

**Annexes to the Report on
Trends in National Institutional Arrangements in
Geospatial Information Management**

**Prepared by the UN-GGIM Working Group
On Trends in National Institutional Arrangements**

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Annexes

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Annex I

Methodology for Selecting Case Studies Within the UN-GGIM National Institutional Arrangements (UN-GGIM NIA) Working Group

Foreword:

The present document intends to provide information about the envisaged methodology for achieving the preparation of a publication detailing best practices in geospatial institutional arrangements, and the creation of an index or indexes for evaluating and monitoring the status or evolution of geospatial institutional arrangements.

This methodology has been presented to external acknowledged entities to obtain feedback from them. This should help to adopt the best approach and obtain the most representative results in the context of UN-GGIM.

The questions asked to the experts covered the following:

- The suitability of the proposed methodology for selecting case studies.
- The need to use ancillary data such as country area, indexes on development and/or on information and communication technology (ICT) and e-Government.
- The suitability of the overall methodology for the purpose of the working group.

After considering all suggestions, the commonly agreed methodology will be re-sent to acknowledged entities seeking their endorsement.

Current NIA Situation Analysis:

The portrait of the different initiatives in National Institutional Arrangements currently implemented across the world was defined based on results received through a questionnaire, distributed among all UN-GGIM Member States, composed of questions about production systems, funding structures, dissemination systems, data policy models, structure in management organizations and the role of people as voluntary producers in the field of geospatial information. The questionnaire was structured around a set of geospatial themes selected according to their relevance to address the needs of the United Nations sustainable development agenda.

The set of selected geospatial information themes is not closed, but only an initial approach adopted at this time to move forward with the NIA WG work plan. It should be noted that the definition of the set of fundamental geospatial data themes is not an objective of this working group. In this sense, the establishment of a working group on determining an initial set of global fundamental geospatial data themes has been agreed by the UN Committee of Experts on Global Geospatial Information Management at its 5th session and NIA WG will coordinate with this working group, and keep abreast of the progress of its work and follow its conclusions on this issue.

Conclusions drawn from the NIA WG questionnaire allows for a broad view of the current situation of national institutional arrangements in geospatial information management worldwide, and its regional differences among countries.

Envisaged Methodology:

The final aim of NIA WG is to develop an index based on the results of the questionnaires and research in the area. However, as a first step, the Bureau has recommended to all TG to extract indicators in each area able to identify countries with best performance on them, and propose them as case studies. In a later stage, based on those indicators and other elements (socio-economic indexes, specific characteristics of each country, etc.) the final index on best practices on NIA is to be developed, aiming to find the link between all elements.

1. Selection of Case Studies

Key areas that have influenced and determined the success of NIA were identified within each TG. After, based on the questionnaires, literature research and the assistance and validation of external acknowledged entities (to cite some of them: EuroSDR, JRC, Eurostat, Eurogeographics, the Pan-American Institute of Geography and History, Universities), a set of indicators were extracted. There was a limitation in the extraction of these indicators. The answer to them should be obtained directly from the information provided by the NIA WG questionnaires already sent and answered by the Member States or from existent literature. So these questionnaires must be considered for this work.

These indicators are qualitative data (i.e. questions to be answered with yes/no). This has allowed finding on each theme for those countries which best performs, and the selection of case studies. The challenge has been to correctly identify those key areas and the indicators that define them, together with the justification underpinning this selection.

The following tables contain the indicators selected by all three TGs, based in the topics addressed in the questionnaires:

TG1 indicators

Production systems		
Production methods	Are the methods applied for creation/update automatic or semi-automatic? (In 50% or more of the production process)	Automatic or semi-automatic methods applied for production are considered as best practice due to the cost reduction and the possibility of applying "standards" processes already proved
Creation/ update of GRI¹	Are collaborative methods, understood as contribution with resources or economical, between public or private institutions used?	The collaborative production involves a share of knowledge and costs which makes the production more efficient
	Is VGI included in the process?	The collection of geospatial data by VGI although doesn't come with the quality assurances, has a level of detail and maintenance regimes that are required to inform major business or public-service questions
Approach for GRI creation/ update	Is BOTTOM-UP approach applied in the creation/update in more than 3 GRI themes among administrative units, transport network, hydrography, elevation, land cover or settlements?	The Bottom-up approach with the production with the maximum scale/resolution, except for Geographical names or Imagery is considered as a best practice as is consistent with the INSPIRE principles

¹ GRI- geographic reference information

Production systems		
Production scale	Are more than 6 GRI themes produced with 1:25.000 scale or higher?	The scale 1:25.000 is a much extended scale used for national or subnational management. So the limit has been put on this scale considering as a best practice when more than 6 of the 9 GRI themes are produced at this scale or higher
GRI update	More than 3 GRI themes are update in a continuous way?	Information update at any time would be desirable and we have considered that 3 GRI themes continuously updated will be a best practice
	The update period is ≤ 5 years for at least 4 GRI selected themes?	Less than 5 years period for reviewing at least 4 GRI themes will means a GRI information considerably updated

TG2 indicators

Funding structures		
Funding origin	Is there any existing public funding model for acquisition, processing and dissemination of GI?	Due to high costs needed for producing and managing GI, it is necessary to share resources and avoid duplicities
	Is there any private structured model for acquisition, processing or dissemination of GI?	Involvement of private sector in production of official GI helps minimizing costs and broaden scope
	Is there any funding coming from international sources for GI production?	Making use of funds available from international organizations support availability and GI update
	Is the percentage of the budget assigned to manage GI over 0,05% of the GDP?	It is necessary to have a threshold in terms of total budget assigned to GI management
Return on investment	Is any model of return on investment available?	Due to high costs of producing GI, a plan for obtaining a certain return is necessary
	Does the use of GI implies any cost for citizens?	This may help to recover part of the invested costs in production, but it also may diminish interest on official GI
Destination of funding	Is part of the funding dedicated to research activities?	Assures adoption of innovations and emerging technologies related to production and management of GI
	Is part of the funding dedicated to the development of a local, national or regional SDI?	Allows to have available resources for boosting actions for facilitating a SDI initiative and associated elements
Dissemination system		
Access and data sharing	Is the NCMA the responsible authority for disseminating official GI?	Guarantees a unique source for acquiring official GI
	Do other public organizations participate in the dissemination of official GI?	An organized network of agents helps the access and acquisition of official GI
	Does any type of feedback exist from the users with respect to the available GI?	Allows awareness of real users' requirements, as well as the evaluation of the availability and use of GI
Frame for data sharing	Are web services the main channel for accessing and consulting GI?	Web services are a standardized mean for accessing and consulting GI

	Is there any geoportal available for GI exchange?	Eases procurement and sharing of GI, as well as associated services and products
	Do the implemented means for disseminating GI satisfy user requirements?	Contributes to the use and exploitation of GI by users and not by the producers
	Is there a mean implemented by which users know the available IG?	Is important to ensure users of GI are able to find and obtain the data they require
Drive factors for data sharing	Is a relationship with the academic sector maintained for promoting knowledge and use of GI?	Allows designing strategies for data sharing, depending on user types and managed data
	Is a relationship with the private sector and/or NGOs for promoting knowledge and use of GI?	
	Is the produced official GI accessible for public access?	Avoids that data associated costs becomes an obstacle of their sharing and exploitation
Data policy models		
Legality	Is there any current legal frame regulating data acquisition and processing?	A current national legal framework is important to ensure compliance
	Is there any current legal frame for data dissemination?	A current national legal framework is important to ensure compliance
Frame for data sharing	Is there any law promoting the establishment and maintenance of a national SDI?	Ensures the implementation of a plan for development and maintenance of a National SDI.
Data use	Is there any restriction in accessing official GI?	Guarantees legality and property rights of official GI
	Is there any policy or regulation on standardize data access and distribution?	Drives interoperability of GI and associated processes
	Is there, or is it planned, any initiative on open geospatial data?	Allows all data become re-usable by everyone at any moment
	Is there any policy or strategy related with GI governance?	Favours promotion and development of knowledge and geographic culture

TG3 indicators

Coordination & Collaboration Among Entities		
Representation of Entities	Is the majority of users and producers of GI represented in the NIA?	An ideal NIA should have active representation of both users and producers. This would ensure that the various entities are able to voice their concerns and work together to achieve common objectives. For example, the producers can better understand if the GI they are sharing meets the needs of users; or the users can let the producers know their requirement before GI is collected.
	Are non-government entities (i.e. NGO, Academia, Business Sector, Community Organizations) represented in the NIA?	An ideal NIA should have active representation of both the government and non-government entities. Non-government entities produce and use GI as well and should be kept engaged through participation in the NIA.

Coordination	Is there an apex decision-making body?	Having an apex decision-making body is generally acknowledged to bring efficiency in the system, especially so when required to provide direction for the NIA, to coordinate the activities of the NIA and to resolve any disputes arising. This decision-making body can comprise of a single organisation or a committee formed from the representation of various organisations.
	Is the NIA formed by legislation or by directive/decreed of the highest political office?	An ideal NIA should have the mandate to perform its function effectively. An NIA formed through such instruments is an indication of the importance a country places on GIM
Collaboration	Does the NIA put in place collaborative mechanisms that bring together stakeholders to work together to achieve goals?	Implementing GIM initiatives is a massive task that the NIA has to achieve. An ideal NIA should have collaborative mechanisms to bring together various entities to work together to achieve common goals. The collaborative mechanism can be used to achieve goals from the following few categories: <ul style="list-style-type: none"> - strengthening capacity building - resolving data sharing disputes - administering data policies - embarking on research and development - production of GI - creation of GI platforms and tools - provision of GI training and support
Facilitating Infrastructure & Technology		
Adoption Support	Does the NIA provide technical support for the implementation of new technology?	Implementing new GI technology may be an overwhelming task for some entities. Providing technical support, through the NIA, to resolve initial issues encountered by GI adopters would ease the transition to new GI technology.
	Does the NIA offers training to build up the capabilities in using GI technology?	Capacity building is important to equip adopters with the relevant know-hows to generate or use GI. Training can be provided personally by the players in the NIA or can be out-sourced with the NIA as the central coordinator.
Research	Does the NIA adopt and implement a R&D plan?	Having an R&D plan guides the NIA in the areas to build up its capabilities in and guides it in its investment of strategic technological projects required to further future GIM initiatives.
	Is there R&D collaboration between the government and non-government entities?	The Government usually has weaker expertise in the realm of R&D. Collaboration with non-government entities, such as academia and the business sectors, would allow for the co-creation of useful products and services that furthers the cause of the NIA.
Use of GI for Policy & Decision Making		
Support	Does the NIA provide tools (i.e systems, platforms or software) for government agencies to use GI for policy and decision making?	Users of GI often require certain tools to analyse GI to derive insights. The NIA should provide the necessary tools to encourage and facilitate the use of GI in policy and decision making.
	Does the NIA extend their professional expertise to help government agencies analyse their GI?	Analysing GI is a science and not all users have the required skills to conduct in-depth analysis on their data. To help government agencies analyse their data, the NIA should provide expertise to assist the users achieve their analysis intent.
Extent of Usage	Besides traditional users of GI (i.e users from the defence, infrastructure, environmental and land use planning sectors), do users of GI come from other sectors such as the social, healthcare, economic sectors (“non-traditional users”)?	Traditionally, users of GI are mainly from the defence, infrastructure, environmental and land use planning sectors. However, using GI can benefit users from the other sectors as well, such as the social, healthcare and economic sectors. A successful NIA should involve users from these sectors.

Data & Service Standards		
Adoption	Does the NIA adopt standards defined by internationally recognised organizations?	Internationally recognised organisation that recommends standards for GI includes Open Geospatial Consortium (OGC), Federal Geographic Data Committee (FGDC) and International Organisation for Standardisation (ISO). The adoption of standards recommended by these organisations assures users of the reliability and quality of the GI provided.
Compliance	Does the NIA put in place procedures or frameworks intended to check on the compliance to data standards?	The NIA should ensure that the GI produced adhere to the data standards. The standards document should be published and regular checks or audits should be conducted on the GI produced by the NIA.
Service Standards	Does the NIA implement quality and service standards?	"The NIA ensure that GI data is delivered with quality and within stipulated service standards. Service standards are important to ensure users are able to obtain data promptly and with quality assured.
Role of VGI		
Usage	Does the NIA recognise the impact of VGI?	VGI has an impact on traditional way of generating data and the NIA should recognise the significance of VGI as an alternative mode of obtaining geographic information
	Does the NIA use VGI?	The NIA should recognise VGI as a valuable source of generating geographic information and use it to supplement its data collection efforts.
	Does the NIA use VGI for decision-making processes?	VGI may provide insights that are valuable to the NIA as these are content that are generated by users instead of authoritative entities
Awareness	Are there non-governmental users of VGI?	VGI is a valuable source of generating geographic information and its use should not be confined to just governmental entities.
	Are majority of the non-governmental entities active contributors of VGI?	The NIA should involve as many entities as possible in the generation of VGI to foster an active community for data discovery.

The work flow for the current stage is shown in the next figure:

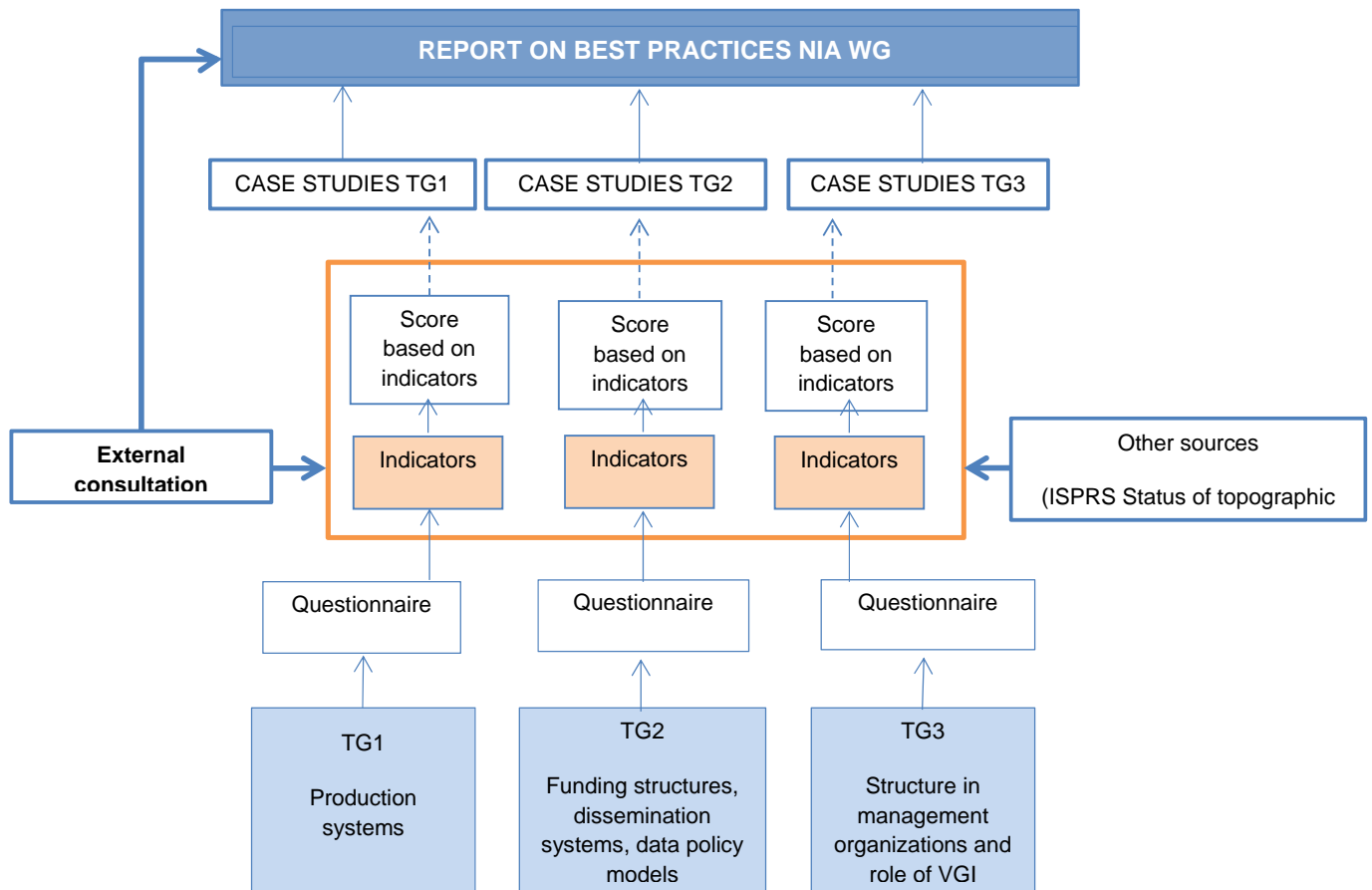


Figure 1 Proposed workflow for selecting case studies within NIA WG

2. Index building

In a later stage, with the results based on the previous indicators selected and other considered elements as socio-economic indexes, country size, etc., the final index on best practices on NIA will be developed, aiming to find the link between all elements.

Official socio-economic parameters and somehow country side must be taken into account since a single solution model cannot be assumed as representative result for the whole world, as socio-economic contexts and resources available in different countries are very diverse. Therefore, different NIA can be seen as best practices depending on the context of the studied country.

By following this approach, more appropriate conclusions about the performance of each country's NIA can be made, and conclusions per country or by group of countries will be possible to be obtained. This methodology is explained below in Figure 2.

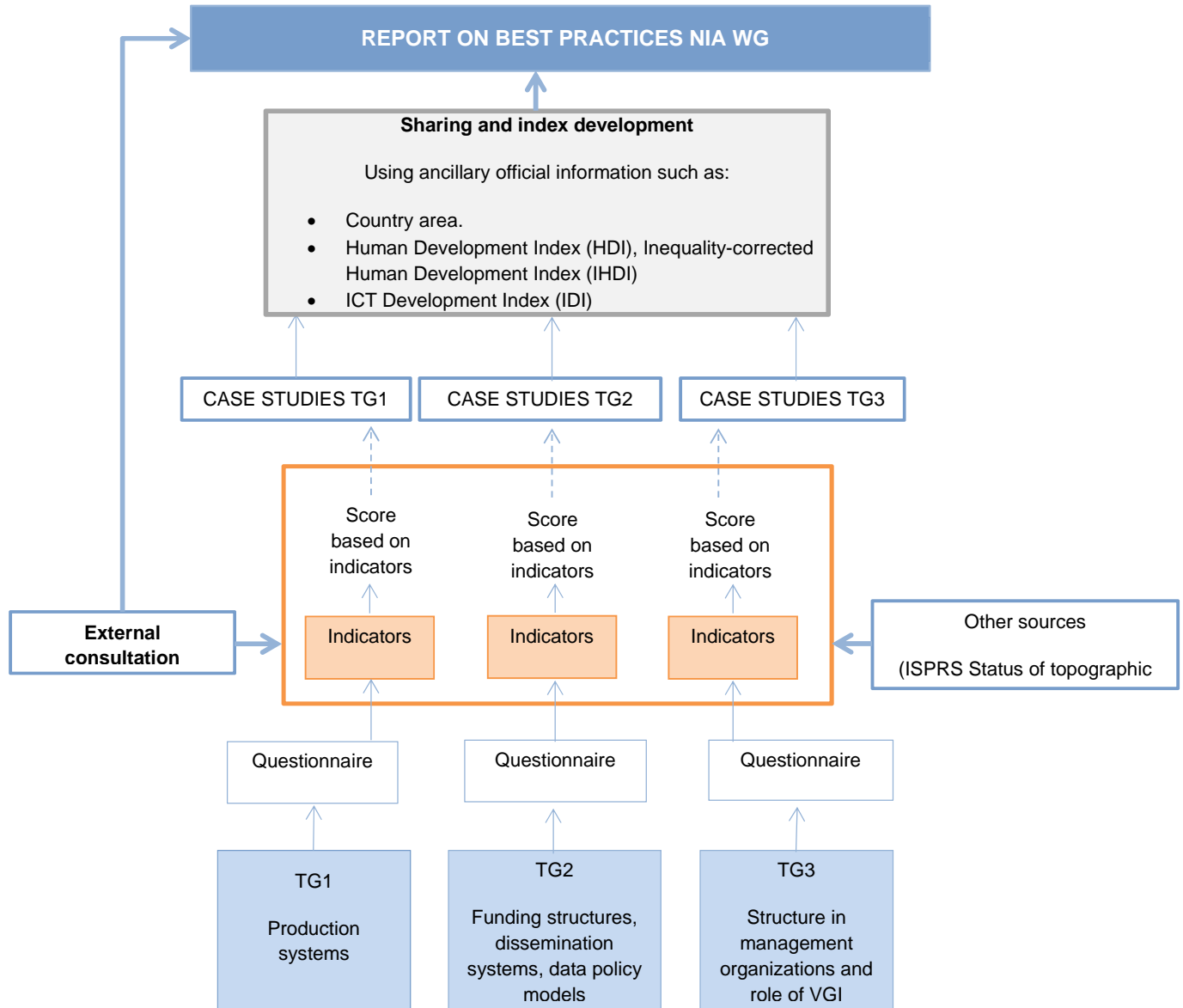


Figure 2. Proposed workflow for developing an index for best practices in NIA



Annex II

External Acknowledged Entities Consulted

One of the activities done under this framework has been the consultation of acknowledged experts. The NIA WG sought feedback from external acknowledged entities about the envisaged methodology, and also any comment and/or suggestions. This has helped to adopt the best approach and obtain the most representative results in the context of UN-GGIM. The entities consulted were 11 international external acknowledged entities, as listed below, with acknowledged prestige within the geographical information world. They have been consulted about the suitability of the methodology to the aims proposed and the possibility of considering the use of other ancillary data in the process.

1. Eurostat
2. Joint Research Centre
3. EUROSDR
4. UN-GGIM Expert Group on Land Administration and Management
5. UN-GGIM Europe Working Group-A
6. EuroGeographics
7. Carleton University
8. Commonwealth Scientific and Industrial Research Organisation (CSIRO)
9. UN-GGIM Europe Working Group -B
10. Hannover University
11. UN-GGIM Working Group on Global Fundamental Data Themes²
12. UNECA
13. Pan American Institute of Geography and History (PAIGH)
14. GeoSur

The NIA WG obtained responses from 10 of the 14 organizations enquired, and their comments are summarized in the following pages.

Eurostat

1. Suggests to consider in NIA activities the institutional arrangements of the European Statistical System (ESS), with the ESS Code of Practice and the EC Regulation 223/2009 at its apex, which covers aspects such as governance, quality management, statistics as free and open data, a supranational legal architecture.
2. Proposes as possible case studies the Global statistical geospatial framework defining areas for cooperation between National Mapping Cartographic Agencies (NMCAs) and National Statistic Institutes (NSIs) under GGIM and GEOSTAT 2 under the leadership of Statistics Sweden.
3. States to consider Big Data as an important area for institutional arrangements.

² The Secretariat of UN-GGIM: Europe acts as the permanent secretariat to the Working Group

EuroGeographics

1. Considers appropriate the proposed methodology and the phase of data collection.
2. Remarks the importance of having EuroGeographics members involved (European national mapping, cadastral and land registration authorities) and those with first-hand experience of the issues.
3. Considers fundamental to take into account ancillary data that will allow to analyze different NIA in different situations.
4. Suggests the reinforcement of some points.

UN-GGIM Expert Group on Land Administration and Management

1. Suggests the clarification of the themes intended to compare: institutions involved in GI management and/or the processes within the involved national GI organizations.
2. Asks for an explanation of the goals to be achieved with this overview of best practices.
3. Considers important to take into account not only the production but also the use, measurement and monitoring of geo-information.
4. Asks about the prevision of updating regularly the indexes obtained in the process.
5. Suggests to consult if the indicators used are still valid before defining case studies, as the survey has been conducted more than a year ago.
6. Proposes a benchmark approach between organisations/businesses, as a more useful and tangible approach rather than an overall one on a GI architecture for society at large.

UN-GGIM Europe Working Group-A

1. Notes that indicators reflect the practices more frequent but additional indicators, quantitative and not boolean, would be needed to know whether these frequent practices are good.
2. Regarding effectiveness, suggests measuring how much the production process achieves its objectives. The indicators are considered appropriate although some refinement may be necessary.
3. Regarding efficiency, suggests to measure the ratio between the efforts and the results. How the production process is organized is not good or bad in itself but it has to fit with the context.
4. Considers the proposed indicators applicable for developed countries but not so much for developing countries.

Carleton University

1. Considers ancillary data absolutely essential for understanding of best practices and must be considered.
2. Remarks the strong focus on technical aspects of GI management, considering that good management is often as much an art as a science and the best technical solution would be different depending of the available resources.

UN-GGIM Europe Working Group-B

1. Comments about some indicators:
 - “Is VGI included in the process?” considers necessary to know not only if it is part of the process but how VGI is managed in what kind of processes.
 - For the indicator “Are collaborative methods, understood as contribution [...]?” asks if the concept is analyzed on all public administrative levels (federal, regional, municipality) and if the collaborative methods may differ in terms of share of knowledge, costs and efficiency if the public administration is a federal one or a municipality.
 - For the indicator “Are more than 6 GRI themes produced with 1:25.000 scale or higher?” asks if the amount of GRI themes will be/should be increased .
2. Asks if the final index on best practices will become a guidance (document) for institutions (mainly NMCAs) to follow and how could it be used for a global monitoring and by whom.
3. Requests the proposals for indicators for TG1, TG2 and TG3 for a good evaluation of the final index development.

Hannover University

1. Remarks the scale problem as the NMA’s working at large scales are the ones having a large number of staff, which they could justify by including cadastral data into the fundamental data. Countries with only graduate programs were not able to build up the required staff numbers.
2. Has contributed putting together the budget and staff numbers per squared km from their UNGGIM-ISPRS Topo Mapping Study.

UN-GGIM WG FDS

1. Remarks the different focus that this NIA WG would have if in the country already exists a NMA that will be how to improve existing structures instead of create national geospatial entities.
2. Asks about the way of analysing Geospatial Information Management organizations all around the world by NIA WG, as there have been discussions at UN-GGIM meeting about not resending a questionnaire and this has been the approach adopted in the end.
3. Is pleased to see that the work of this NIA WG not interfere with the work of UNGGIM WG Data Themes.
4. Wonders about the result of this analysis due to the low response rate of the questionnaire, as it has not been resent.
5. Suggests the use of the Country Reports page of the UN-GGIM Knowledge Base (<http://ggim.un.org/country%20reports.html>) as the starting point to avoid duplication of efforts and resources as Member States are going to be proposed as case studies.
6. Proposes caution on basing a justification on data that has been collected for a different, although similar purpose.
7. Wonders about the link between the three TG about the information requested to the MS.
8. Asks about the way of including socio-economic factors and for the relevance of linking them to country size.
9. Considers that, although the practical workflow seems logical, given the number of missing respondents and lack of representative sample from Regions, it would be necessaire to

increase the response rate before drawing an accurate conclusion from the proposed methodology.

10. Considers that there is a risk of missing key indicators, as they have been set from data previously collected.

United Nations Economic Commission for Africa

1. The information contained in the report Fundamental Geospatial Datasets in Africa (A. Nonguierma, 2015) has been taken into account for the methodology and selection of countries in Africa.

Pan-American Institute of Geography and History (PAIGH)

1. Comments to indicators:
 - For the indicator “Are the methods applied for creation/update automatic or semi-automatic?” considers that is a highly biased indicator as it presumes that there exist production methods, or even production activity.
 - For the indicator “Are collaborative methods, understood as contribution with resources or economical, between public or private institutions used?” considers that it should be distinguished between cooperation with other public sector institutions, cooperation with private companies and cooperation with individuals (or NGOs).
 - For the indicator “Is BOTTOM-UP approach applied in the creation/update in more than [...]” expresses insecurity about the meaning of the term BOTTOM UP for the intended audience
 - For the indicator “Are more than 6 GRI themes produced with 1:25.000 scale or higher?” considers that country size must be take into account.
 - For the indicator “The update period is \leq 5 years for at least 4 GRI selected themes?” remarks the importance of the period of 10 years due to it can be linked to census data cycles.
2. About the overall methodology expresses its fear with having only “politically correct” answers. Also that available funding is the key so suggests requesting the gross budget available to produce geographic information (maybe discriminated per institution) and later an indicator could be build using the country size, or other indicator showing in practice the commitment to achieve results.



Annex III

Preliminary Findings on the Typology of NIA Organizational Structures

Foreword:

This document summarises the preliminary findings of the third Task Group of the Working Group on National Institutional Arrangements (NIA) governing geospatial information management, within the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM). The Task Group's objective is to identify best practices in the organisational structures of national spatial data infrastructures (NSDI).

Literature Review and Methodology:

The findings are based on existing literature, survey responses, and additional desktop research. The initial work focused on a review of the literature for an understanding of the various components, functions, and processes, which shape the developments and trends of NIA. The perspectives around data production and use, governance, as well as adoption of technology, have been observed to evolve over the past two decades (Masser, 1999; Masser, 2005). Social and economic developments, such as the emergence of the World Wide Web, the advancement of GPS and GIS, reduction in production costs, and increased availability of geospatial information, have transformed both policy and implementation structures of NSDIs (Rajabifard et al., 2006). Different NSDIs have organised their functions differently as a result.

Dessers et al. (2011) provide useful concepts for comparing the diverse organisational structures of NSDIs. The following typology can be adapted and applied to the needs of this research: 1) function-based, 2) process-based, and 3) hybrid. The first type refers to NSDIs with the separation of their coordination functions from their operational ones, as well as the separation of different operational functions into distinct units. The second type refers to NSDIs with the integration of their coordination and operational functions, as well as the integration of different operational functions across various units. The third type refers to NSDIs that display combinations of both types. An attempt was then made to categorise NSDIs accordingly, using the responses of 51 countries to a survey conducted in 2015, and additional desktop research.

Findings & Observations:

No trend in regional distribution across the categories has been observed. Countries that could be recognised to have well-established NSDIs are also spread evenly across the categories. The lead entities of the NSDIs include national mapping agencies, geospatial agencies, land administration authorities, ICT agencies, ministries³, and multi-stakeholder steering committees. In several instances, lead agencies or ministries have been observed to be supported by subordinate multi-stakeholder steering committees and/or advisory councils. Yet, in others, these lead entities employ executive committees to coordinate the implementation of NSDI operations. This implementation could be carried out in vertical policy domains, technical working groups, or networks of working groups, service providers and data producers. A summary of the NSDIs' classification and specific examples based on each classification can be found in Annex III-A.

³ Ministries often lead NSDIs through a subordinate office or steering committee. Their portfolios include Planning and Budget; Environment; Defence; Land, Infrastructure, and Transport; and Agriculture.

There does not appear to be a single solution model on how best to structure a NIA. Various countries appear to be able to achieve effectiveness in their GIM initiative despite having organised themselves differently. As no single organisational structure fits all NIA, the report's findings are meant to be a framework for comparison at best, and other factors should be examined for a more holistic assessment. The findings from the other Task Groups will provide useful material in this regard.

ANNEX III-A

Type of Organisational Structure*	With Private Sector, Academia Representation	Without Private Sector, Academia Representation
1. Function-based control and production structures		Colombia; El Salvador; Ethiopia
2. Process-based control and production structures	Australia; Germany; USA	Singapore
3. Hybrid structures		
a) Function-based control structure, hybrid production structure		Panama
b) Process-based control structure, hybrid production structure	Spain; UK	Italy; Qatar
c) Hybrid control structure, process-based production structure	Bhutan; Canada; Denmark; Norway	
d) Hybrid control structure, hybrid production structure	China; Finland; Jamaica; Japan; Romania; South Africa; The Netherlands	Greece; Uruguay
e) Hybrid control structure, function-based production structure	Abu Dhabi; Argentina; Bahamas; Brazil; Burundi; France; Georgia; Korea; Latvia; Mexico; Nigeria; Palestine; Slovakia; Sweden; Turkey	Bahrain; Chile; Namibia; Philippines

Table 1 Categorisation of Countries' NSDI's according to the proposed typology of organisational structures. This is not definitive and is subject to verification by the countries

*Control structures are the architecture of strategic (i.e. coordination and regulation) functions, while production structures are that of operational (i.e. productive, preparative, and support) ones. In function-based structures, these functions are concentrated in separate organisational units; whereas in process-based structures, they are integrated within the same units. Function-based control structures reflect centralised management systems, whereby strategic functions are separated from operational ones; while function-based production structures reflect the division of various functions of geospatial information production amongst distinct units. Process-based control structures reflect decentralised management systems, whereby the strategic and operational functions are integrated; while process-based production structures reflect the integration of various functions of geospatial information production across various units (Dessers et al., 2011).

Example 1 - Function-based control and production structures

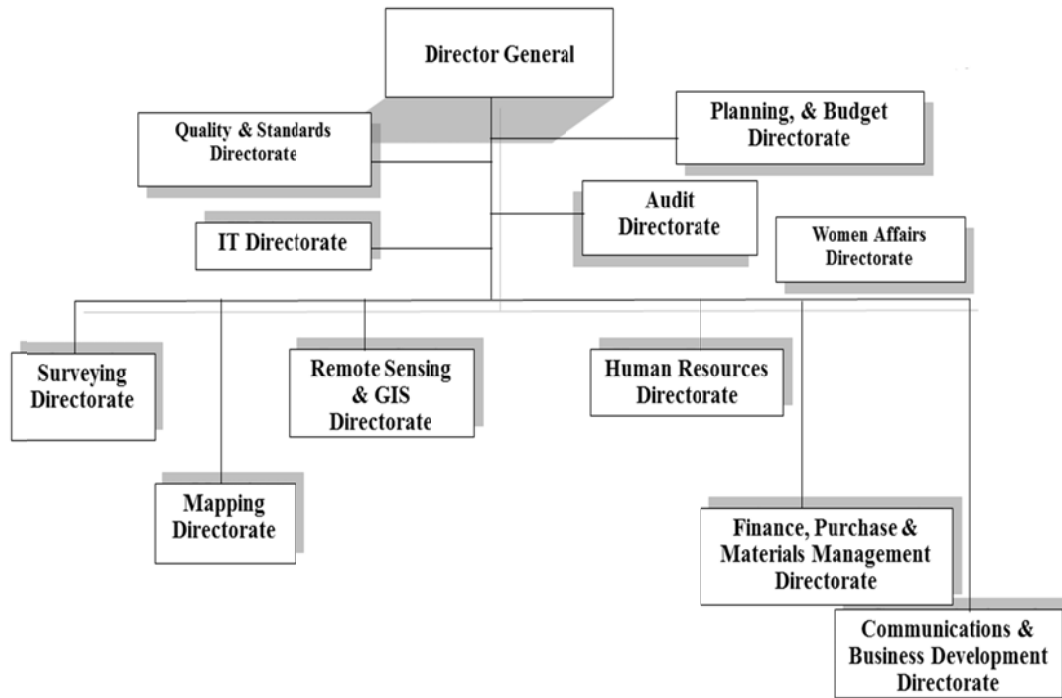


Figure 1 Organisational Structure of the Ethiopian Mapping Agency.

The Ethiopian Mapping Agency (EMA) leads Ethiopia's NSDI, and is observed to have a centralised command function with a hierarchical reporting system, with the implementation of tasks carried out by directorates in charge of distinct functions

Example 2 - Process-based control and production structures

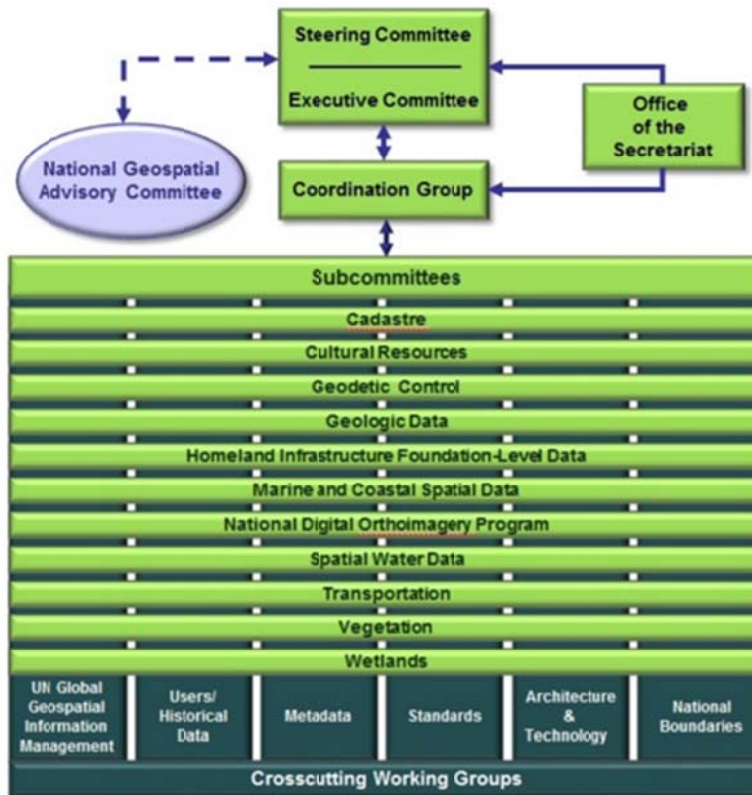


Figure 2 Organisational Structure of USA's NSDI

USA's NSDI is governed by the Federal Geographic Data Committee (FGDC), which is a networked, collaborative framework spanning all sectors and levels of government. Nested sets of groups with intertwining functions are present throughout the FGDC. Specifically, its strategic functions are held by the FGDC Steering Committee, Executive Committee, National Geospatial Advisory Committee, and Office of the Secretariat. These establish policy and provide direction for the FGDC.

On the other hand, the operational functions are led by the FGDC Coordination Group and implemented by thematic subcommittees and cross-cutting working groups. Both the strategic and operational functions are observed to be integrated in the form of overlapping representation by agencies in multiple groups. For example, each thematic subcommittee and working group is chaired by a federal agency, which also has a representative in the Steering Committee. Similarly, the FGDC Coordination Group is represented by federal agencies in the Steering Committee, working groups, and thematic subcommittees. The latter two are observed to draw their membership from one another too. For example, each FGDC subcommittee, working group, and member agency is a member of the Standards Working Group. The cross-cutting relationship of these bodies breaks down organisational lines when joining up separate functions needed for the production of geographic information.

Example 3 - Function-based control structure, hybrid production structure

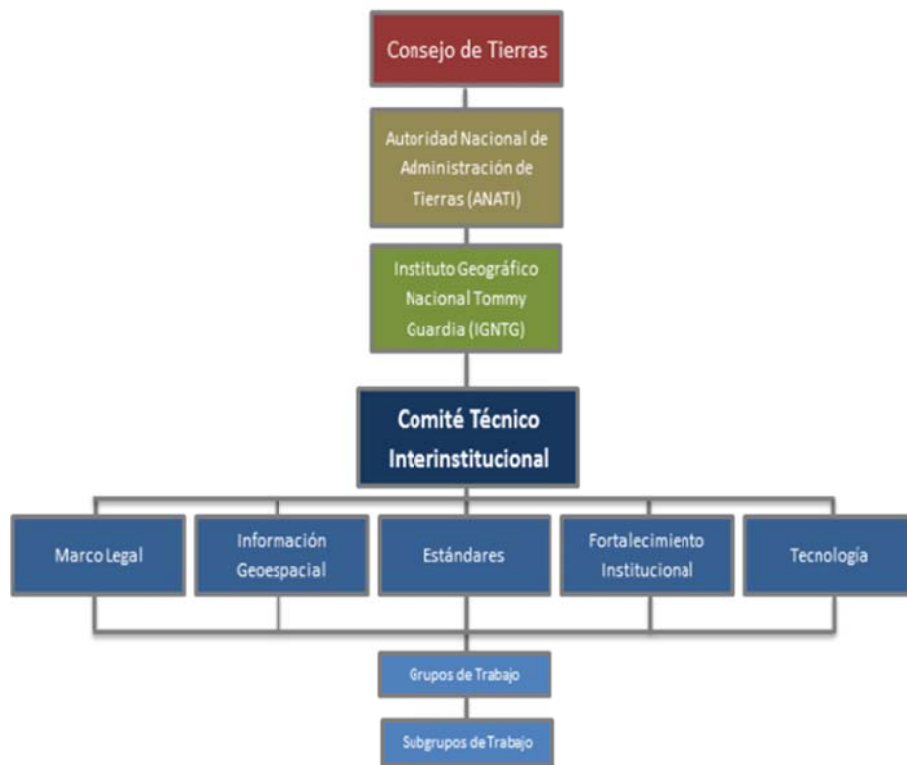


Figure 3 Organisational Structure of Panama's NSDI

Panama's NSDI (IPDE) is led by the National Council on Lands, where its strategic function is concentrated, and implemented by the Inter-Institutional Technical Committee, which operates through five distinct components. Namely, these are legal framework and policies, geospatial information, standards, technology, and institutional strengthening, and they have work groups and sub-work groups. The components have members that are observed to be part of the Inter-Institutional Technical Committee too, and thus both bodies are intertwined with each other within the production structure.

Example 4 - Process-based control structure, hybrid production structure

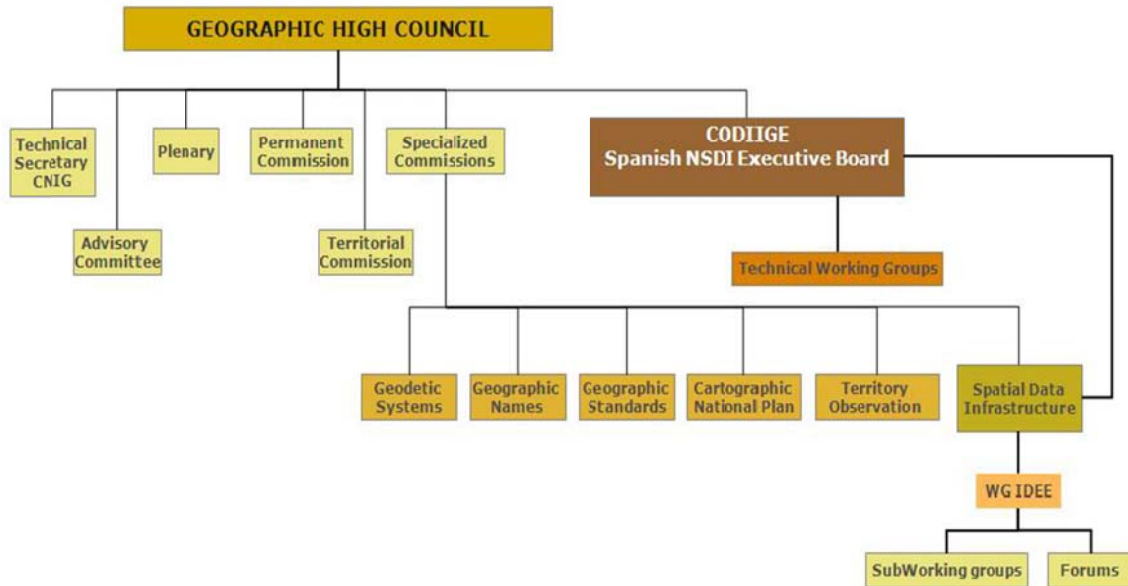


Figure 4 Organisational Structure of Spain's NSDI

Spain's NSDI (IDEE) is coordinated by the National Geographic High Council (CSG), and comprises representatives from the national, regional and local levels of government. Under the CSG are specialised commissions committed to carrying out technical duties in distinct areas. An executive board (CODIIGE) also leads various technical working groups for data and services implementation, such as metadata and catalogue; monitoring and reporting; and architecture, standards and network services. CODIIGE and the CSG are observed to be intertwined as the former includes members of specialised commissions under the latter, as well as members from all three levels of government.

One of these specialised commissions focuses on NSDI-wide programmes and reports directly to CODIIGE too. The Specialised Commission on SDI operates through a Working Group IDEE, which is made up of experts from the CSG who are geographic data producers, academics, and companies dealing with catalogue and data services. On the other hand, the technical working groups have their own coordinating dynamics and often converge with the specialised commissions. For example, the Specialised Commission for Geographic Names is the main coordinating mechanism for the technical working group for Geographic Names. Hence, processes are observed to integrate the strategic and operational functions, as well as the various operational functions that remain distinct along organisational lines at the same time.

Example 5 - Hybrid control structure, process-based production structure

Bhutan's NSDI is led by a single national mapping agency, the National Land Commission Secretariat, and its subordinate Center for Geographic Information System (CGIS). The CGIS coordinates the NSDI through the inter-agency Government Data Steering Committee (GDSC) that provides overall leadership and direction. Under the GDSC is a Working Committee (WC) which oversees and approves specific programmes and policies, as well as facilitate data sharing among agencies. The WC coordinates the Geospatial Data Management Work Group (GDMWG), Geospatial Technology Adoption Work Group (GTAWG), and Geospatial Project Teams, which are in charge of data management activities, technology innovations for geospatial applications and services, and ad hoc initiatives, respectively. These work groups are observed to provide broad scopes for government agencies to form collaborative networks for implementing specific initiatives.

Example 6 - Hybrid control structure, hybrid production structure

The NSDI of the Netherlands is led by the Ministry of Infrastructure and the Environment through the GI Council, which comprises all ministries and agencies involved in the NSDI. Separately, the Ministry funds Geonovum, an inter-agency organisation committed to increasing the accessibility of geospatial information, to implement data management activities, including standards, metadata, and network services. The Ministry, however, also heads a system of key geo-registers for maintaining datasets and services, such as cadastral, topographical, and addresses and buildings. Their tasks are distributed among different municipalities and the national mapping agency Kadaster. Hence, the production structure is observed to have both function- and process-based division of labour.

Example 7 - Hybrid control structure, function-based production structure

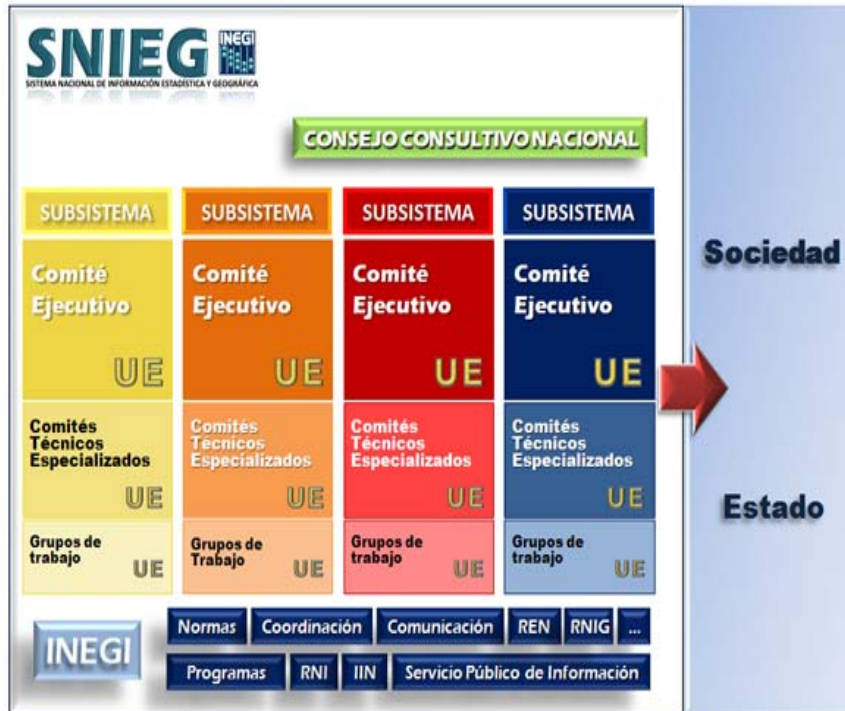


Figure 5 Organisational Structure of Mexico’s NSDI

Mexico’s NSDI consists of a lead agency, the National Institute of Statistics and Geography (INEGI), a National Advisory Council, and four National Information Subsystems. While INEGI is a distinct lead agency, the National Advisory Council supports it in its coordination function through a network of high-level representatives of all federal agencies, States, the Central Bank, the legislative and judicial branches, as well as the private sector. Hence, the strategic and operational functions are observed to be integrated at the same time as they are divided into independent organisational units.

The operational function, on the other hand, is divided among four National Information Subsystems. Each of them is in charge of a policy domain; namely Society and Demographics, Economics, Geography and the Environment, and Government, Public Security, and Justice. These Subsystems consist of State Units, which are administrative areas with the authority to develop statistical and geographic activities, such as federal agencies, states and municipalities, and the legislative and judicial branches. Each Subsystem is led by an executive committee, and contains several specialised technical committees focused on specific areas. For example, the Geographic and Environmental Subsystem consists of the Water, Atmosphere and Climate, as well as Land Use, Vegetation and Forest Resources specialised technical committees. The Subsystems are observed to represent vertical, hierarchical structures with few horizontal processes for inter-Subsystem coordination. This demonstrates a clear function-based production structure.

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