three distinct sections to capture both theoretical understanding and practical implementation aspects. The first section (Question 1) seeks to establish respondents' conceptual understanding of domain integration within geospatial information management. The second section (Question 2) explores potential use cases, specifically examining the benefits of terrestrial-maritime integration in supporting national development priorities and contributing to the SDGs. In analyzing these two sections, responses were synthesized, and common themes were identified across countries to understand prevalent perspectives and approaches.

The final section leverages the UN-IGIF strategic pathways framework to identify critical success factors and implementation challenges. Respondents were asked to identify both their top three pathways critical for successful integration (Question 3)

and the three pathways where they most needed additional support (Question 4). To quantify these responses, each mention of a strategic pathway was assigned a score of 1, creating a matrix of respondents versus strategic pathways. Given the cross-cutting nature of the strategic pathways, the analysis was further categorized according to the UN-IGIF's three core areas – Governance (strategic pathway 1-3), Technology (strategic pathway 4-6), and People (strategic pathway 7-9) – to enable more meaningful insights. This structured approach illuminates both success factors and implementation gaps across the strategic pathways while revealing broader patterns within each core area.

2.0 Summary of Responses from Questionnaire

This section provides an overview of the responses gathered from the questionnaire.

2.1 What is Terrestrial and Maritime integration?

The integration of terrestrial and maritime geospatial information remains an emerging and evolving field within geospatial information management. Analysis of the questionnaire responses from Member States assessed alongside existing literature developed under the UN-GGIM framework reveals a range of perspectives on how they interpret and apply the concept of domain integration, reinforcing the multidimensional nature of this topic.

A wide variety of themes were provided in response to the question, “What is domain integration?” Some common themes respondents highlighted were use-cases that drive integration such as coastal adaptation, marine spatial planning, or infrastructure development. Others highlighted technical enablers, including the establishment of common reference frames and the alignment of spatial data infrastructure across domains. A third group drew on national experiences, illustrating how domain integration is being operationalized in context-specific ways, shaped by institutional mandates, geographic conditions, and governance structures.

Across these responses, several recurring themes emerged. At its core, domain integration can be understood as the harmonized collection, management, and application of geospatial data across land and sea domains, grounded in open-source principles and aligned with FAIR data standards (Findability, Accessibility, Interoperability, and Reusability). This could enable the creation of a coherent spatial data ecosystem in which information across land, marine, cadastral, and built environments is interoperable across processes, platforms, and agencies.

Respondents also pointed to the overarching purpose of domain integration, namely, to improve decision-making, resource planning, and sustainable development across traditionally independent terrestrial and maritime sectors. Successful implementation, however, often hinges on clarity around the intended use-cases and the specific outcomes sought by the integration effort.

Figure 1 from the UN-IGIF Hydro (Part 2), first introduced in section 1.0, illustrates the range of institutional actors and stakeholders spanning the land-sea continuum, and the corresponding implications for integrated geospatial data management and adoption. In this context, terrestrial and maritime domains often align more closely with their respective sectoral authorities than with geospatial domains per se. As such, approaching integration through the lens of existing governance and institutional frameworks may yield different outcomes compared to an approach that focuses primarily on the technical aspects of terrestrial-maritime geospatial data integration.

From these responses, this section highlights that there is not yet a universally agreed definition of “domain integration” under the UN-GGIM framework. This is largely due to the varied priorities and pathways that different countries pursue in response to their unique national circumstances, use-cases and requirements. To facilitate deeper cooperation and consistent progress in this area, there is value in establishing a shared conceptual foundation of what domain integration can entail.

2.2 Benefits from the Integration of Terrestrial and Maritime Domains

This section discusses the potential benefits that can be and have been realized from the integration of data across domains and highlights responses from Member States that have expounded on the benefits that data integration could bring to them. Readers may note that the key benefits outlined in this guide are not exhaustive, and that benefits might vary depending on specific circumstances, contexts and localities.

Coastal Protection and Management

Coastal protection and management are innately tied to *SDG 11 (Sustainable Cities and Communities)*, *SDG 14 (Life Below Water),* and *SDG 15 (Life on Land)*. This connection between the terrestrial and maritime domain is well understood by questionnaire respondents, who identified enhanced coastal protection and management as a key benefit of domain integration, citing it in 39.4% of their responses. The integration and interoperability of data could enhance predictive modeling capabilities, allowing for improved modeling and simulations of various coastal management scenarios. This enhances the resilience of vulnerable coastal communities towards coastal hazards that threaten life and property. Integrated data can also improve risk management and climate mitigation strategies, particularly in coastal areas prone to erosion that can be identified and managed earlier. The integration of geospatial information also enables precise monitoring of marine and terrestrial protected areas. Respondents have also indicated that the integration of terrestrial and maritime domains into a unified reference frame will allow for precise monitoring of protected areas and support the sustainable management of fisheries and land management practices near coastal regions

Mexico, for instance, highlights how their integration efforts support *SDG 14* and *SDG 15* and serves as a crucial enabler for sustainable development using unified geospatial data. The USA's use of a common geodetic reference framework also helps address issues relating to datum incompatibilities in the tidal zone, allowing for better assessment of their coastline ecosystems and habitats. This approach is crucial for coastal communities that are dependent on ecosystem services as the current management of land-based ecosystem service is inadequate in ensuring equitable distribution of resources.

By enabling data integration in a standardized approach, cooperation and monitoring in coastal protection and management can also be enhanced through interoperable data.

Disaster Management and Preparedness

Closely coupled with coastal management, efforts in disaster management and preparedness, which align with *SDGs 9 (Industry, Innovation and Infrastructure), 11 (Sustainable Cities and Communities), 13 (Climate Action), 14 (Life Below Water)*, and *15 (Life on Land)*, are widely expected to benefit from the integration of terrestrial and maritime domains. By providing an authoritative and reliable dataset of vulnerable areas for decision-making in times of crisis, disaster relief and mitigation efforts can be strengthened, demonstrating the importance of accurate, interoperable data that is easily accessible by various agencies. For example, the creation of digital twins of vulnerable regions, enabled by integrated terrestrial and maritime data, may improve disaster response for the coastal region in response to natural hazards such as tsunamis and storm surges.

The Republic of Korea, for instance, has highlighted the importance of investing in integration for the purpose of minimizing disaster risk through the creation of digital twins that underpin its disaster response efforts. Fiji has also emphasized the importance of data integration in its disaster management efforts, outlining enhanced preparedness, response, and awareness of communities that are exposed to these risks. By seeking to integrate data from both domains, Nigeria also hopes to enhance near real-time monitoring efforts to improve its disaster response through the adoption of satellite and drone-based surveillance, driving informed decision-making.

Overall, respondents strongly recognize the value of domain integration for disaster management and preparedness, with 33.3% identifying this as a key benefit in their responses. The consensus among respondents suggests that harmonizing terrestrial and maritime data could significantly strengthen disaster management capabilities, potentially reducing the impact of disasters on human life and property.

Sea-Level Rise Monitoring

In support of *SDG 11 (Sustainable Cities and Communities)*, *SDG 13 (Climate Action) and SDG 15 (Life on Land),* the monitoring of sea-level rise has seen significant advancement through domain integration. Accurate monitoring is crucial in risk

assessment for vulnerable communities situated along the world's coastlines. Varying approaches to data capture, processing, and management across terrestrial and maritime domains between national authorities may result in varying methodologies and datums being established. As agencies seek to unify the two domains, legacy issues may impede progress, including the need to calibrate historical data and the impact of datum changes to existing operations.

For example, a critical factor in sea level projections is vertical land motion. Vertical land motion significantly impacts sea level projections, with land subsidence accelerating relative sea level rise and increasing flood risks. Understanding this land movement is therefore as crucial as tracking sea level changes themselves. By integrating terrestrial and maritime domains to monitor vertical sea level rise, stakeholders are more able to accurately monitor, predict and model long term sea-level rise and the impacts of storm surges.

The USA has highlighted how the difficulties of tracking changes in tidal zones and sea-level rise can be mitigated using a common geodetic reference framework for better holistic assessment of these regions. Along the same vein, the Republic of Korea is also experimenting with the use of digital twins for predictive modeling of sea level rise to aid their monitoring efforts. Meanwhile, Saudi Arabia also briefly cites the importance of domain integration to improve the monitoring of sea levels and currents. Singapore has also demonstrated its commitment to domain integration for sea-level rise monitoring, outlining its vulnerability as a coastal nation by investing in projects meant to monitor vertical land motion and unify reference frames across technical agencies.

Questionnaire respondents have listed sea-level rise monitoring as a primary benefit in 12.1% of survey responses, noting its supporting role in climate adaptation efforts. This use case highlights the crucial benefits that domain integration offers communities situated at the coastlines, underscoring the need to embark on unification efforts to reap these benefits.

Benefits to the Blue Economy

Supporting SDGs 8 (Decent Work and Economic Growth), 9 (Industry, Innovation and Infrastructure) and 14 (Life Below Water), the integration of terrestrial and maritime geospatial domains drives sustainable coastal development and Blue Economy growth. This integration enables risk-informed planning at the land-sea interface, with interoperable data improving modeling and decision-making for resilient infrastructure and marine resource management.

The integration of marine geospatial data has delivered significant benefits to respondents' Blue Economy initiatives. Nigeria anticipates gains in marine resource outputs and port efficiency through geospatial data-sharing. Montenegro also reports improvements in port planning and logistics through cross-sector coordination. These Marine Spatial Data Infrastructures (MSDIs) underpin sustainable spatial planning,

with benefits extending beyond national borders through enhanced maritime trade and connectivity.

Domain integration thus provides a strategic foundation for advancing the Blue Economy, supporting data-driven, inclusive, and sustainable development. Consequently, this benefit was mentioned in 18.2% of responses by respondents.

2.3 Domain Integration through the UN-IGIF

This section explores how the strategic pathways of UN-IGIF can be used to integrate both terrestrial and maritime domains. Drawing on the questionnaire responses, this section also highlights the common pitfalls and struggles that were faced by Member States in domain integration, with the aim of identifying potential action areas to address common issues and catalyze domain integration efforts.

Strategic Pathway 1: Governance and Institutions

Geospatial governance is often organized by domains, potentially creating silos across terrestrial and maritime functions. As outlined in strategic pathway 1: Governance and Institutions – Global Consultation Version (United Nations, 2019), several national institutions within the same country may oversee the management of geospatial information, with the division of responsibilities usually domain-specific (urban, forestry, cadastral, etc.) (United Nations, 2019). The inherent fragmentation means that few policies focus on cross-domain coordination, with organizational “information silos” that lead to duplicate datasets and ambiguity. Moreover, agencies may even collect the same geospatial data independently due to the lack of coordination and data sharing principles that make it difficult to “determine if geospatial information exists and/or which organization has the responsibility to provide it” (United Nations, 2019).

In many countries, mapping agencies and hydrographic offices are separate entities, with both agencies collecting and creating geospatial data for their own individual purposes in accordance with their own technical specifications. This data is often managed and processed without distribution to wider communities. Coastal data may even be collected and maintained by numerous government or private agencies but is not freely shared due to classification or format restrictions. This inevitably leads to resource duplication and underutilization of available data.

Drawing from survey responses, 19.6% identified Governance to be amongst the top three priority pathways for successful domain integration, while 13.0% considered this pathway as amongst the top 3 pathways that they required further support in. In the survey response, Spain suggested the need to establish strong coordination between the municipal, regional, and national levels of governance as a possible mechanism for integrating terrestrial and maritime domains. The proposed suggestion includes implementing a decentralized governance structure with interagency committees, which could potentially enable cross-government coordination in spatial planning.

Spain also suggested that embedding integrated governance into legislation might provide agencies with the necessary mandate for cross-agency collaboration.

Questionnaire respondents emphasize the need to balance domain-specific agency autonomy with cross-agency collaboration in geospatial data integration. The Republic of Korea and Italy have highlighted the need to respect the unique characteristics of each agency responsible for their respective domains while simultaneously striving for the harmonious integration and alignment of their systems for effective data integration. By maintaining strong governance, the institutions can recognize the importance and necessity of data integration in creating a unified management system. By learning from the collective experiences provided by the respondents, readers could strengthen their own governance and institutions, paving the way for effective domain integration.

Breaking down these silos requires governance models that intentionally connect terrestrial and maritime functions. Pathway 1 therefore calls for collaborative leadership across agencies. Integrated frameworks should be established so that geospatial information from multiple domains can be combined. For example, by aligning mandates and establishing inter-agency steering committees, countries can ensure that survey, mapping, and hydrographic offices can capture, create, and maintain data in an interoperable format that facilitates sharing and adoption. The UN-IGIF calls for a collaborative governance model that connects terrestrial and maritime functions, noting that “multiple organizations work together to deliver geospatial data, products and services” across the government. Such cooperative governance is foundational for integrating the terrestrial and marine domains and optimizes resource availability by adopting a “collect once, use many times” approach.

As leadership and policies align, information can flow seamlessly across traditional boundaries when enabled by well-designed governance and institutions. In short, breaking down domain silos through unified institutions and policies is the first step toward a truly integrated national geospatial infrastructure.

Strategic Pathway 2: Policy and Legal

Effective laws and policies underpin data integration across land and sea domains. As described in strategic pathway 2: Policy and Legal – Refined Version (United Nations, 2020), the UN-IGIF emphasizes that robust legal frameworks lead to “effective and secure management, sharing, integration and application of geospatial information”. A strong and enabling policy and legal environment is essential for effective geospatial information integration.

In practice, this means legislating shared access through mandates that require cadastral agencies, hydrographic offices, and statistics bureaus to adopt common data-sharing protocols. Such frameworks make clear to geospatial data collectors that the data collected should not be collected and managed in siloes. Working in conjunction with strategic pathway 1, providing clarity in responsibilities and mandates

of the various agencies can strengthen governance and accountability in integrated geospatial management. Such policies should also be agile and responsive to societal progress and technological developments to keep pace with changing needs of society.

Open data sharing policies drive domain integration by enabling broader access to cross-domain data and facilitating interoperability. As emphasized in the UN-IGIF-Hydro, maritime and terrestrial geospatial data should share common reference systems and formats. This facilitates the alignment of each domain's needs and bridges the gap between them. A comprehensive legal framework establishes policies that define data standards, quality requirements, and stakeholder responsibilities, enabling effective data management and sharing. Furthermore, these frameworks underpin a viable business model and framework for data licensing that can balance the need for revenue recovery and free and open data release, benefiting the financial strategic pathway as well. This forms the basis for the long-term sustainability of these ventures that may benefit many.

Responses from the survey saw 19.6% of respondents consider Pathway 2 to be amongst the top 3 priority pathways required for the integration of maritime and terrestrial domains, while 7.8% find this pathway as amongst the top 3 pathways that they required further support or assistance in. Respondents such as Greece highlighted that the current situation with geospatial governance remains driven by multiple frameworks such as the European INSPIRE Directive and the United Nations Convention on the Law of the Sea. Kyrgyzstan also underscored the need for developing a comprehensive framework to harmonize terrestrial and maritime policies and define clear jurisdictional mandates that pave the way for establishing data sharing agreements for the alignment of terrestrial and maritime geospatial data. The Republic of Korea has also shared that Policy and Legal is a challenging strategic pathway to adopt but remains crucial to addressing potential conflicts of interest arising from varying regulations and policies, and to promote the sharing of use cases of the data collected.

A key consideration for this pathway is the promotion of effective and secure geospatial information management while balancing national security and privacy concerns. Addressing issues such as data protection, licensing, data sharing, and institutional accountability often requires stronger coordination across multiple agencies, as no single entity can independently manage the full range of implementation tools and stakeholder interests. While these complexities may present challenges, the Policy and Legal pathway remains a critical enabler of collaboration, given its ability to transcend institutional and sectoral boundaries.

In summary, Pathway 2 calls for legal and policy reforms that mandate interoperability and open exchange, so that terrestrial and maritime information can be lawfully combined in support of national priorities. This is achieved through strengthening legal frameworks to provide the institutional structure for terrestrial and marine geospatial

data sharing, discovery, and access. Importantly, there is no one-size-fits-all approach. As digital transformation accelerates, policy and legal frameworks must be adaptive – supporting an open, interoperable, and resilient geospatial information ecosystem that reflects each country's specific context and capacities.

Strategic Pathway 3: Financial

Robust financing frameworks are essential for accomplishing integrated geospatial information management across organizations and sectors. Strategic pathway 3 focuses on the business model, opportunities, benefits realization, and investment needs that are crucial in the financing of domain integration projects. Regardless of scale, sustained financing underpins domain integration efforts. A well-developed project for one domain has the potential to yield concurrent benefits for other domains. For developing countries, limited financial resources and competing national priorities may constrain investment in these systems despite the potential benefits of geospatial information.

To circumvent resource limitations, Member States could explore financial partnerships. The UN-IGIF notes that countries can tap diverse funding sources, including loans, grants and public-private partnerships. Using these mechanisms, governments and the private sector can share data and co-invest in projects that span across government agencies or boundaries, addressing cross-domain challenges such as coastal resilience or climate risk mitigation efforts that bridge land and sea. Sustained financial planning should incorporate diverse stakeholders from the start, enabling coordinated investments across domains to maintain integrated geospatial infrastructure and services, especially for cross-border and multi-agency geospatial projects.

Incorporating cost recovery mechanisms when seeking funds is also recommended to enhance funding viability in the face of competing needs for government funding, particularly in developing countries that face more material threats. By ensuring adequate funding and assistance for government bodies undertaking terrestrial and maritime integration projects, diversifying funding sources, and developing cost-recovery mechanisms, financial stability and the ability to carry out these integration efforts is assured, promoting the longevity and success of these national programs.

From the questionnaire, 5.4% of respondents consider Pathway 3 to be amongst the top 3 priority pathways required for the integration of maritime and terrestrial domains while 14.3% find this pathway as amongst the top 3 pathways that they required further support or assistance in. Respondents highlighted that adopting the guiding principles of the financial pathway can benefit the implementation and longevity of their geospatial projects. Chile emphasized that domain integration funding should align with other institutional objectives and legal frameworks to ensure sustainable implementation despite budget fluctuations. Mexico, Nigeria, and Côte d'Ivoire have also explored public-private partnerships and sourcing for international grants to overcome its resource limitations to scale its integration projects. Mexico also

proposes developing a value-based business model and shared financial plan among national agencies to address funding challenges for large-scale integration projects. Finland also highlighted the difficulties behind funding for developmental projects beyond current operational commitments because these projects are often neglected for other national priorities. Funding for cross-border and regional projects are also consistently difficult to secure, impeding progress in these crucial areas. Moreover, the need for expertise in securing funding for geospatial projects is another key skill set beyond technical know-how as it is fundamental in achieving sustained financing of cross-sectoral projects.

Overall, one key takeaway for readers is to understand the various means of sustaining financial plans that are required to establish and maintain an integrated geospatial information. While aspirations of domain integration remain strong, financial concerns frequently pose a material threat to these large-scale projects. Considering this, Member States are encouraged to look beyond their own organizations and explore innovative ways to fund these integration projects through a variety of means to overcome the financial limitations faced.

Strategic Pathway 4: Data

The effective management of geospatial data constitutes the foundation upon which integrated terrestrial and maritime information systems are built. As articulated in s*trategic pathway 4: Data – Integrated Geospatial Information Framework (IGIF)* (United Nations, 2025), establishing a national geospatial data framework, including clearly defined custodianship and data lifecycle responsibilities, is essential for ensuring interoperability, accessibility, and long-term sustainability of integrated geospatial datasets.

Based on the questionnaire responses, 17.3% of respondents consider Data to be amongst the top 3 priority pathways required for the integration of maritime and terrestrial domains, while 12.9% of respondents considered this pathway as amongst the top 3 pathways that they required further support or assistance in.

Enabling data custodians to meet their data management, sharing, and reuse responsibilities through well-defined data supply chains is foremost and paramount (United Nations, 2025). It must account for and bridge the inherent differences between terrestrial and marine environments. These differences include variations in reference frames, data formats, precision requirements, and intended use cases. For example, hydrographic data, collected for maritime navigation and safety, is structured under standards by the International Hydrographic Organization, while terrestrial geospatial data supports land administration, infrastructure planning, and urban development based on various international and national coordinate systems, reference frames and data models.

Technologies cited by questionnaire respondents include Light Detection and Ranging (LiDAR), Sound Navigation and Ranging, Unmanned Aerial Vehicles, satellite

imagery, remote sensing, post-processing 3D/4D modeling works. These technologies enable the collection of high-resolution data to be used for integrating both bathymetry-topography datasets to monitor coastal height undulations, monitoring ship wakes and wind waves patterns for navigation and safety, and sediment transport for shoreline movements of coastal deposits. In summary, these adopted technologies offer solutions that provide consistent, near real-time, high-resolution data that enables the domain integration of terrestrial and maritime information.

This integration facilitates better decision-making, enhanced collaboration, predictive modeling, and sustainable planning across coastal zones, ensuring environmental protection, coastal resilience, and effective resource management. By leveraging these technologies, countries can build a unified geospatial infrastructure that supports the shared goals of sustainable development and climate adaptation. Another key challenge is data discoverability and accessibility. In many jurisdictions, terrestrial, maritime and cadastral data are managed by different institutions, each maintaining separate databases or platforms. This fragmentation can hamper integrated analysis, particularly at the land–sea interface such as coastal erosion, marine spatial planning, and climate adaptation.

The table below presents common pain points identified by questionnaire respondents in this pillar, and potential solutions recommended by respondents, to enable seamless integration between these domains.

Pain Points	Suggested Actions
Lack of data sharing protocols across domains	Establish open data-sharing protocols across institutions to facilitate integration. Developing or enhancing National Spatial Data Infrastructures (NSDIs) and Marine Spatial Data Infrastructures (MSDIs) to ensure seamless cross-domain access.
Poor data accuracy, timeliness, and security concerns	Implement rigorous data validation processes for quality control and accuracy, adopt relevant technologies that enable near real-time updates and promote privacy-compliant sharing.
Terrestrial and maritime datum mismatches	Adopt common reference frames such as the International Terrestrial Reference Frame (ITRF) to unify geospatial data and deploy data transformation services or translation tools that can align datasets across domains.
Sectoral data silos hindering integration	Promote multi-sectoral approach of sharing geospatial data through improved governance structures and by highlighting the benefits of terrestrial and maritime integration.

Disparate IT environments hindering access	Organize & structure data in common IT environments to facilitate seamless access and use. Harmonize storage and visualization mechanisms across terrestrial and marine datasets. Also, where multiple agency-specific portals exist, promoting interoperability via standardized metadata and API-based data exchange.

Table 3: Pain points and suggested actions to consider through the lens of strategic pathway 4: Data

Strategic Pathway 5: Innovation

Innovation serves as both a catalyst and a key enabler of integrated geospatial information management for addressing complex global challenges, particularly at the land-sea interface. As emphasized in s*trategic pathway 5: Innovation-Integrated Geospatial Information Framework (IGIF)* (United Nations, 2025), the adoption of new technologies, the development of innovative processes, and the fostering of forward-looking institutional environments are essential to support sustainable geospatial integration.

Based on the questionnaire responses, 4.3% of respondents consider Innovation to be amongst the top 3 priority pathways required for the integration of maritime and terrestrial domains, while 11.6% of respondents considered this pathway as amongst the top 3 pathways that they required further support or assistance in. Simulating Innovation as a driver of digital transformation in geospatial information management, it enables countries to leapfrog outdated systems and embrace cost-effective technologies and process improvements (United Nations, 2025). Technologies such as GIS platforms, remote sensing, LiDAR, and satellite imagery are increasingly leveraged to support climate resilience, coastal zone management, and disaster response. However, technology alone is insufficient. The successful integration of terrestrial and maritime domains requires a holistic innovation ecosystem encompassing legal frameworks, institutional coordination, and data standards.

The table below presents common pain points identified by questionnaire respondents that illustrate how these innovative challenges and solutions could be addressed in practice.

Pain Points	Suggested Actions
Lack of predictive and near real-time data capabilities	Consider adopting AI for predictive modeling and leverage drones and remote sensing for near real-time data collection to support disaster management and urban planning, especially where the terrestrial and maritime domains meet.

Low adoption rates of AI, IoT, and big data in geospatial applications	Invest in R&D and training to build local capacity in AI-driven, IoT, and big data applications for geospatial technologies, addressing inefficiencies in current data management practices.
Insufficient investment in geospatial education and an aging workforce	Garner political support to invest in upgrading geospatial-related education and address an ageing workforce through the use of technology adoption.
Terrestrial and maritime data are not interoperable	Consider capturing and storing data in common reference frames across domains to enable data interoperability and promote innovation.
Concerns on data privacy limiting innovation	Undertake data sharing agreements and data anonymization/aggregation to enable data to be shared, hence promoting innovation

Table 4: Pain points and suggested actions to consider through the lens of strategic pathway 5: Innovation

Innovation plays a critical role in supporting national development priorities, sustainable economic growth, and climate resilience. Key enabling conditions can include:

- **Standardized data models** and **interoperable geospatial frameworks** to ensure consistency across domains;
- **Robust governance structures** that foster cross-sector collaboration and innovation uptake;
- **Capacity development**, particularly in emerging technologies such as **AI**, **digital twins**, and **IoT**;
- And the alignment of **legal and institutional frameworks** to support innovation in privacy-conscious and data-driven environments.

Rapid advances in artificial intelligence (AI) and geospatial AI (GeoAI) are changing how geospatial information is managed. These technologies make it easier and faster to collect, process, and use location-based data. The latest AI can support analyses of satellite images, track land use changes, model environmental risks, and support data-driven infrastructure planning. This is helping governments, businesses, and communities make better decisions using geospatial data. However, more research is

needed to understand how AI can support the integration of land and marine data, and to ensure its use is responsible, inclusive, and supports long-term development goals.

AI therefore presents an upcoming field of work that relevant technical bodies may choose to explore—particularly in developing guidelines, standards, and capacity-building efforts to ensure the responsible use of AI in integrated geospatial information management across geospatial domains. Such efforts could include defining fit-for-purpose use-cases for AI and GeoAI in cross-domain applications (e.g., coastal erosion prediction, port-city planning), identifying ethical and data sovereignty safeguards, and promoting interoperability between terrestrial and maritime AI-driven data models. Advancing this area of work will be critical to ensuring that innovation in AI is aligned with the principles of inclusivity, sustainability, and coherence that underpin the IGIF.

As underscored in the IGIF, innovation is not only technological—it is also institutional. By building adaptive geospatial ecosystems fertile to innovation, Stakeholders may be better equipped to develop new tools and practices to support informed decision-making, optimize infrastructure investment, and achieve greater coherence in environmental and spatial governance across land and sea.

Strategic Pathway 6: Standards

Open standards are the backbone of data interoperability — serving as the technical foundation upon which seamless integration between terrestrial and maritime geospatial information systems is built. . As emphasized in *strategic pathway 6: Standards – Integrated Geospatial Information Framework (IGIF)* (United Nations, 2022), the use of internationally recognized standards—developed by organizations such as International Organization for Standardization (ISO), Open Geospatial Consortium (OGC), and International Hydrographic Organization (IHO) —are critical to enabling seamless data exchange, consistent metadata use, and long-term system integration. These standards ensure that terrestrial and maritime datasets are interoperable which can be effectively aligned, overlaid, and analyzed without loss of context or meaning.

Based on the questionnaire responses, 16.3% of respondents consider Standards to be amongst the top 3 priority pathways required for the integration of maritime and terrestrial domains, while 12.9% of respondents considered this pathway as amongst the top 3 pathways that they required further support or assistance in.

The absence of integrated standards across terrestrial and marine domains would result in misaligned data models, incompatible coordinate systems and inconsistent metadata. In practical terms of integration, this means encoding features such as coastal topography, coastal parcels, and statistical boundaries in standardized formats like GeoPackage, CityGML, or S-101 data formats. This interoperability can enable data from different systems and domains to be visualized and processed together, supporting critical applications such as disaster risk reduction, coastal planning,

environmental monitoring, and sustainable development. With the establishment and promoting of these standards and compliance mechanisms, it enables consistent discoveries and sharing, usage and applications of geospatial information for effective decision-making (United Nations, 2022).

Table 5 below presents common pain points identified by questionnaire respondents that illustrate how challenges and solutions through the standards strategic pathway can be addressed in practice.

Pain Points	Suggested Actions
Difficulty harmonizing datasets due to different coordinate systems and data formats	Adopted standards could consider specifying the use of a unified spatial reference system and suitable, commonly used data formats to ensure seamless integration of terrestrial and maritime datasets.
Lack of uniform standards across national geospatial domains	Develop national-level geospatial standards for data acquisition and metadata across terrestrial and maritime domains. Standardized manuals and data models can improve data compatibility, particularly across states and municipalities.
Fragmented governance structures impeding standards creation and adoption	Identify suitable local, regional, and national governance structures that enable the development and adoption of standards.

Table 5: Pain points and potential actions to consider through the lens of strategic pathway 6: Standards

These examples collectively underscore the critical role of open standards in bridging the terrestrial and maritime domains. A standards-based approach should hence be grounded in:

- Common reference systems and schemas,
- Metadata and quality standards,
- Standardized data definitions and classification systems to support consistent use and integration.

Currently, there does not yet exist any technical documentation, methodology or standards concerning the integration of datums and reference frames for the terrestrial and maritime domains. This was highlighted by respondents as an important component for stakeholders who might lack the technical know-how to approach domain integration within their jurisdiction. While the specific methodology to domain integration would often be locality-specific and dependent on the operational use-case, respondents have identified technical guidance as a crucial step for operationalization, for the relevant technical bodies to consider.

Strategic Pathway 7: Partnerships

As highlighted in *strategic pathway 7: Standards – Integrated Geospatial Information Framework (IGIF)* (United Nations, 2022), cross-sector and interdisciplinary cooperation is essential for integrating terrestrial and maritime geospatial information. Partnerships can go beyond transactional collaborations, uniting ministries (e.g., land, environment, fisheries), hydrographic and cadastral authorities, academia, private geospatial firms, and civil society to address shared challenges and opportunities. These partnerships create the institutional and operational networks required for multi-domain data to be shared, understood, and applied for common national objectives.

Based on the questionnaire responses, 5.4% of respondents consider Capacity and Education to be amongst the top 3 priority pathways required for the integration of maritime and terrestrial domains, while 6.5% of respondents considered this pathway as amongst the top 3 pathways that they required further support or assistance in.

An integrated geospatial ecosystem cannot be achieved in silos. Collaboration is needed at every level, whether local, national, regional, and global. Initiatives that align coastal studies with national SDG monitoring, for example, must involve hydrographic offices, cadastral agencies, and planning ministries. As the UN-IGIF notes, partnerships “bring different but complementary skills, experiences, knowledge and resources” to the table (United Nations, 2022). In practice, this may enable joint ventures such as shared spatial data infrastructures that unify terrestrial land-cover datasets with marine protected area boundaries, supporting seamless decision-making across land and sea.

Table 6 provides a list of potential stakeholders to engage in advances in the integration of terrestrial and maritime domains, based on the categories included in the UN-IGIF Implementation Guide: SP9 (United Nations, 2022). This table has been extracted from the UN-IGIF-Hydro Part Two and builds on it by including additional stakeholders listed by questionnaire respondents. The examples provided in Table 6 are non-exhaustive. It should also be noted that depending on the complexity of the project, initiative or collaboration concerned, multi-stakeholder engagement may be required.

Partnerships are therefore crucial to the integration of terrestrial and maritime domains. Establishing cross-sectoral and interdisciplinary collaboration across

government, academia, and industry can facilitate effective integration. Partnerships are also vital in reaching out to stakeholders with the potential to tap on various perspectives and sources of knowledge through this participatory process. pathway 7 thus emphasizes the creation of the people-centric networks through which terrestrial and maritime information can be integrated and shared for common goals.

Stakeholder(s)	Example(s)
Politicians and Policy Makers	● Bodies enacting legislation that address the intersection of land and hydro domains ● International relations
Government Organizations	● May perform statutory functions (e.g., nautical charting, marine pollution, maritime safety, and maritime search and rescue)
Multilateral Organizations and development/donor programs	● World Bank ● Various development banks
UN Agencies and other national governments or NGOs	● United Nations Office of Legal Affairs, Division for Ocean Affairs and the Law of the Sea ● Intergovernmental Oceanographic Commission of UNESCO (International Oceanographic Data and Information Exchange/IOC/UNESCO) ● International Hydrographic Organization and its Regional Hydrographic Commissions ● International Federation of Surveyors ● Royal Institution of Chartered Surveyors ● United Nations Global Geodetic Centre of Excellence
Users of Integrated Geospatial Information	● Mapping and charting ● Marine transportation ● Ports and harbors authorities ● Fisheries ● Tourism and recreational users ● Coastal planners and developers
Scientific Organizations	● Oceanographic institutions ● Climate change modeling ● Research institutes and universities
Private sector suppliers	● Geospatial analytics ● Transportation research and analysis ● Maritime shipping and transportation

	• Geospatial data
Government sector suppliers	• National geodetic offices • National hydrographic offices • National oceanographic institutes • National mapping agencies
Professional Bodies	• Fishing organizations and cooperatives • Land organizations and cooperatives
Consumers and Citizens	• Map users • Civil society

Table 6: Examples of stakeholders to consider through the lens of strategic pathway 7: Partnerships

Examples of potential activities pertaining to this pathway, as suggested by questionnaire respondents, are listed in Table 7 below.

Suggested Actions	Description
Engage stakeholders across multiple disciplines	Collaboration can include geospatial professionals, land surveyors, marine scientists, policymakers, and community representatives to ensure that diverse perspectives inform domain integration efforts.
Develop public–private–academic partnerships	Multi-stakeholder partnerships could include academia, industry, and government, facilitating innovation, knowledge exchange, and co-investment in data infrastructures.
Foster and mobilize regional partnerships and international collaboration	Regional organizations and relevant Regional Hydrographic Commissions could co-develop capacity-building programs and data-sharing programs, to ensure regional coherence and equitable access to resources and technical expertise.

Table 7. Potential actions and their descriptions to consider through the lens of strategic pathway 7: Partnerships

Strategic Pathway 8: Capacity and Education

This strategic pathway emphasizes the importance of sustained capacity development and education programs to ensure that the value and benefits of integrated geospatial information management—particularly between the maritime and terrestrial domains—are sustained over the long term. Integration at the land–sea interface requires not only interoperable data and systems, but also a skilled and dynamic

workforce capable of navigating different standards, reference frameworks, and institutional cultures.

Based on the questionnaire responses, 7.6% of respondents considered Capacity and Education to be amongst the top 3 priority pathways required for the integration of maritime and terrestrial domains, while 16.8% of respondents considered this pathway as amongst the top 3 pathways that they required further support or assistance in.

By fostering strategic and sustained investment in people, Member States can ensure that land–sea integration is not only technically feasible but institutionally embedded. A capable and collaborative geospatial workforce is essential to deliver and sustain the goals of integrated geospatial information management.

As such, readers could consider making strategic investments in human capital. This could include building institutional knowledge, strengthening education systems, modernizing professional development, and fostering inclusive partnerships. A skilled, adaptive, and cross-disciplinary workforce is essential to realize the full value of integrated geospatial information management.

Examples of potential activities pertaining to this pathway, as suggested by questionnaire respondents, are listed in Table 8 below.

Suggested Actions	Description
Develop formal education pathways to grow the pipeline of geospatial professionals trained in both terrestrial and marine domains.	Curricula can integrate geodesy and geospatial competencies with courses in hydrography, oceanography, and hydrology to ensure a robust technical foundation across both marine and terrestrial domains. This can include embedding domain in national education systems, addressing capacity gaps by updating geospatial curricula, and offering targeted certification programs.
Invest in continuous professional development for current practitioners, ensuring adaptation to evolving technologies and integration needs.	Steps to consider include offering government-led training on integrated spatial planning, as well as providing training in data processing and metadata standards. This includes engaging both early-career and mid-career professionals to ensure sufficient supply of talent and skills to support the work required for domain integration.

Broaden capacity-building beyond the geospatial sector to include policymakers, administrators, and data users.	Steps to consider include having government agencies underscore the importance of training to build institutional understanding and continuity. Stakeholders may also consider training in emerging technologies like AI and drones to ensure consistent data collection practices.
Strengthen partnerships with academia, industry, and international organizations to co-develop training programs and exchange best practices.	Steps to consider include partnering with universities to create locally tailored training modules aligned with integration goals. Stakeholders may also consider collaborating with international bodies to offer workshops and establish regional knowledge-sharing platforms.
Leverage multi- and bilateral cooperation to scale capacity-building efforts and disseminate practical guidance.	Steps to consider include participating in UN-GGIM initiatives and technical bodies (e.g. UN-GGCE) to access global training resources. Relevant stakeholders may also consider establishing regional knowledge-sharing platforms focused on land–sea integration. Respondents have noted that access to UN-IGIF-aligned training and workshops is essential to advance integration and maximize geospatial data utility.
Expand outreach to youth, start-ups, and civil society to embed geospatial literacy across sectors and encourage innovation.	UN-IGIF promotes a culture where broader society—especially students and entrepreneurs—can engage with integrated land–sea data to develop new solutions. Such initiatives could be tied in with efforts under SP7: Partnerships and SP9: Communication and Engagement.

Table 8: Potential actions and their descriptions to consider through the lens of strategic pathway 8: Capacity and Education

Strategic Pathway 9: Communication and Engagement

This strategic pathway recognizes that stakeholder identification, user engagement, and strategic communication are essential enablers of effective and integrated geospatial information management. It emphasizes the importance of deliberate,

sustained engagement across all sectors—government, private industry, academia, civil society, and the broader user community—at both national and sub-national levels. For domain integration to succeed, particularly across the terrestrial and maritime domains, clear communication is required to build awareness, trust, and understanding of the value of integrated geospatial information for sustainable economic, social, and environmental development (United Nations, 2022).

Based on the questionnaire responses, 4.3% of respondents considered Communication and Engagement to be amongst the top 3 priority pathways required for the integration of maritime and terrestrial domains, while 3.9% of respondents considered this pathway as amongst the top 3 pathways that they required further support or assistance in.

Pathway 9 plays a critical role in enabling domain integration. Given the large and diverse number of stakeholders involved across geospatial domains, proactive outreach is necessary to foster a shared vision, highlight tangible use-cases, and promote meaningful collaboration. As more specialists and decision-makers witness the integration of land and sea data on modelling and visualization platforms - for instance, merging land-use zoning with coastal flood risk models - they can become more engaged and see first-hand the benefits of domain integration from decision making processes. Such an effort can grow awareness, creating demand for integration and facilitating buy-in across stakeholder groups.

Examples of potential activities pertaining to this pathway, as suggested by questionnaire respondents, are listed in Table 9 below.

Action Item	Description
Stakeholder and user engagement, which involves developing enduring relationships and partnerships with advocates, data users, and decision-makers.	Engagement efforts are encouraged to be iterative and responsive to the evolving needs and motivations of stakeholders
Strategic messaging and storytelling, such as real-world examples where domain integration has provided tangible outcomes for its stakeholders, in terms of cost-savings, efficiency gains, improved processes and more.	As highlighted in the UN-IGIF, communicating what geospatial information is and the benefits that stakeholders can realize from its use is fundamental. The same applies when garnering stakeholder support to operationalize and finance the integration of geospatial domains where required.
Hosting inclusive platforms and forums, such as online portals, community forums, and international dialogues.	Convening multi-stakeholder forums can help align local, regional, and national interests.

Participatory education and advocacy, which nurture informed champions and strengthens collective capacity to address cross-domain challenges.	This could include public education campaigns to explain the value of land–sea integration.
Monitoring and evaluating the impact of communications plans can help assess the effectiveness of communication strategies.	This activity could serve as a continual improvement mechanism to ensure that engagement remains strategic, targeted, and impactful.

Table 9: Potential actions and their descriptions to consider through the lens of strategic pathway 9: Communications and Engagement

By encouraging transparency, feedback loops, and the open sharing of challenges and successes, this pathway actively breaks down institutional and informational silos. Furthermore, the creation of a participatory environment allows stakeholders to generate new use-cases, share innovative ideas, and identify synergies between the public sector and private, academic, and scientific communities.

3.0 Insights and Recommendations

The analysis of the responses reveals several critical insights that shape our understanding of effective terrestrial-maritime domain integration. This section synthesizes these insights and proposes strategic recommendations to advance integration efforts across the world.

3.1 Key Strategic Insights

A fundamental challenge in advancing terrestrial-maritime integration lies in defining the key elements that enable effective integration and establishing the ideal relationship between both domains. Analysis of Question 1 responses reveal that successful integration requires careful consideration of elements such as common reference systems, standardized data formats, and aligned institutional frameworks. The relationship between terrestrial and maritime domains should be seamless and complementary, where data flows freely across domains, decisions are made holistically, and stakeholders work collaboratively towards shared objectives. Given the complexity and multi-faceted nature of domain integration, establishing a clear and shared definition becomes crucial. Without this common understanding, Member States may pursue different approaches to integration, potentially limiting the effectiveness of cross-border collaboration and hindering the full potential of integrated geospatial information management in addressing critical challenges at the land-sea interface.

An insight emerging from Question 2 responses is the transformative impact of successful terrestrial-maritime integration across multiple domains. The benefits

include supporting coastal protection and management, disaster preparedness, sea-level rise monitoring, and advancement of the Blue Economy. The examples highlighted in the earlier section demonstrate how integrated geospatial information can enable more precise monitoring of protected areas, improved predictive modeling, and enhanced decision-making for coastal communities. However, many of these success stories remain under-documented or are not shared widely enough to benefit other Member States. As such, opportunities exist for Member States to benefit from having access to a repository of detailed use cases and implementation experiences that can inform their own integration efforts, accelerating their learning and operationalization from successes and challenges faced elsewhere.

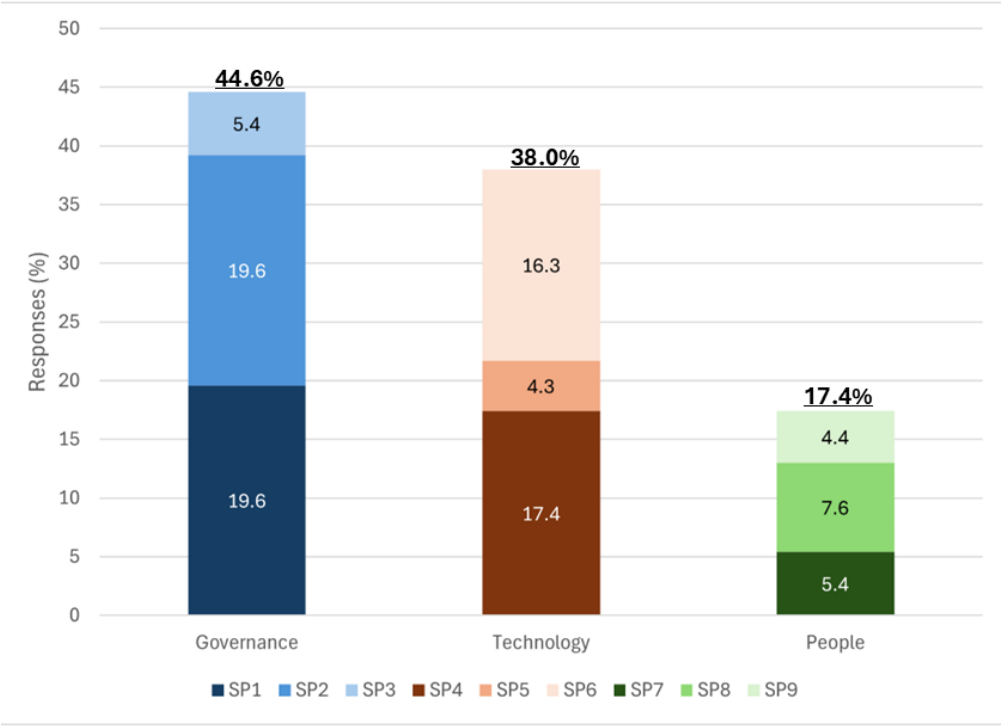

Figure 4: Distribution of strategic pathways identified by Member States as critical enablers for terrestrial-maritime domain integration (Question 3).

When asked to identify the most critical strategic pathways to advance terrestrial-maritime integration, the Governance domain (SP1-3) emerging as the most significant, garnering 44.6% of responses (Figure 4). The strong emphasis on governance underscores that effective integration is fundamentally an institutional challenge, requiring coordinated leadership, clear mandates, and sustainable funding models.

The Technology domain (SP4-6) emerged as the second most critical area, with 38.0% of responses highlighting the need to bridge the technology-practice gap. Member States face significant challenges in this domain, particularly in harmonizing varying reference frames, data formats, and integration methodologies across nations. The complexity is compounded by the far-reaching implications of standardization

efforts on established legal frameworks, especially in sensitive areas such as maritime boundary delimitation and coastal zone management.

The People domain (SP7-9), while receiving comparatively lower emphasis (17.4%) in questionnaire responses, remains fundamental to sustainable integration. Member States consistently highlighted significant gaps in technical expertise, particularly in areas requiring cross-domain knowledge such as geodesy, marine spatial planning, and integrated coastal zone management. This points to the growing need for multidisciplinary skillsets that can effectively bridge the terrestrial-maritime divide while fostering meaningful stakeholder engagement.

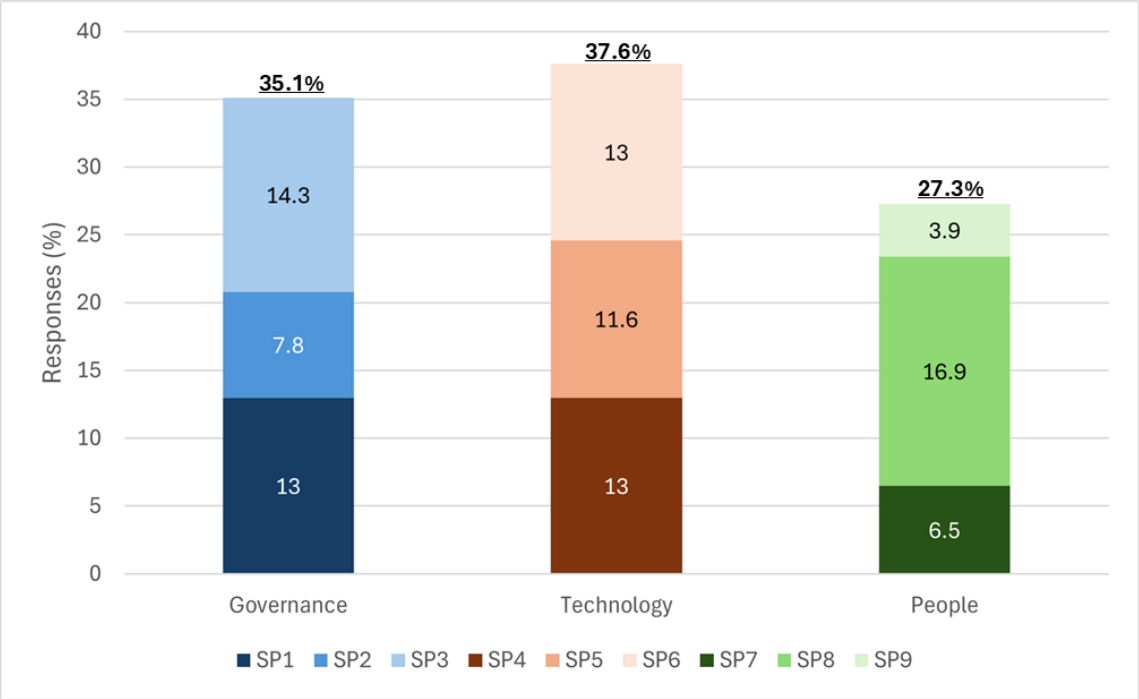

Figure 5: Distribution of strategic pathways where Member States indicated need for additional support in terrestrial-maritime domain integration (Question 3).

Notably, when asked about pathways requiring the most assistance, the data reveals a shift in perceived support needs compared to the pathways previously identified as critical (Figure 5). Analysis of the responses regarding pathways requiring the most assistance reveals that the Technology domain (SP4-6) received the highest mentions at 37.6%, followed closely by the Governance domain (SP1-3) at 35.1%, while the People domain (SP7-9) received 27.3% of mentions. This is in contrast with Figure 4 which indicates the Governance domain as critical enablers for terrestrial-maritime domain integration. This comparison provides valuable insights into where Member States need the most support to advance their terrestrial-maritime integration efforts.

In the Technology domain, which received the highest mentions for assistance needed, Data (SP4) and Standards (SP6) were equally cited as important, followed closely by Innovation (SP5) . The relatively even distribution across these pathways

suggests that Member States face comprehensive technical challenges rather than isolated issues. This aligns with respondents' additional comments highlighting the interconnected nature of technical challenges, from harmonizing reference frames to implementing standardized approaches across domains. The need for assistance across all technology pathways underscores the complexity of technical integration and the importance of coordinated support in these areas.

Within the Governance domain, Financial (SP3) emerged as the most pressing concern, followed by Governance and Institutions (SP1), and Policy and Legal (SP2). This emphasis on financial assistance is notable - while Member States previously identified Governance and Policy as critical pathways for success, they specifically highlight financial support as their primary need for assistance. This might indicate that sustainable financing remains a key barrier to implementing domain integration projects, even if proper governance structures and mandates were put in place.

While the People domain received the lowest overall mentions for assistance, it contains the single most frequently cited pathway requiring support – Capacity and Education (SP8), followed by Partnerships (SP7), and Communication and Engagement (SP9). This strong emphasis on Capacity and Education suggests that successful integration requires more than technical infrastructure – it demands a workforce equipped with both specialized technical competencies and a clear need for comprehensive training programs that can bridge the terrestrial-maritime divide while fostering meaningful stakeholder engagement.

The analysis of responses to Questions 3 and 4 of the Questionnaire provides insights into the gap between recognizing critical pathways and needing assistance in integration. While the responses clearly identify governance as fundamental to success (44.6% citing SP1-3 as critical), the requests for assistance focus more heavily on technical aspects (37.6% seeking help with SP4-6). This suggests that while Member States understand the importance of governance frameworks to enable successful integration, they may feel more immediate pressure to address technical challenges. Perhaps the most striking contrast appears in the financial pathway (SP3) - 5.4% of the responses identified it as critical in Question 3 (Figure 4), 14.3% indicated needing financial assistance in Question 4 (Figure 5), highlighting a significant gap between strategic understanding and practical implementation. Similarly, Capacity and Education (SP8), though not frequently cited as critical in Question 3, emerged as the single most requested area for assistance across all nine pathways in Question 4.

These contrasts underscore a key insight: although Member States may grasp the principles of successful integration, they continue to face difficulties in translating theory into practice. Accordingly, support mechanisms should go beyond outlining what needs to be done and focus more concretely on how to enable effective implementation.

3.2 Recommendations

Based on the above insights, we propose seven interconnected strategic recommendations. First and foremost, there is an urgent need to establish a clear definition of terrestrial-maritime domain integration. This definition should foster a shared understanding among Member States and provide a foundation for coordinated implementation of land-sea geospatial frameworks. The Committee of Experts could consider leading this definitional work to ensure consistency and broad acceptance across the international community.

Second, a recommendation is the systematic documentation and sharing of successful use cases. Member States have demonstrated remarkable achievements in applying integrated geospatial information to address critical challenges. The Committee of Experts could consider establishing a framework for collecting and sharing these detailed case studies, enabling Member States to learn from each other's experiences and better leverage geospatial solutions in advancing the UN Sustainable Development Goals.

Third, Member States can consider strengthening their governance frameworks by establishing cross-domain governance structures, developing clear legal mandates for data sharing and interoperability, and creating sustainable financing models that treat geospatial integration as critical infrastructure. The Committee of Experts could consider facilitating this by sharing knowledge on successful cross-domain governance frameworks and implementation experiences.

Fourth, immediate attention should be given to addressing technical integration challenges. This can involve harmonizing reference systems between terrestrial and maritime domains, developing standardized approaches for data integration at the coastal interface, and prioritizing open standards and interoperable solutions. The Committee of Experts could consider providing technical guidance to support these efforts.

Fifth, building sustainable capacity emerges as a crucial priority. This could entail developing capacity building programs that combine technical and strategic skills, establishing formal education pipelines and professional development pathways, and creating platforms for knowledge exchange. The Committee of Experts could consider developing targeted capacity building programs specifically for terrestrial-maritime integration.

Sixth, strategic communication and partnerships could be pursued through targeted materials that demonstrate the benefits of domain integration, through formal multi-stakeholder coordination platforms, and through international collaboration frameworks. The Committee of Experts could consider developing communication strategies and partnership frameworks to promote awareness, understanding, and uptake among stakeholders.

Finally, the report recommends the development of roadmaps that include clear milestones, responsibilities, and success metrics, addressing both immediate technical needs and long-term strategic objectives. The Committee of Experts could consider developing a roadmap template, tapping on existing UN-IGIF and UN-IGIF-Hydro frameworks, to guide Member States in their journey towards successful domain integration.

4.0 Conclusion

Successful implementation of domain integration requires a balanced approach that begins with establishing a clear, shared understanding of terrestrial-maritime integration, supported by real-world examples and use cases. This foundation enables more effective prioritization of governance foundations while addressing immediate technical needs. The approach must build human and institutional capacity alongside technical systems, promote inclusive stakeholder engagement, establish sustainable funding and partnership models, and leverage international best practices while respecting local contexts.

The path forward demands recognition that terrestrial-maritime integration is not merely a technical challenge but a complex institutional and social endeavor with tangible benefits for sustainable development. The successes observed in coastal protection, disaster management, sea-level rise monitoring, and Blue Economy advancement demonstrate the practical value of integration efforts. By adopting holistic strategies and learning from successful implementations, Member States can ensure their integration efforts are not only technically sound but also institutionally supported, socially accepted, and sustainable over time. To support this, the development of comprehensive technical documentation will be instrumental in providing clear guidelines and methodologies for successful domain integration.

As such, the Committee of Experts plays a crucial role in facilitating this journey by providing guidance, sharing best practices, and fostering international collaboration. This includes creating platforms for Member States to share detailed use cases and implementation experiences, enabling others to adapt and apply successful approaches in their own contexts.

Through coordinated action on these recommendations and active sharing of implementation experiences, there holds strong potential for Member States to build robust, integrated geospatial information systems that effectively bridge the terrestrial-maritime divide and support evidence-based decision-making for sustainable development. This journey begins with a shared understanding of integration, and advances through governance, technical implementation, and capacity building. It is continuously enriched by peer learning and shared best practices.

This report therefore represents an initial effort by the EG-LAM and WG-MGI to raise awareness about the importance of terrestrial-maritime integration and catalyze

broader discussions within the geospatial community. It aims to serve as a foundation to spark conversations and inspire innovative ideas about integration approaches. The report hence encourages Member States to exchange action points and recommendations that can be incorporated into their respective country's action plans. Such collaboration bridges gaps and strengthens the bonds within the UN Community, embodying the principle of "Leaving no one behind."

5.0 Points for Discussion at the Committee of Experts Meeting

The Committee of Experts is invited to:

(a) Take note of the draft compilation report.

(b) Express its views and provide further substantive input and feedback on the proposed recommendations of the draft compilation report.

i. Recommendation 1: The Committee of Experts may consider establishing a **clear definition of terrestrial–maritime domain integration** to foster a shared understanding among Member States and to guide the coordinated implementation of land–sea geospatial frameworks.

ii. Recommendation 2: The Committee of Experts may consider **sharing successful use cases** of terrestrial–maritime integration to help Member States better leverage geospatial solutions in advancing the **UN Sustainable Development Goals**.

iii. Recommendation 3: The Committee of Experts may consider **sharing their experiences and challenges** in establishing **cross-domain governance frameworks** to support Member States in establishing legal mandates and sustainable financing for the effective integration of geospatial information.

iv. Recommendation 4: The Committee of Experts may consider **addressing immediate technical gaps** at the interface of terrestrial and maritime geospatial **data, standards, and innovation**, such as through harmonized reference systems, open standards, and fit-for-purpose tools.

v. Recommendation 5: The Committee of Experts may consider the development of **capacity development programs and workshops** to build expertise in terrestrial–maritime geospatial integration.

vi. Recommendation 6: The Committee of Experts may consider **developing targeted communication materials** that illustrate and visualize the benefits of terrestrial–maritime domain integration, to **promote awareness**, **understanding**, and **uptake** among stakeholders.

vii. Recommendation 7: The Committee of Experts may consider developing an integration **roadmap template** with **clear milestones**, **responsibilities**, and **success metrics** to guide Member States in their progressive implementation of terrestrial-maritime domain integration.

Appendix A

QUESTIONNAIRE ON THE INTEGRATION OF TERRESTRIAL, MARITIME AND CADASTRAL DOMAINS

Dear colleagues,

The Expert Group on Land Administration and Management (EG-LAM) and Working Group on Marine Geospatial Information (WG-MGI) invites you to participate in this survey related to the ongoing work on the integration of terrestrial, maritime and cadastral domains using geospatial information and technologies. Your input is crucial for developing an understanding towards a comprehensive reference with use-cases in the integration of terrestrial, maritime and cadastral domains, and how the United Nations Integrated Geospatial Information Framework (UN-IGIF) supports these domain integration activities.

Objectives

1. To collect and analyze Member States' experiences and challenges in integrating domains using geospatial information and technologies.
2. To identify innovative approaches and good practices in implementing the UN-IGIF for the integration of terrestrial, maritime and cadastral domains.
3. To understand the support needed by Member States in advancing their efforts in integrating terrestrial, maritime and cadastral domains.
4. To gather insights on the potential roles that integrating terrestrial, maritime and cadastral domains can play in addressing national development priorities and global development agendas.

Your responses will contribute significantly to achieving these objectives, informing the development of a valuable reference for our UN-GGIM community. We appreciate your time, expertise and contribution.

Respondent's Information

Name of Member State	*[Fill in the blanks]*
Representative agency	*[Fill in the blanks]*
Name of respondent(s)	*[Fill in the blanks]*
Designation	*[Fill in the blanks]*
Email address	*[Fill in the blanks]*

Section 1: Understanding the integration of terrestrial, maritime and cadastral domains

1. How would you define the integration of terrestrial, maritime and cadastral[3] domains in the context of geospatial information management?

[Fill in the blanks]

You may use the following guiding questions to provide your responses:

What key elements should be considered when integrating terrestrial and maritime geospatial data?

How would you describe the ideal relationship between the terrestrial and maritime domains in an integrated approach?

[3] For the purposes of this questionnaire, the maritime domain includes the coastal waters, seas, oceans, and their ports and harbours, and the remaining 70% of Earth's surface covered by water, including coastal zones, deltas, and inland waterways and water bodies.

Section 2: Potential Use Cases for the Integration of Terrestrial, maritime and cadastral Domains

2. How could the integration of terrestrial, maritime and cadastral domains contribute to your country's efforts in achieving national development priorities and the Sustainable Development Goals? Please provide specific examples where this integration could be beneficial for your country or region. Include any additional information (such as website links, charts or diagrams) to support your use case(s) whenever possible.

[Fill in the blanks]

For each use case in your country or region, please provide (where relevant):

Brief description: Outline the problem addressed, technologies used, and how domain integration is conducted.
Potential benefits: Describe the expected outcomes and contributions to national priorities.
Challenges and solutions: Identify main obstacles faced and how they were overcome.
Key stakeholders: List the main parties involved and their roles in the integration effort.

Section 3: Implementation through UN-IGIF Strategic Pathways

For the following questions, kindly support your views with your country's experiences and use cases whenever possible.

3. Out of the nine strategic pathways in the UN-IGIF, which three pathways are the most critical for integrating terrestrial, maritime and cadastral domains in your country, and why? Where relevant, please elaborate on how these pathways are being used to achieve this integration in your country or region.

[Fill in the blanks]

You may use the following guiding questions to provide your responses:

Governance and Institutions: How could governance structures and institutions be adapted or created to support efforts to integrate terrestrial and maritime domains?
Policy and Legal: What legal, regulatory and policy frameworks would be necessary to enable effective integration of terrestrial and maritime domains?
Financial: How could financial resources be mobilised and allocated to support initiatives to integrate terrestrial and maritime domains?
Data: What data-related strategies or principles would be crucial to successfully integrate terrestrial and maritime domains?
Innovation: How could innovation (e.g. Artificial intelligence or the adoption of emerging technologies) be fostered to drive the sustainability and scalability of initiatives to integrate terrestrial and maritime domains?
Standards: What standards would need to be developed or adopted to ensure interoperability in the integration of terrestrial and maritime domains?
Partnerships: How could partnerships be leveraged to facilitate the integration of terrestrial and maritime domains?
Capacity and Education: What capacity development and educational initiatives would be necessary to support the integration of terrestrial and maritime domains?
Communication and Engagement: How could stakeholder communication and engagement be effectively managed and utilised to support objectives in the integration of terrestrial and maritime domains?

4. Out of the nine strategic pathways in the UN-IGIF, which three does your country or region most need support with for integrating terrestrial, maritime and cadastral domains, and why? How might these challenges be addressed? Where relevant, please elaborate on how these pathways are being addressed in your country or region.

[Fill in the blanks]

You may refer to the guiding questions from the previous question for reference.

5. Do you have any other inputs you would like to share?

[Fill in the blanks]

Do provide any additional information or insights that may not have been covered by the previous questions. You may also use the following guiding questions to provide your additional responses:

What practical guidance or materials do you hope to gain from this reference?
How could this reference better support your work in integrated geospatial information management?

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