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SERIES

STUDIES AND PERSPECTIVES 119

ECLAC SUBREGIONAL HEADQUARTERS FOR THE CARIBBEAN

Advancing geospatial information management for disaster risk management in the Caribbean

Artie Dubrie
Elizabeth Emanuel
Jacob Opadeyi
Valrie Grant

UNITED NATIONS

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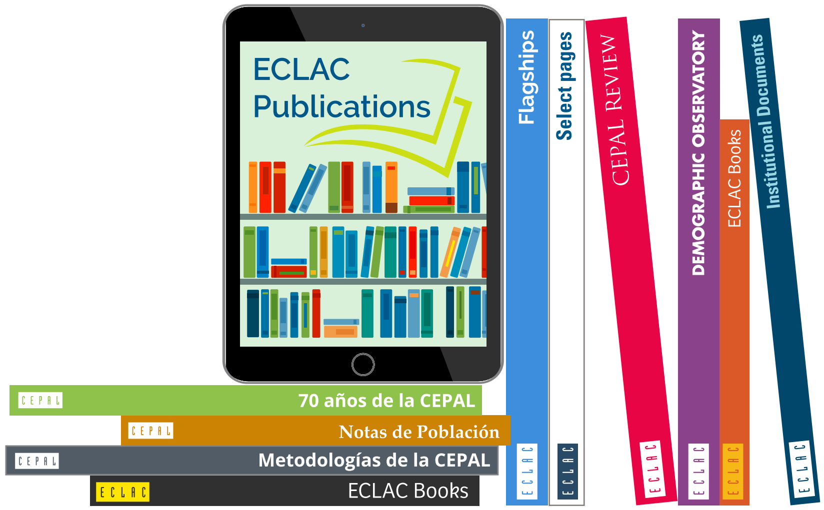

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This document was prepared by Artie Dubrie and other members of the Sustainable Development and Disaster Unit of the subregional headquarters for the Caribbean of the Economic Commission for Latin America and the Caribbean (ECLAC). Formatting assistance was provided by Esther Chong Ling, Programme Management Assistant. The research and data inputs were provided by Elizabeth Emanuel, Technical Assistance Manager of the Caribbean Catastrophe Risk Insurance Facility (CCCRIF) and geospatial information management consultants Jacob Opadeyi and Valrie Grant. This document received contributions from the following expert reviewers: Cecille Blake, Statistician of the Statistics Division of the Department of Economics and Social Affairs; Álvaro Mauricio Monett Hernández, Regional Adviser on Geospatial Information Management of the Statistics Division of ECLAC.

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Abbreviations

BNGISC	Bahamas (The) National GIS Centre
CARICOM	Caribbean Community
CARIGEO	Caribbean Geospatial Development Initiative
CCA	Climate Change Adaptation
CCCCC	Caribbean Community Climate Change Centre
CCRIF SPC	Caribbean Catastrophe Risk Insurance Facility
CCRS	Caribbean Centre for Remote Sensing
CDB	Caribbean Development Bank
CDEMA	Caribbean Disaster Emergency Management Agency
CDM	Comprehensive Disaster Management
CIMH	Caribbean Institute Meteorology and Hydrology
DBMS	Database Management Systems
CRIS	Caribbean Risk Information System
DEM	Digital Elevation Models
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction

ECLAC	Economic Commission Latin America and Caribbean
ECOSOC	The United Nations Economic and Social Council
EO	Earth Observation
GDACS	Global Disaster Alert Coordination System
GFDRR	Global Facility for Disaster Reduction and Recovery (World Bank)
GIM	Geospatial Information Management
GIS	Geographic Information Systems
GNSS	Global Navigation Satellites Systems
GAC	Geospatial Advisory Council (of The Bahamas)
GSGF	Global Statistical Geospatial Framework
GST	Geospatial Technology
IGIF	Integrated Geospatial Information Framework
MOU	Memorandum of Understanding
NOAA	National Oceanic and Atmospheric Administration (of the United States of America)
NERGIST	National Emergency Response Geographical Information Systems Team
NSDI	National Spatial Data Infrastructure
NSDMD	National Spatial Data Management Division (of Jamaica)
OCHA	Office for Coordination of Humanitarian Affairs
OECS	Organisation of Eastern Caribbean States
OSOCC	On-Site Operations Coordination Centre
RSO	Regional Support Centres
SIDS	Small Island Developing States
SPHERA	System for Probabilistic Hazard Evaluation and Risk Assessment
UNDAC	United Nations Disaster Assessment and Coordination
UNDDR	United Nations Disaster Risk Reduction
UN-GGIM	United Nations Committee of Experts on Global Geospatial Information Management
UN-IGIF	United Nations-Integrated Geospatial Information Framework
UWI	University of the West Indies
UNOOSA	United Nations Office for Out of Space Affairs
UNOSTAT	United Nation Operational Satellite Centre
UN-SPIDER	United Nations Platform for Space-based Information for Disaster Management and Emergency Response
WG-GISD	Working Group on Geospatial Information and Services for Disasters

Abstract

The Caribbean is highly vulnerable to the impacts of climate change, extreme weather events and other natural hazards. The subregion is also exposed to anthropogenic hazards, including petroleum and other industrial chemical spills, fires, and soil, air and water pollution. These hazards can result in loss of life and other health impacts, damage to infrastructure, social and economic disruptions and ecological degradation. To significantly reduce the negative effects of these hazards, it is important that key stakeholders, including national disaster management agencies, development partners, and the private sector, particularly insurance companies be integrally engaged in the shaping of comprehensive disaster risk management (DRM) strategies and plans. The success of DRM will depend on the effective management of relevant information and data. Geospatial Information Management (GIM) has enabled more timely, data-driven, informed DRM decision-making.

This research provides an introduction to the status and use of GIM in support of DRM in the Caribbean region. The data and information obtained from on-line surveys and desk studies indicated that the Caribbean countries are at varying stages of progress towards the integration of GIM in DRM. Policy setting, legislation, education, capacity building, technological investment and institutional strengthening driving geospatial data management are priority areas identified for further advancing this progress. The study offers recommendations towards further strengthening the use of GIM in DRM both nationally and at the level of the Caribbean region.

Introduction

The Caribbean is highly vulnerable to a range of extreme hydroclimatic events, with flooding being the most frequent, and hurricanes and storms the most damaging. The subregion is also subject to other natural hazards including volcanic eruptions, earthquakes, drought, sea-level rise and the annual inundation of sargassum blooms. Considering that 60% of the subregion's population and 70% of its economic activity are located at or near the coastline, the impact of hazards due to climate change in particular are projected to intensify (CDEMA, 2014). The subregion's unique ecosystems and its socioeconomic dependence on tourism, the marine environment and coastal areas therefore demand that disaster risk management (DRM), including risk reduction mechanisms be paramount in the shaping of its sustainable development agenda.

With a view to addressing the requirements for effective and sustainable management of the impacts of natural disasters, countries and development agencies of the subregion have made progress in developing DRM[1] normative and institutional frameworks (ECLAC 2019). The effective functioning of these frameworks must be data driven and serve to support a reduction in vulnerability,[2] and enhanced capacity for recovery and resilience building following the impacts of disasters.

Data acquisition, access, visualization, analysis, reporting, and storage are necessary for effective DRM. The data obtained can be used for conducting damage and loss assessments, trend analysis of the occurrences of disasters over a geographic region, natural hazard prediction and modelling,

1 Disaster risk management is the application of disaster risk reduction policies, institutional arrangements, processes and actions to prevent new risk, reduce existing disaster risk and manage residual risk contributing to the strengthening of resilience. DRM is designed to mitigate and or reduce the impacts of and recover from disasters by providing a framework for helping at-risk persons and/or communities. DRM includes a range of activities, prior to an impact, during and after a disaster, link : https://www.prevention web.net/files/45462_backgoundpaperonterminologyaugust20.pdf, accessed February 19, 2023.

2 Vulnerability can be described as the conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards, see link at:https://www.undrr.org/ter minology/vulnerability#:~:text=The%20conditions%20determined%20by%20physical,to%20the%20impacts%20of%20hazards, ace ssed on December 21, 2022.

simulation of response rate to vulnerable communities, storm run-off prediction from watersheds and site suitability screening for hazardous waste facilities (Hamilton, 2000). The accessibility of quality data and information from authoritative sources facilitates more systematic and integrated approaches to data collection, storage, retrieval and sharing capabilities and use for informed DRM decision making.[3] In support of these requirements, DRM operations are currently benefiting from the use of Geospatial[4] Information Management (GIM) to advance efficiency and effectiveness in data acquisition, data analysis and data management systems before, during and after disasters (UN-GGIM, 2017).

DRM processes such as vulnerability assessment, hazard and multi-hazard risk mapping, evacuation planning, and mitigation management can now be undertaken using modern technologies and direct access to timely differnet high-resolution satellite imagery at lower cost than before. Technological innovations[5] have provided efficiency and effectiveness in the data acquisition challenges of DRM. These technologies have brought dramatic benefits such as: access to data from a wide range of sources, lower cost of data collection, higher data resolution and accuracy, shorter time frame with possibility for real-time data collection and higher repeatability. Caribbean examples where GIM has been used for DRM include hazard mapping and vulnerability assessment in Antigua and Barbuda (Hodgkinson-Chin and Rogers, 2001), hazardous chemical transport in Barbados (Riley, 2001), the development of a hazard emergency management information system in Trinidad and Tobago (Ali, 2001) and using partial participatory geographic information systems (GIS)[6] in vulnerability and disaster risk reduction in Grenada (Canevari-Luzardo et al, 2017). These examples of country driven approaches are consistent with emerging regional and global developments in the application of GIM in disaster management.

GIM is required for all stages of DRM. When applied to DRM, GIM supports increased effectiveness in decision making through improved data collection. It also increases the comparability and compatibility of diverse data sets, enables higher data resolution and accuracy, and promotes shorter time frame with possibility for real-time data collection and higher repeatability (ECLAC, 2021).

The following are examples of the use of GIM in DRM:

- Preparation of national vulnerability assessments including land use planning, coastal zone management, infrastructure development and integrated water resources management;
- Early detection, predictive disaster and risk analysis, monitoring and reporting on the economic, social, environmental and infrastructure impacts including those of damage and loss;[7]
- Management, allocation and deployment of social, health and environmental services, as well as logistical and other resources during and after a disaster;

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3 E/2018/L.15 (UN, Economic and Social Council), Draft resolution Strategic Framework on Geospatial Information and Services for Disasters, 2018.

4 Geospatial describes the collective data and, various associated technologies that have a locational or geographical component. It can be considered as an umbrella term covering various types of technologies including geographic information system (GIS) and geographical data. See link at: The Difference Between GIS & Geospatial | GeoDecisions Blog, accessed December 21, 2022.

5 The following are the more common GST technologies use in DRM: GIS, high resolution commercial observational satellites; airborne video; Global Navigation Satellite Systems (GNSS); and telemetric data acquisition systems etc.

6 Geographic information system (GIS) is a suite of soft-ware tools that creates, manages, analyses, and maps data that is georeferenced. GIS connects data to a map, integrating location data (where things are) with descriptive information (what things are like there). This provides a foundation for mapping and analysis that is used in science and almost every industry. GIS helps users understand patterns, relationships, and geographic context. The benefits include improved communication and efficiency as well as better management and decision making, link at: https://www.esri.com/en-us/what-is-gis/overview, accessed January 18, 2022.

7 The post-disaster damage and loss assessment (DaLA) was developed by ECLAC. Further information of the DaLA can be sourced from the Handbook for Disaster Assessment (2014), see link at: https://repositorio.cepal.org/handle/11362/36823, accessed December 21, 2022.

- Integration of new sources of data such as for the Earth Observations[8] and other related data sources;
- Provision of data inputs required for monitoring, assessment, measuring and reporting requirements under global Agreements, notably the 2030 Agenda and its Sustainable Development Goals (SDGs),[9] Small Island Developing States - Accelerated Modalities of Action, the Sendai Framework for Disaster Risk Reduction (2015-2030), the Paris Agreement and the New Urban Agenda;
- Provision of inputs for negotiations with bi-lateral and multilateral DRM financing and other developmental partners;
- Provision of data and information to the insurance sector in the modelling, exact location,[10] prediction, assessment of damage and claims management (KOREM, 2023).

A. Applications of geospatial information management in disaster risk management

The impacts from disasters are inherently spatial.[11][12] GIM provides real-time geospatial data and information supporting the requirements for authoritative and informed decision making at all stages of DRM (National Research Council 2007; Thomas. D 2018). These applications of GIM at the mitigation, planning and preparedness, response, recovery and reconstruction stages of DRM are briefly discussed below.

1. Disaster Mitigation, Planning and Preparedness

In the pre-disaster mitigation, planning and preparedness phases, actions are taken towards ensuring effective response and recovery in the event of a disaster. These phases require multidisciplinary approaches guided by a clear understanding of the underlying scientific principles and processes inherent in a wide range of natural and man-made hazards, incident types, and underlying vulnerabilities. GIM can play a particularly important role through the modelling of hazard and risk scenarios to identify potential physical, virtual, and social vulnerabilities that can be mitigated or reduced through increased resilience efforts. Incorporating modelling into GIM can add value to disaster planning in the preparedness phase as it allows for scenario planning and simulations. This will allow the relevant disaster managers to view the scope of a disaster, where the damage may be the greatest, the properties that are at highest risk, and the response required.

The management of the GIM services are also to be planned and adequately resourced. Considering the wide range of natural disaster possibilities based on numerous underlying hazards including location

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8 Earth observation is the gathering of information about planet Earth's physical, chemical and biological systems. It involves monitoring and assessing the status of, and changes in, the natural and man-made environment, link: https://www.earth observations.org/g_faq.html, and https://www.euspa.europa.eu/european-space/eu-space-programme/what-earth-observation, accessed December 4, 2022.

9 The 2030 Agenda recognises the value that geospatial information management provides to enable information and decision making. The UN SDGs Geospatial RoadMap aims to provide practical guidance for the use of geospatial information for the measurement and monitoring of the SDGS, link: https://ggim.un.org/meetings/GGIM-committee/11th-Session/documents/The_Geospatial_SDGs_Roadmap_WGGI_IAEG_SDGs_20210804.pdf, accessed December 20, 2022.

10 Location data also known as geographic information or geospatial data, refers to information related to objects or elements present in a geographic space. The two types of location data are: vector data and raster data, link: https://www.tableau.com/learn/articles/location-data-types, accessed February 14, 2023.

11 These include for example, the interactions between people, the places they live, the built and natural environment that surround them and the events that impact and affect them.

12 The data and information are obtained primarily through a Geographic Information Management System (GIMS). GIMS is a data system that creates, manages, analyzes, and maps all types of data. It provides a foundation for mapping and analysis of datasets within a geographic context, link: https://www.esri.com/en-us/what-is-gis/overview, accessed December 21, 2022.

specificities, it is prudent to prepare and curate fundamental datasets including maps for potential and early warning disaster situations. Preparedness can also include planning activities such as the upgrading and building of GIS hardware, software and datasets, as well as training and capacity building to meet operational and decision-making requirements.

2. Disaster Response phase

In the *response phase*, actions are taken immediately before, during, and after an event to alleviate the suffering of the community and to prepare for recovery. GIM is critical to supporting situation awareness. Disaster managers are required to be constantly aware of the situation they are dealing with in a number of different dimensions such as locations of response personnel, communities to be evacuated, disaster victims, location of relief supplies, public information among others. The time-sensitive nature of disaster response also dictates that geospatial and other allied technologies are needed to keep up with a rapidly evolving situation and are able to generate disaster-response products that are readable, accessible and usable to support effective decision making.

In the area of public information and awareness, natural hazards such as hurricanes are often portrayed using maps to inform on estimated time, intensity and location of impact, thereby serving as essential data sources for early warning and assessment. This information and data are often used by DRM agencies and the media to inform on situational analysis and on actions to be taken.

3. Disaster Recovery phase

Disaster recovery is focused on the transition of the built environment, businesses , and communities to a state of acceptable operation following a disaster event. This requires long-term planning and commitment to achieve recovery goals. Disaster recovery operates at varying space and time scales and the nature of the specific recovery operation (USA-FEMA, 2021).

For example, in the short-term recovery stage, disaster managers are assigned to support the transition of affected persons from emergency shelters to regular housing. In this case, GIM and in particular that of GIS can be used for location-specific planning and coordination such as identifying people in specific shelters and the locations to which they can be moved, the establishment of essential services as well as monitoring the rebuilding and redevelopment of communities (Tomaszewski, 2020). Other location-specific recovery activities, such as provision of public health services can rely on GIS data for decision making, site-selection and to locate temporary health centres (Egawa, Murakami, and Sasaki,2017).

I. Methodology

This study seeks to assess the status of advancements on the use of GIM as a necessary tool for effective DRM in the Caribbean region. The field data and information to support this research were obtained through the following sources:

- Interviews conducted with GIM and disaster management professionals on addressing international, regional and national GIM strategies, policies, institutional, human resources, operative arrangements and structures supporting DRM. Interviews were conducted with representatives from UN Statistics-Department of Economics and Social Affairs; ECLAC Geospatial Information Management-Statistics Division, Caribbean Disaster and Emergency Management Agency (CDEMA), Caribbean Climate Change Centre, Organisation of Eastern Caribbean States (OECS), University of the West Indies-Department of Geoinformatics, St. Augustine and the Caribbean Development Bank. These interviews were conducted on-line in December of 2021 (see Survey instruments - annex 1 and annex 2).
- Questionnaire on the use of Geospatial Technologies (GST)[13] and Data for DRM. Official letters and questionnaires were electronically administered to 16 Caribbean countries and targeting national DRM agencies in the period April-September 2021. Responses to these questionnaires were received from 10 Caribbean Countries including: The Bahamas, Barbados, British Virgin Islands, Grenada, Guyana, Jamaica, St. Kitts and Nevis, Trinidad and Tobago, Sint Maarten and Turks and Caicos Islands (see Survey instruments: annex 3 and annex 4).

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[13] Geospatial Technology includes for example: GIS, Remote Sensing (RS), and Global Positioning System (GPS). Geospatial technology enables us to acquire data that is referenced to the earth and use it for analysis, modelling, simulations, and visualization. Link:http://www.bcc.cuny.edu/academics/geospatial-center-of-the-cuny-crest-institute/what-is-geospatial-technology, accessed February 15, 2023.

Other sources of information used for the preparation of this study were: Training needs assessment survey and recommendations drawn from two (2) Geospatial - regional training workshops conducted by ECLAC in 2021[14] (see annex 5 - Training needs pre-assessment online-survey) and desk research.

The data obtained from the on-line surveys, training needs assessments and desk research were analysed to identify current practices, gaps and provide recommendations on priority areas and strategies to advance the use, accessibility, and application of GIM in DRM in the Caribbean.

Limitation of the study: The national surveys were administered online during the COVID-19 pandemic control measures in 2021. This resulted in communication challenges in reaching relevant offices for the administration of the questionnaires and to conduct virtual interviews.

[14] These reports can be accessed at: Workshop I on policy issues towards effective applications of geospatial technologies and data in support of disaster risk management in the Caribbean (LC/CAR/2021/8), link https://repositorio.cepal.org/handle/11362/47605 and Workshop II on technical issues towards effective applications of geospatial technologies and data in support of disaster risk management in the Caribbean (LC/CAR/2021/11): https://repositorio.cepal.org/handle/11362/47608.

II. Geospatial information management and disaster risk management

The overview of select international frameworks employing the use of GIM in DRM presented below is intended to be illustrative. It describes illustrates successful applications of GIM in DRM, and includes case examples drawn from two Caribbean institutions.

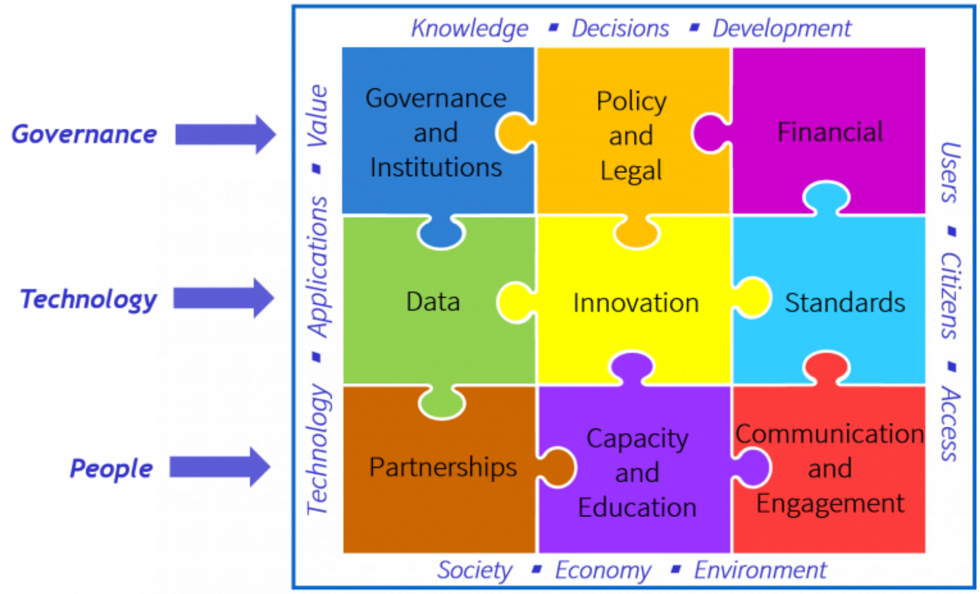
A. International Frameworks

1. The United Nations-Integrated Geospatial Information Framework

The United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM) through its Integrated Geospatial Information Framework (IGIF) provides a set of strategic and practical guidelines to establish, integrate and strengthen GIM arrangements at the national level. This framework enlists key elements as requirements to build a national data sharing environment and demonstrates the value of applying geospatial information for decision-making (UN-IGIF, 2023).[15] The UN-IGIF contains nine strategic pathways serving to support this process including: governance and institutions, policy and legal, financial, data innovation, standards, partnership and capacity and education. These strategic pathways are illustrated in Diagram 1 with a focus on building and supporting GIM requirements at the national level.

[15] The UN-IGIF supports decision-making and public policies and the implementation of the Sustainable Development Goals (SDGs) especially in developing countries. The strategic pathway (2022) is available at link: https://ggim.un.org/IGIF/documents/SP1_Governance_and_Institutions_Refined.pdf, accessed February 19, 2023.

Diagram 1
United Nations Integrated Geospatial Information Framework.



Source: UNGGIM 2017.

(a) The UNGGIM- Strategic framework on geospatial information and services for disasters

The UN-GGIM-Working Group on Geospatial Information and Services for Disasters (UNWG-GISD), at its 2017 meeting adopted a strategic framework for geospatial information and services for DRM.[16] [17] Taking into account national circumstances and consistency with domestic laws as well as international obligations and commitments, this framework is based on guiding principles that emphasize the fundamentals of data *sustainability*, *accessibility*, *complementarity, and interoperability.*[18]

The UN-GGIM Framework for Disaster provides a framework for countries to optimize the benefits of the use of geospatial information and services across all phases of DRM. This framework is aligned to the 2030 Agenda for Sustainable Development, contributes to the implementation of the Sendai Framework for Disaster Risk Reduction 2015-2030 and assists in addressing knowledge gaps in DRM by improving systems and networks for the collection and analysis of information on disasters, vulnerabilities and disaster risks to facilitate informed decision-making (UN-GGIM, 2017). This is illustrated in diagram 2.

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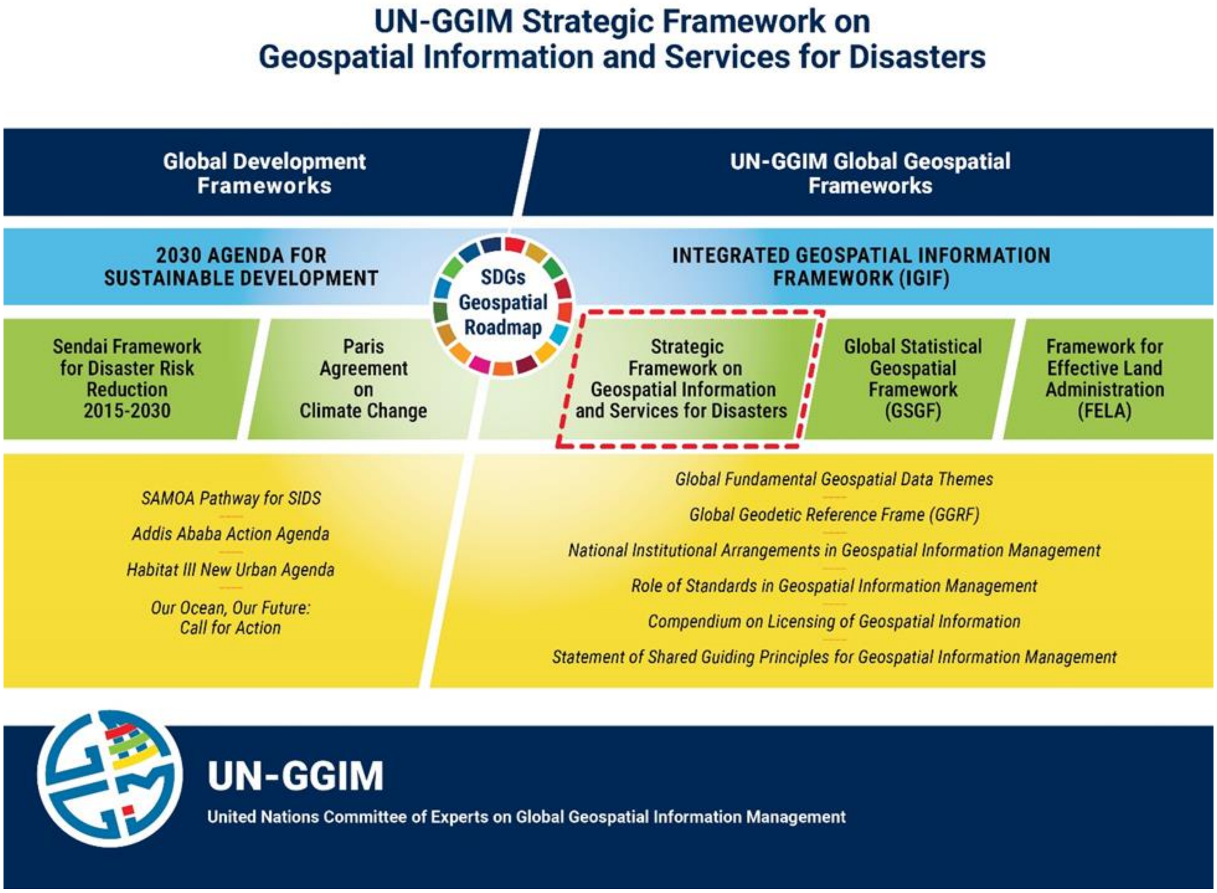
16 UN- Committee of Experts on Global Geospatial Information Management Report on the seventh session (2-4 August 2017), link, https://undocs.org/E/2017/46-E/C.20/2017/18, accessed September 30, 2022.

17 The strategic Framework on Geospatial Information and Services for Disasters was adopted by the UN Economic and Social Council under resolution 2018/14, link: https://ggim.un.org/meetings/GGIM-committee/7th-Session/documents/GGIM-7_Report_e.pdf, accessed December 21, 2022.

18 Interoperability in data management can be defined as ability of different information systems, technologies and applications (systems) to access, exchange, integrate and cooperatively use data in a coordinated manner, within and across organizational, regional and national boundaries. This serves to provide timely and seamless portability of information and data for informed decision making, link: https://www.himss.org/resources/interoperability-healthcare#Part1, cited December 26, 2022.

Diagram 2
Integration of Geospatial Information Management with the global sustainable development agendas and including Disaster Risk Management



Source: UNGGIM, 2022.

2. The Sendai Framework for Disaster Risk Reduction 2015–2030

The Sendai Framework for Disaster Risk Reduction 2015-2030 advocates for the substantial reduction of disaster risk, loss of life and livelihoods, and promotes the protection of socio-economic, infrastructural and environmental assets through the management of risk and resilience building. The priorities of the Sendai Framework are to (1) understand disaster risk; (2) strengthen disaster risk governance to manage risk; (3) invest in disaster risk reduction (DRR)[19] and resilience; and (4) enhancing disaster preparedness for effective response and to "Build Back Better"[20] in recovery, rehabilitation and

[19] Disaster risk reduction is aimed at Disaster risk reduction is aimed at preventing new and reducing existing disaster risk and managing residual risk, all of which contribute to strengthening resilience and therefore to the achievement of sustainable development, link: https://www.undrr.org/terminology/disaster-risk-reduction#:~:text=Disaster%20risk%20reduction%20is%20aimed,the%20achievement%20of%20sustainable%20development, accessed February 20, 2023.

[20] In the context of DRM, The UN Office for Disaster Risk Reduction (UNDRR) has this "Build Back Better" defined terminology as: The use of the recovery, rehabilitation and reconstruction phases after a disaster to increase the resilience of nations and communities through integrating disaster risk reduction measures into the restoration of physical infrastructure and societal systems, and into the revitalization of livelihoods, economies and the environment, link: https://www.undrr.org/terminology/build-back-better; accessed February 20, 2023.

reconstruction (Sendai Framework, 2015).[21] [22] This global framework recognizes the importance of a forward-looking and action-oriented framework for DRR and underscores the importance of disseminating risk information with the use of geospatial information technology. Box 1 povides examples of select items specific to GIM as contained in the Sendai Framework:

Box 1
Sendai Framework for Disaster Risk Reduction 2015-2030 in reference to GIM

Priority 1: Understanding disaster risk:

National and Local Level:

Line 24 (c): Develop, update periodically and disseminate, as appropriate, location-based disaster risk information, including risk maps, to decision makers, the general public and communities at risk to disaster in an appropriate format by using, as applicable, geospatial information technology; Line 24 (f): Promote real-time access to reliable data, make use of space and in situ information, including (GIS), and use information and communications, technology innovations to enhance measurement tools and the collection, analysis and dissemination of data.

Global and Regional levels:

Line 25 (c): To Promote and enhance, through international cooperation, including technology transfer, access to and the sharing and use of non-sensitive data, information, as appropriate, communications and geospatial and space-based technologies and related services. Maintain and strengthen in situ and remotely-sensed earth and climate observations. Strengthen the utilization of media, including social media, traditional media, big data and mobile phone networks to support national measures for successful disaster risk communication, as appropriate and in accordance with national laws.

Line 25 (g): Enhance the scientific and technical work on disaster risk reduction and its mobilization through the coordination of existing networks and scientific research institutions at all levels and in all regions.

Source: The Sendai Framework for Disaster Risk Reduction 2015-2030 (2015).

3. United Nations Office for the Coordination of Humanitarian Affairs

The UN Office for the Coordination of Humanitarian Affairs (OCHA) is one of the key agencies within the United Nations system charged with coordinating humanitarian activities in response to disaster emergencies.[23] This includes responsibility for consolidating and publishing information across the spectrum of humanitarian response, facilitating the use of such information by local stakeholders in crisis situations to make informed DRM decisions. Information management employing GIM tools is a core element of this service, often delivered in coordination with other agencies and development partners.[24]

4. United Nations Disaster Assessment and Coordination

Managed by OCHA-Emergency Services Branch, the United Nations Disaster Assessment and Coordination (UNDAC) teams are deployed during the first phase of a rapid-onset emergency to support

[21] What is the Sendai Framework for Disaster Risk Reduction, link: https://www.undrr.org/implementing-sendai-framework/what-sendai-framework, accessed January 15, 2023.

[22] The 2022 UNDRR Global Assessment Report on DRR further emphasized on the need for data for the understanding and management risk and for making informed decision making, link: https://www.undrr.org/publication/global-assessment-report-disaster-risk-reduction-2022, accessed February 20, 2023.

[23] UN Office for the Coordination of Humanitarian Affairs (OCHA), link https://www.unocha.org/about-ocha/history-ocha, accessed October 25, 2022.

[24] OCHA- Information management resources, link :https://www.unocha.org/our-work/information-management, accessed February 21, 2022.

governments of disaster-affected countries and other UN partner agencies.[25] Their specific tasks include conducting emergency site first-needs assessments and incoming international relief coordination assistance, for example, prioritizing needs for food, shelter, medical support amongst other services. UNDAC often partners with Map Action.[26] The UNDAC Field Handbook offers practical advice on using GIS and mapping approaches as well as (GIS) data sources.[27]

5. United Nations Operational Satellite Applications Programme

United Nations Operational Satellite Applications Programme (UNOSAT) promotes evidence-based decision-making for peace, security, and resilience using geo-spatial information technologies. Through the use of GIS and satellite imagery, UNOSAT provides timely and high-quality geo-spatial information to member States, international organizations and non-governmental organizations. UNOSAT develops solutions on integrating field collected data with remote sensing imagery and GIS data through web-mapping and information sharing mechanisms, including remote monitoring of development projects and sharing of geographic data using web-services. UNOSAT's Maps and Data[28] show maps and datasets available for major international disaster efforts under the purview of the UN, making UNOSAT an important source for GIS products and data related to international disaster management and at all stages of DRM.[29]

6. United Nations Platform for Space-based Information for Disaster Management and Emergency Response

United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER) established by General Assembly resolution 61/110,[30] is implemented through the United Nations Office for Out of Space Affairs (UNOOSA) and serves as a platform facilitating the use of space-based technologies for disaster management and emergency response. It is a programme of the United Nations intendedto ensure that member States as well as international and regional organizations have access and develop the capacity to use space-based information to support DRM.

At the regional level, the UN-SPIDER has regional support offices (RSOs). For the Caribbean region, the UNOOSA in 2008 signed a cooperation agreement with the University of the West Indies.[31] This cooperation agreement has as its principal objectives:

- Providing the leadership that drives the rationalization, integration, and development of all initiatives in disaster risk reduction and disaster management within the University of the West Indies (UWI);

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25 UN Disaster Assessment and Coordination (UNDAC), link: https://www.unocha.org/our-work/coordination/un-disaster-assessment-and-coordination-undac, accessed October 25, 2022.

26 Map Action is a non-profit organisation providing services for applying geographic analysis and data to humanitarian situations, link: https://mapaction.org/about-us/, accessed February 21, 2023.

27 OCHA- UNDAC- Field Handbook, see section J .2.1 on use of GIS. This handbook guides that GIS – Mapped information is required for creating a shared operational picture of a disaster situation and for coordinating the response. It identifies that effective mapping of assessments and aid delivery is needed to avoid gaps or overlaps in response efforts, link: https://reliefweb.int/report/world/un-disaster-assessment-and-coordination-undac-field-handbook-7th-edition-2018,accessed October 25, 2022.

28 UNOSAT's Maps and Data: This is available at United Nations Institute for Training and Research (UNITAR), link: https://unitar.org/maps, accessed February 21, 2023.

29 United Nations Satellite Centre (UNOSTAT), UNOSAT is the United Nations Satellite Centre, it is part of the United Nations Institute for Training and Research (UNITAR), with a mandate to provide United Nations funds, programmes and specialized agencies with satellite analysis, training and capacity development, at their request as well as support Member States with satellite imagery analysis over their respective territories and provide training and capacity development in the use of geospatial information technologies, links: https://www.unitar.org/sustainable-development-goals/united-nations-satellite-centre-UNOSAT, and https://unitar.org/sites/default/files/media/publication/doc/UNOSAT-catalogue_factsheet_20072017_print.pdf, accessed October 25, 2022.

30 A/Res/61/110: United Nations Platform for Space-based Information for Disaster management and emergency responses (2007).

31 University of the West Indies-Disaster Risk Reduction Centre, link: https://www.un-spider.org/network/regional-support-offices/university-west-indies-disaster-risk-reduction-centre, accessed February 22, 2023.

- Mobilizing resources to supplement those provided by the UWI, to advance the university's disaster management programme;
- Developing partnerships and other collaborative mechanisms that allow the UWI, its students and staff to maximize the effectiveness of their interventions in disaster management to advance sustainable development in the Caribbean region.

This RSO also supports capacity building and tertiary level degree programmes in the areas GIS and Geoinformatics.

7. Global Disaster Alert and Coordination Systems

Global Disaster Alert and Coordination Systems (GDACS) is a cooperation framework supported by the United Nations and the European Commission.[32] It includes disaster managers and disaster information systems worldwide and aims at filling the information and coordination gaps in the first phase after major disasters (GDACS, 2019). GDACS provides real-time access to web-based disaster information systems and related coordination tools. GDACS provides to its members the services of the On-Site Operations Coordination Centre (OSOCC)[33] an online, virtual collaboration platform used by the UN and other humanitarian disaster-response actors to coordinate and collaborate relief efforts. GDACS also provides data, maps, and satellite imagery for the various events tracked through the Virtual OSOCC and the International Charter[34] among other mechanisms.[35]

8. World Bank Global Facility for Disaster Reduction and Recovery

The World Bank Global Facility for Disaster Reduction and Recovery (GFDRR) is a global partnership established in 2006 to support low- and middle-income countries to better understand, manage, and ultimately reduce their risk from natural hazards and climate change.[36] GFDRR partnership provides specialized expertise, data including geospatial tools, and technical assistance supporting resilience building to climate change and variability. Through this service, emphasis is placed on open-data initiatives for DRR such as promoting open access to risk information as a basis for effective DRM.[37] In support of resilience building through knowledge building and use of open-source tools, this partnership can support communities' mapping of their exposure to disasters and climate change (GFDRR, 2018).

B. Caribbean Agencies

1. Caribbean Disaster and Emergency Management Agency

The Caribbean Disaster Emergency Management Agency (CDEMA) is the inter-governmental agency for disaster management in the Caribbean Community (CARICOM). CDEMA has highlighted the importance of geo-spatial data as an important asset for making informed decision at all stages of DRM.[38] This Caribbean intergovernmental body has developed and promotes the practice of Comprehensive

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[32] Global Disaster Alert and Coordination Centre (GDACS): for more details see link at: https://www.unocha.org/our-work/coordination/site-operations-coordination-centre-osocc, accessed February 23, 2023.

[33] On-Site Operations Coordination Centre (OSOCC), for more details see link at: https://www.unocha.org/our-work/coordination/site-operations-coordination-centre-osocc, accessed February 21, 2023.

[34] The International Charter is composed of space agencies and space system operators from around the world who work together to provide satellite imagery for disaster monitoring purposes.

[35] Further details on the Global Disaster Alert and Coordination Systems (GDACS) can be found at link: www.gdacs.org/Satellite/overview.aspx., cited October 25, 2022.

[36] World Bank Global Facility for Disaster Reduction and Recovery (GFDRR), link: https://www.gfdrr.org/en, link: October 25, 2022.

[37] Open Access to Risk Information. The GFDRR's Innovation Lab team has make freely available using open geospatial platforms over 1,500 geospatial datasets on more than 30 countries, link: https://www.gfdrr.org/sites/default/files/publication/Risk%20Information.pdf, accessed February 21, 2023.

[38] See CDEMA, link: https://www.cdema.org/geo-spatial-data, accessed October 26, 2022.

Disaster Management (CDM)[39] as an innovative concept for reducing the risk and loss associated with natural and technological hazards and the effects of climate change to enhance sustainable development in the subregion. The objective of the CDM is to integrate disaster management considerations into the development planning and decision-making process of CDEMA's participating States. Its Regional Comprehensive Disaster Management Strategy & Results framework 2014–2024 includes the following elements:

- National, regional and sectoral institutions with adequate/minimum standards of capacity to deliver the CDM programme;
- Knowledge management which is applied for fact-based decision-making;
- Disaster resilience which is enhanced within key sectors of the economy;
- Operational readiness at regional, national, sectoral and local levels;
- A clearly established and understood nexus between Climate Change Adaptation and Disaster Risk Reduction (DRR) with programming and governance harmonized;
- Community resilience which has been enhanced for the most vulnerable with gender concerns addressed at all stages and levels;
- Resource allocation which underpins the ability to deliver the regional strategy.

A Caribbean Risk Information System (CRIS) has been established and managed by CDEMA with support from the African, Caribbean and Pacific Group of States and the European Union-Natural Disaster Risk Reduction Program (ACP-EU NDRR),[40] Caribbean Risk Information Program II. The CRIS is an integrated platform for geo-spatial data, DRM and climate change adaptation information. It is comprised of three (3) components, these are:

(i) GeoCRIS which provides access to geospatial data for the CDEMA participating States.[41] This includes data required for risk and hazard mapping, disaster preparedness and response operations;

(ii) Virtual Library[42] containing links to CDEMA services, products and other resources and

(iii) Databases providing information on disaster events, early warning and risk profiles.

2. Parametric Insurance of the Caribbean Catastrophe Risk Insurance Facility-Segregated Portfolio Company

The insurance and risk management sectors are increasingly gaining prominence in DRM. One of the prototypes used in the insurance sector is that of catastrophe modelling. Catastrophe loss modelling has been found to play a valuable role in assessing what may happen before, during and after an event.

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[39] CDEMA's Regional CDM – Strategy and results framework: CDM is defined as the management of all hazards through all phases of the disaster management cycle – prevention and mitigation, preparedness, response, recovery and rehabilitation - by all peoples-public and private sectors, all segments of civil society and the general population in hazard prone areas. CDM involves risk reduction & management and integration of vulnerability assessment into the development planning process, link https://www.cdema.org/CDM_Strategy_2014-2024.pdf, accessed October 26, 2022.

[40] ACP-EU Natural Disaster Risk Reduction Program, link: https://www.gfdrr.org/en/feature-story/acp-eu-ndrr-program-activity-report-2020-2021, accessed December 26, 2022.

[41] CDEMA participating States are: Anguilla, Antigua and Barbuda, Cayman Islands, Commonwealth of the Bahamas, Barbados, Belize, Commonwealth of Dominica, Grenada, Republic of Guyana, Haiti, Jamaica, Montserrat, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Republic of Trinidad and Tobago, Turks & Caicos Islands and the Virgin Islands, link: https://www.cdema.org/index.php?option=com_content&view=article&id=89#which-states-are-members-of-cdema, accessed December 24, 2022.

[42] CDEMA's Virtual Library, link: https://cdema.org/virtuallibrary/index.php, accessed December 24, 2022.

This includes identifying which areas will likely be impacted, who should be evacuated, what assistance is needed, the location of the damage and what should be insured. This service plays an important role in DRM decision making including disaster risk reduction.

The parametric models are based on a loss modelling approach with the capacity to estimate loss probabilities for individual countries, price contracts for specific countries and to estimate site specific hazard levels and losses for specific events during the contract period. The models capture and use the variables of hazard, exposure and vulnerability to determine loss and calculate the insurance pay-out. For the Caribbean and Central America subregions, the Caribbean Catastrophe Risk Insurance Facility-Segregated Portfolio Company (CCRIF-SPC) provides parametric insurance[43] based on damage models with a view to disbursing payments to countries within fourteen (14) days following an event. Pay-outs are intended to close the gap and provide quick liquidity to governments following a disaster and to ensure that vulnerable communities receive the aid needed to recover. The models are underpinned by data on the occurrence of a predefined level of a hazard, its impact, and the intensity of an event. The models are heavily dependent on GIM services including high quality remote sensing data and locally obtained on-the-ground data. CCRIF SPC country risk profiles for each peril supports the policy, and the representation of government exposure in ensuring the accuracy of the models and the modelled losses for hazard events. Since 2007, CCRIF-SPC has made a total of 54 pay-outs totalling US 245 million made to 16 countries, the largest pay out being made to Haiti following the recent (2021) earthquake.[44]

CCRIF-SPC currently offers five different categories of policies encompassing, *earthquake, tropical cyclone, excess rainfall, fisheries, and electric utilities*.[45]

CCRIF-SPC also uses the System for Probabilistic Hazard Evaluation and Risk Assessment (SPHERA)[46] exposure and Rainfall XSR 2.5[47] models for tropical cyclones/earthquakes and excess rainfall, respectively, and a fisheries model specifically tailored to the fisheries industry.[48] The SPHERA Model draws data from the United States of America-National Oceanic and Atmospheric Administration (NOAA) within the geographic region, including wind and storm surge for cyclones and earthquake data, specifically peak ground acceleration from the United States Geological Survey. It relates the wind and storm surge to infrastructure damage ratios. The XSR 2.5 model uses data from satellites and weather forecast models from NOAA and creates damage functions based on the volume of rainfall. For these models, it is important for the location, economic value and physical attributes of buildings/airports/port facilities and road networks to be defined.

The fisheries model is premised upon a Livelihood Protection component which links daily revenue losses of fisherfolk to wave height and strong rainfall (for at least 3 consecutive days), and a Tropical Cyclone component which incorporates tropical cyclone-induced strong winds and storm surges in the estimation of direct damages to fishing vessels, equipment and infrastructure.

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43 Parametric insurance describes a type of insurance contract that insures a policyholder against the occurrence of a specific event by paying a set amount based on the magnitude of the event, as opposed to the magnitude of the losses in a traditional indemnity policy. This has an important role in disaster insurance, link: https://content.naic.org/cipr-topics/parametric-disaster-insurance, accessed January 19, 2023.

44 See home page of the CCRIF SPC, link: https://www.ccrif.org/, accessed January 19, 2023.

45 CCRIF SPC, link: https://www.ccrif.org/sites/default/files/publications/newsletters/CCRIF-SPC-JulySeptember2020-Newsletter.pdf, accessed December 24, 2022.

46 See example of use of the System for Probabilistic Hazard Evaluation and Risk Assessment (SPHERA), model, link: https://www.ccrif.org/sites/default/files/riskprofiles/EQ_Annex1_r2.pdf, accessed December 24,2022.

47 Examples of the use of the CCRIF Excess Rainfall (XSR 2.5) mode, link: https://www.ccrif.org/sites/default/files/riskprofiles/XSR2.5_Annex1_r1.pdf, accessed October 26, 2022.

48 The fisheries model is the Caribbean Ocean and Aquaculture Sustainability Facility (COAST), additional details is at link: https://www.ccrif.org/projects/coast/caribbean-ocean-and-aquaculture-sustainability-facility?language_content_entity=en, accessed March 14, 2023.

The SPHERA exposure Module uses remotely sensed data and economic statistics from various sources to generate valuation estimates which are then used to determine the country's exposure. The categories encapsulate residential, commercial, public, industrial, energy, healthcare and transportation facilities. The SPHERA Incident Exposure Derivative is built and validated on country level census data, technical documentation, international peer reviewed literature, public reports and databases and satellite images. The identification of the most common types of construction in each country is important in determining degree of risk. In all these applications, GIM is used to represent the spatial distribution of economic value across the country.

The SPHERA Vulnerability damage functions assess the structural behaviour and fragility of the assets in the exposure. For tropical cyclones, this is based on two damage functions which are wind and storm surge and in the case of earthquakes the damage is based on ground shaking. This is underpinned by literature review of existing fragility and vulnerability functions. The susceptibility of an asset such as buildings or crops to damage from wind or storm surge is usually expressed through damage curves. The storm surge vulnerability measure usually considers:

- Hazard properties at the building locations for example water depth
- Characteristics of the exposed buildings for example structural type and
- Replacement cost

A "what if analysis" is used for each building component to describe the damage mechanisms. It provides a probabilistic relationship between event intensity and loss which is the ratio between the damage and total replacement cost. It considers classes or structures rather than individual buildings and was calibrated and validated using the country scale post disaster losses from past events.

The loss module translates the damaged ratio derived in the vulnerability module into a dollar loss by multiplying it by the value at risk, for each asset class across the country. Losses are then aggregated at policy level, which can be national or subnational. The loss probability curves are generated from the results in the long-term loss event.

The insurance module compares the modelled losses from the event to the conditions of the country's policy to determine if the policy is triggered and calculates the value of the pay-out. CCRIF-SPC policy is triggered when the modelled loss for an event is equal to or exceeds the attachment point stipulated in the policy contract. There are specific procedures for claims verification, and administrative and pay out processes depending on the nature of the event. Model validation is done using real time data emanating from satellite imagery as events occur.

A consequence database with countries and their corresponding loss assessments is used to validate the models. These feed off information from disaster databases garnered from international agencies such as ECLAC's Damage and Loss Assessments, CDEMA, NOAA. However, there are limitations to the consequence database such as different sources giving different values which result in a level of uncertainty.

In this regard, country risk profiles are vital because they provide simple, accurate and robust information to country risk managers, assess the impact of historical losses, illustrate and facilitate the risk transfer decisions and aid the decision-making process. CCRIF-SPC policy premiums are informed by these country risk profiles. The policy premiums depend on the selection of three elements by the Government these being the attachment point, the ceding age and the exhaustion point. The attachment point is the minimum severity of the event loss which gives rise to payment and therefore is the loss value at which the policy is triggered. The ceding age is the age of coverage that a country decides to acquire, and the exhaustion point refers to the severity of the event loss at or above which the maximum payment is triggered. Therefore, the coverage limit is calculated as the difference between the exhaustion point and the attachment point, multiplied by the ceding percentage.

CCRIF-SPC has also applied GIM in the development of its parametric models used for both the actuarial pricing of products and the estimation of pay-outs for the impacts of natural events.

III. Geospatial Information Management for Disaster Risk Management in the Caribbean

This section analyses the status of GIM advancements in DRM in the Caribbean region based on the surveys conducted in 2021.[49]

A. Institutional arrangements

The institutional settings considered for the effective mainstreaming of GIM into DRM were a whole-of-government approach to DRM (see annex 3). The results from the surveys are analysed in the following sections:

1. The integration of public sector agencies into the Disaster Risk Management

The data obtained from the ten (10) countries surveyed revealed that disaster response activities are integrated[50] into the operating functions of the protective and the public utilities agencies. The other public sector agencies have partially integrated DRM into their core functions. For example, agencies engaged in physical planning, social and community development whose mandates include disaster risk mitigation and reducing the vulnerability of communities, are often not integrated into DRM

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[49] See Annexes 1, 2a, 2b, 3 and 4 for details of the survey instruments used for collection of the data and information.

[50] Full national integration occurs when all the agencies and stakeholders are drafted into all elements of DRM: risk identification, risk mitigation, risk transfer, disaster preparedness, emergency response, rehabilitation, and reconstruction.

institutional infrastructure.[51] The data further revealed that the existence of key agencies not having assigned DRM functions. This arrangement has limited the effectiveness of GIM in support of DRM. Annex 6 provides examples of Caribbean countries employing GIM in DRM.

2. Spatial Data Infrastructure.

Caribbean countries are making progress in the development of National Spatial Data Infrastructure (NSDI) including DRM data requirements. The Bahamas and Jamaica have developed NSDI strategies as follows:

(i) The Bahamas: The Bahamas National Spatial Data Infrastructure Act (2014) establishes the Bahamas National GIS Centre (BNGISC) as a Department of Government within Section 127 (c) of the Constitution.[52] This Act defines the purposes, functions, scope and operations of the Bahamas Spatial Data Infrastructure system and program and the powers and function as well as the constitution and proceedings of the Geospatial Advisory Council (GAC). The BNSDI Act addresses access, exchange, and dissemination of interoperable non-confidential spatial data for the Bahamas. It also includes spatial data services across different sectors. The Director of the National Emergency Management Agency is also a member of the GAC.

(ii) Jamaica: The Jamaica Disaster Risk Management Act of 2015 identifies geospatial information in support of the various elements of the DRM. The National Spatial Data Management Division (NSDMD) of the Ministry of Economic Growth and Job Creation has the mandate to coordinate the development and implementation of a national GIS network, inclusive of comprehensive and accurate spatial data for land and land related agencies, and to develop and provide advice on policy, institutional requirements, legislation and regulations.[53] Jamaica also has a National Emergency Response Geographical Information Systems Team (NERGIST). Approved by Cabinet in 2010, the NERGIST is a group of volunteer GIS professionals with capacity in such fields as: geospatial analysis, scenario modelling, image interpretation, data collection, and damage assessment in response to disasters. The group is comprised of specialists from multiple government, private sector, and tertiary educational institutions. The NSDMD of the Ministry of Economic Growth and Job Creation serves as Secretariat for this group (ECLAC, 2021).

B. Policies and standards

An enabling policy framework, including agreed standards is essential for effective use of GIM in DRM. Figure 1 gives an indication of the percentage of countries having GIM policies and standards in the Caribbean. As illustrated in figure 1, 45 % of the countries surveyed have policies on metadata,[54] and data maintenance. Another 35 % of the countries surveyed have cartographic standards, data dictionary

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[51] Full national integration occurs when all the agencies and stakeholders are drafted into all elements of DRM: risk identification, risk mitigation, risk transfer, disaster preparedness, emergency response, rehabilitation, and reconstruction.

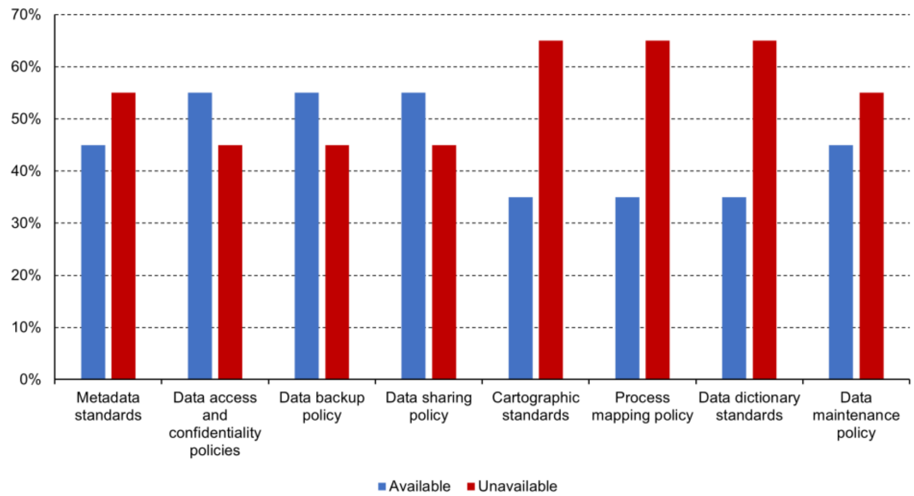
[52] Additional information of the BNGISC can be obtained at link: http://laws.bahamas.gov.bs/cms/images/LEGISLATION/PRINCIPAL/2014/20140009/BahamasSpatialDataInfrastructureAct2014_1.pdf, accessed January 18, 2022.

[53] Caribbean Geospatial workshop, link: https://geo.cepal.org/en/contenido/proyectos/carigeo/pdf/CGDI%20Workshop%20Mexico%20City-%20Jamaica%20ppt.pdf, accessed February 18, 2022.

[54] Metadata is information about data. Similar to a library catalogue record, metadata records document the who, what, when, where, how, and why of a data resource. Geospatial metadata describes maps, Geographic Information Systems (GIS) files, imagery, and other location-based data resources, source: The Federal Geographic Data Committee, link: https://www.fgdc.gov/metadata, accessed December 24, 2022.

standards[55] and process mapping standards, while 45% of the countries do not have data access confidentiality policy, data backup policy, nor a documented data sharing policy.

Figure 1
Availability of national policies and standards in support of Geospatial Information Management
(Percentage)



Source: Based on surveys conducted by ECLAC in 2021. Data received from 10 Caribbean countries.

Countries signalled that investment in GIM, and technologies are not fully sourced from regular national budgets. Countries often rely on extrabudgetary funds and projects to meet their needs. Countries have also identified constraints in community use of available technologies due to disaggregated institutional settings and policies that restrict access across agencies. Jamaica and the Bahamas are two countries that have made progress in the use of GIM in DRM. This achievement is in part due to the strong political support and improved funding through regular public-sector funding. In the case of these two countries, regular budgets are assigned for such activities as the establishment of designated GIM institutional structures and the hiring of technical staff.

1. The availability of policies and standards in support of Disaster Risk Management

There have been important gains in the availability of policies and standards in support of DRM in the Caribbean. All 10 countries surveyed had national DRM plans, this achievement in part due to support received through the CDEMA's Regional Response Mechanism (RRM).[56] In the area of vulnerability assessment, however, 55 % of the countries surveyed did not have corresponding policies and standards. Country response is illustrated in figure 2.

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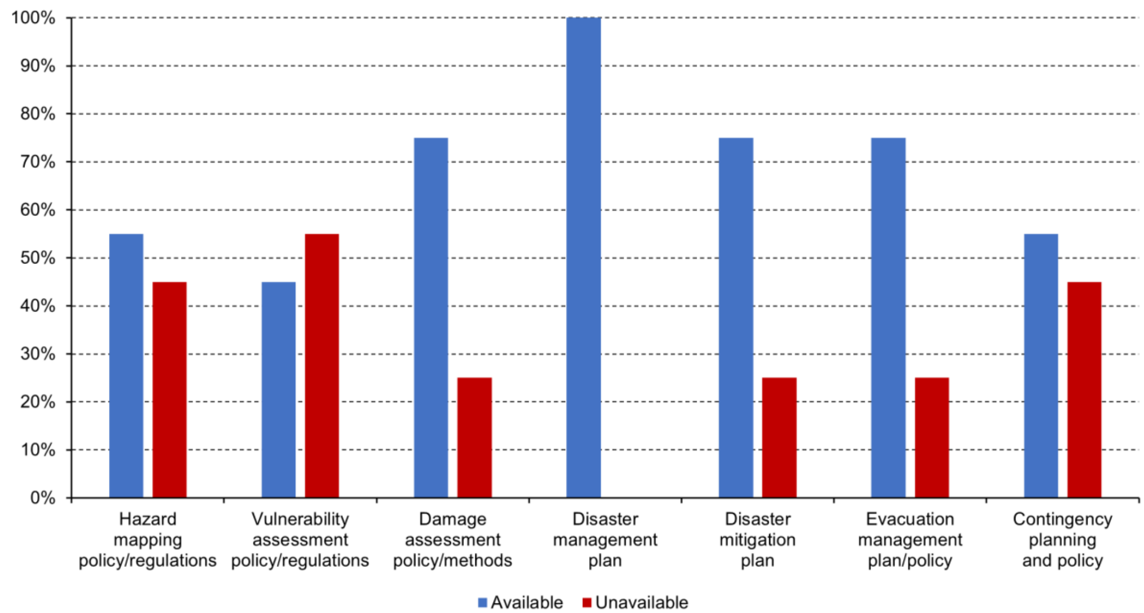
55 A Data Dictionary is a collection of names, definitions, and attributes about data elements that are being used, captured or stored in a database, information system, or part of a research project, UC Merced Library, link: https://library.ucmerced.edu, accessed December 24, 2022.

56 The CDEMA's RRM, is a network of CDEMA's Participating States, national, regional and international disaster stakeholders through which external response and relief operations in support of an impacted CDEMA Participating State (PS) are coordinated, link: https://www.cdema.org/rrm/, accessed on December 4, 2022.

Figure 2
Availability of policies and standards in support of Disaster Risk Management
(Percentage)



Source: Based on surveys conducted by ECLAC in 2021. Data received from 10 Caribbean countries.

C. Geospatial data management

Access to geospatial data[57] in the Caribbean of the quality required for effective decision making has improved in recent years. This progress is in part due to the support provided through organizations including the UN Committee of Experts on Global Geospatial Information Management, the World Bank, The Caribbean Geospatial Development Initiative (CARIGEO)[58], as well as the private sector and academia.

1. Frequency of use of Geospatial Information Management technologies and data products in support of Disater Risk Management

Data on the use of GIM technologies and data to support DRM is very important if one is to consider the cost of acquiring and maintaining these technologies and data. It is through their use as well as the frequency of usage that the value of investment in GIM as essential resources in DRM can be measured.

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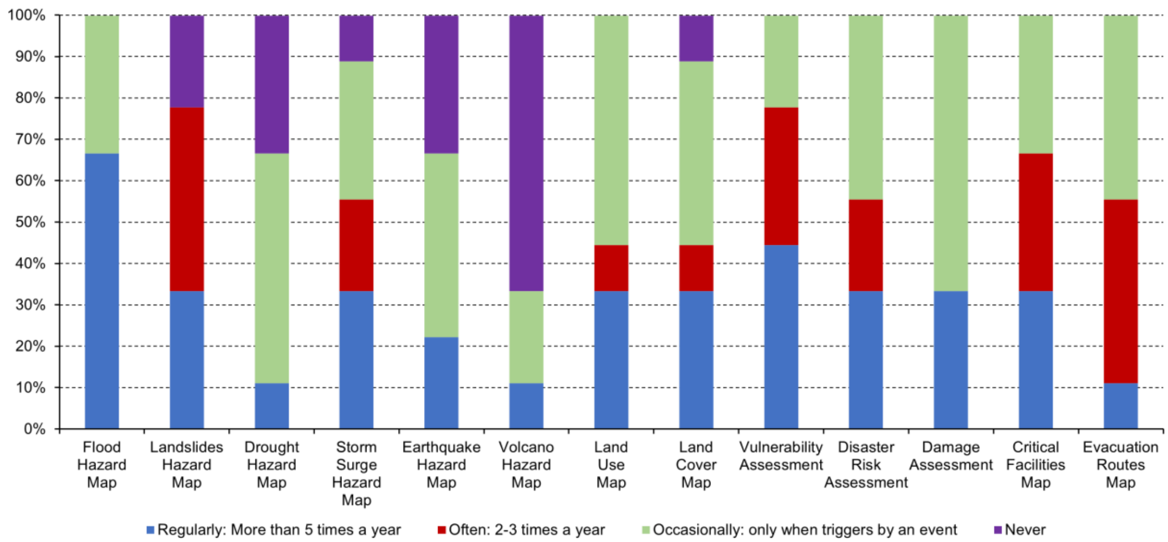
[57] Geospatial data is time-based data that is related to a specific location on the earth's surface. It identifies the geographic location and characteristics of natural or constructed features and boundaries on the earth. This information may be derived from, among other things, remote sensing, mapping, and surveying technologies. Statistical data may be included in this definition at the discretion of the designated data collecting agency, definition adapted from IBM, link: https://www.ibm.com/topics/geospatial-data, accessed December 24, 2022.

[58] CARIGEO is a collaborative effort among the United Nations Regional Committee on Global Geospatial Information Management for the Americas (UN-GGIM: Americas), the United Nations Economic Commission for Latin America and the Caribbean (UN-ECLAC), public agencies of Member States and Territories within the Caribbean, the geospatial industry, academia and civil society. It seeks to provide geospatial support for the Caribbean region, by addressing topics such as disaster risk management and response, resilience management, climate change, economic development, the COVID-19 pandemic response, Agenda 2030 etc. link: https://www.cepal.org/en/events/caribbean-geospatial-development-initiative-carigeo, accessed October 25, 2022.

Based on the data obtained from the respondents in 2021, data products and the frequency with which these products are used in DRM are provided in figure 3.

Figure 3
Frequency of use of Geospatial Information Management technologies and data in Disaster Risk Management
(Percentage)



Source: Based on surveys conducted by ECLAC in 2021. Data received from 10 Caribbean countries.
Note: Not including Saint Vincent and the Grenadines data on the eruption of the La Soufriere volcano in 2021.

Figure 3 demonstrates the use of GIM products linked to the frequency of the type of disaster. For example, there is higher frequency in the use of Flood Hazard Maps, Landslide Maps, and Storm Surge Hazard Maps. Other factors contributing to the frequency of use of GIM were, for example, due to scarcity of data, limited human resource capacity, and the unavailability of appropriate tools.

The data obtained identified the following factors affecting the use of and access to geospatial data in DRM:

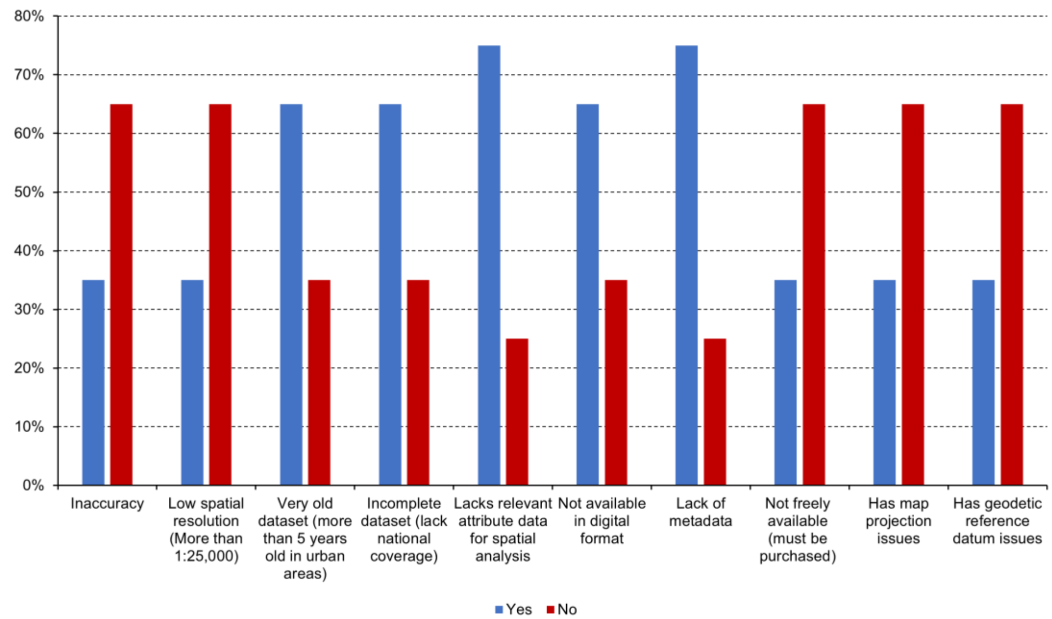
- Data are not stored in an officially designed GIS Enterprise.[59] Data are often collected in different forms, stored and managed at various departments, different Ministries and or are generated specifically for short term projects. This often results in multiple un-official copies of data located in several agencies.
- Data management is not supported through established policies and standards. This can result in limited of use of available data for official decision making and reporting.

[59] This can be defined as a system designed to provide integrated and interoperable data services in which the individual departments and functionaries of an enterprise can create, access, view, and analyze data and information relevant to their tasks, link: https://www.geospatialworld.net/article/an-introduction-to-enterprise-gis/, accessed February 21, 2023.

2. Quality of geospatial data and information

Quality data including data accuracy, reliability, relevance, spatial resolution,[60] map projection and geodetic references[61] are requirements for effective geospatial analysis and to provide for informed decision making at all stages of DRM. Geospatial data quality is generally classified under areas of data completeness, data precision, data accuracy and data consistency[62] (see annex 2). Country responses are illustrated in figure 4.

Figure 4
Quality of geospatial data and information
(Percentage)



Source: Based on surveys conducted by ECLAC in 2021. Data received from 10 Caribbean countries.

Each category listed in Figure 4 illustrates that there is a need for improvement in addressing geospatial quality and information. The following main observations are concluded:

- Sixty-five percent of the respondents reported satisfactory levels in the accuracy of their datasets;
- A high percentage of the respondents (75 %) reported that their databases lack relevant attribute data[63] for spatial analysis;
- Thirty-five percent reported that their data holdings are not freely available from other agencies;

[60] The resolution of an image refers to the potential detail provided by the imagery. Spatial Resolution refers to the size of the smallest feature that can be detected by a satellite sensor or displayed in a satellite image, link: https://cimss.ssec.wisc.edu/sage/remote_sensing/lesson3/concepts.html#:~:text=The%20resolution%20of%20an%20image,displayed%20in%20a%20satellite%20image, accessed December 10, 2022.

[61] Geodetic, another term for Geodesy is the science of accurately measuring and understanding three fundamental properties of the Earth: its geometric shape, its orientation in space, and its gravity field —as well as the changes of these properties with time, link: https://oceanservice.noaa.gov/facts/geodesy.html; accessed December 10, 2022.

[62] GIS Lounge: Spatial Data quality, An introduction, link: https://www.gislounge.com/spatial-data-quality-an-introduction/, accessed February 19, 2023.

[63] Attribute data is defined as a type of data that can be used to describe or quantify an object or entity. An attribute data can be for example a postal (ZIP) code.

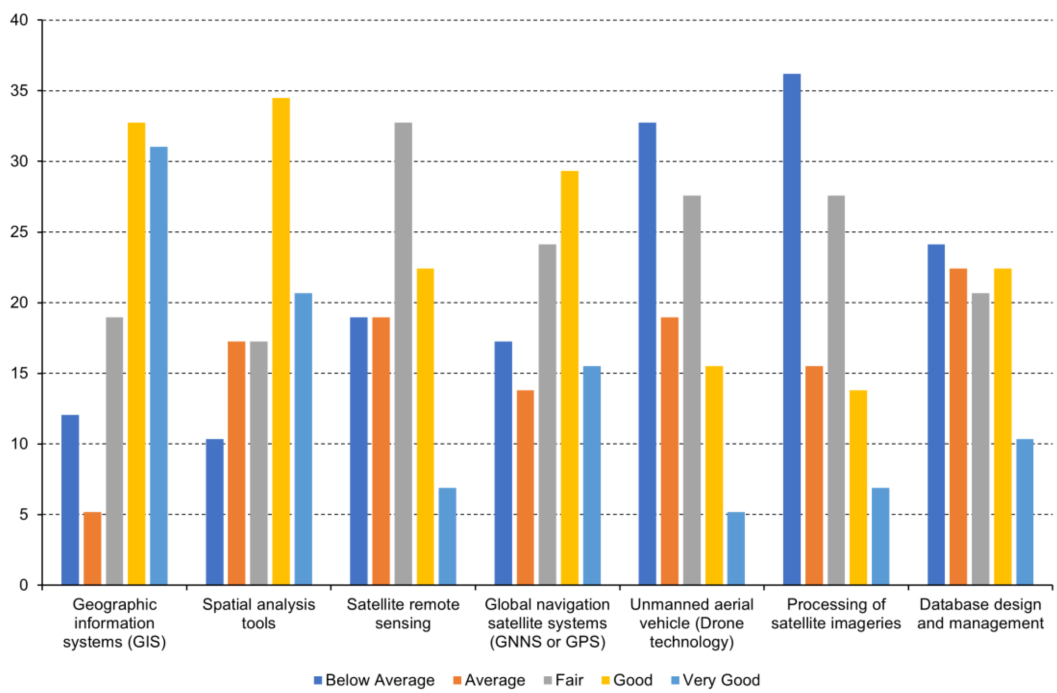
- Sixty-five percent of the respondents indicated that their databases are not current. This will include that the datasets are more than 5 years old in urban areas, are incomplete and lack of national coverage. Additionally, these datasets are still in hardcopy format and lack metadata;
- Thirty five percent of the respondents indicated that their database have map projection and geodetic reference datum issues.

D. Human Resources Capacity

Effective use of GIM in DRM requires trained and skilled personnel in advanced geographical science and analysis. In the survey conducted, participating countries were asked to rate their knowledge of the various geospatial tools required for effective spatial analysis. Figure 5 identifies seven key knowledge areas that are required for effective use of GIM in the Caribbean and the percentage rating of the member States —from good to below average— knowledge of these important tools.

The responses regarding knowledge of various GIM applications in figure 5 was based on an online GST[64] and Data training needs assessment conducted during June-August 2021 (ECLAC, 2021, see annex 5). The GIM applications more commonly used in DRM and considered in the survey were: GIS, spatial analysis tools, satellite remote sensing, global navigation satellite systems (GNSS), drone technology, processing of satellite imageries and database design and management.

Figure 5
Knowledge of Geospatial Information Management Applications
(Percentage)



Source: Based on surveys conducted by ECLAC in 2021. Number of respondents=58.

64 GST is a term used to describe the range of modern tools contributing to the geographic mapping and analysis of the Earth and human societies. Example of GST are: remote sensing imageries and data collected from space- or airborne camera and sensor platforms; GIS, and Global Navigational Satellite System (GNSS), link: https://www.aaas.org/programs/scientific-responsibility-human-rights-law/overview-geospatial-project, accessed January 18, 2022.

1. Technical staff trained in the theory and application of Geospatial Information Management and including Geospatial Technologies

Categorized into training levels of basic, intermediate and advanced, this section of the survey sought to access the coverage in twenty (20) core GIM applications. These core GIM technical skills are required to discharge geospatial data applications in DRM effectively. Table 1 presents the data obtained for the ten (10) countries surveyed.

Table 1
Geospatial Information Management applications – Training Levels

Geospatial Information Management Applications	Training Level: Basic	Training Level: Intermediate	Training Level: Advance
	Number of Countries responding to each training levels		
Use of GIS software	1	4	5
Use of Remote Sensing software	4	4	2
Use of Spatial Database software	3	4	3
	Number of Countries responding to each training levels		
Use of GPS mapping equipment	4	3	3
Use of Drone mapping system	4	6	0
Preparation of hazard maps	3	6	1
Vulnerability assessment	2	3	5
Creating orthophotos from raw satellite images	7	2	1
Georeferencing[a] and mosaicking of images	3	4	3
Satellite image analysis	4	4	2
Satellite image classification	5	4	1
Performing raster to vector conversion	2	6	2
Processing of drone image to produce orthophoto maps	6	4	0
GPS errors processing	4	4	2
Database design and management	4	5	1
GIS applications programming	5	5	0
Metadata creation and management	2	5	3
Spatial data analysis and modelling	3	5	2
Map datum and map projections	3	4	3
Database integration and migration	4	4	2

Source: Based on surveys conducted by ECLAC in 2021. Data received from 10 Caribbean countries.
[a] Georeferencing is the process of taking a digital image for example an air photo, a scanned geologic map, or a picture of a topographic map, and adding geographic information to the image so that GIS or mapping software can 'place' the image in its appropriate real-world location and mosaicking of images, link: https://serc.carleton.edu/research_education/geopad/georeferencing.html#:~:text=Georeferencing.

The following main observations are concluded:

- Basic level training: Over 50 % of the respondents reported basic level training in creating orthophotos from raw satellite images; processing of drone image to produce orthophoto maps, satellite image classification and GIS applications programming;
- Intermediate level training: Over 50 % of the staff received intermediate training in the use of drone mapping system, preparation of hazard maps, performing raster to vector conversion, database design and management, GIS application programming, metadata creation and management, spatial data analysis and modelling;
- Advance level training: Fifty percent of the respondents reported having advanced GIM application training in the use of GIS software and vulnerability assessment. No respondent reported having advanced training in the use of drone mapping system and the processing of drone image to produce orthophoto maps.

Based on the data from the 10 countries surveyed, it can be concluded that the training levels are not uniform. This variation can affect the effective uptake and use of GIM in DRM. Towards supporting the requirements for GIMS capacity development, investment in capacity development could be in the form of formal academic training from Certificate level to Master's degree Level. This should be supported with regular refresher GIM courses to ensure that staff skills are kept abreast of the rapid advancements in this field.

2. Constraints affecting staff capacity development

Given the technology push-factors, staff capacity development including reskilling is an ongoing task. The survey revealed that human resources capacity requirements are constrained by the following factors:

- Financing: Inadequate budgetary allocation for capacity development and training.
- Human Resources: understaffing of GIM units, undermining their ability to effectively support geospatial demands and DRM services. There is also a high rate of attrition of staff trained in GIM and GIS and inadequate succession planning.
- Knowledge levels: Inadequate prerequisite qualifications to support required GIM technological advancements including applications in DRM. This also limits opportunities for upgrading of skills on new and emerging GIM technologies and related subjects.

IV. Recommendations for advancing Geospatial Information Management for Disaster Risk Management

Given the increasing frequency, intensity, and impact of natural disasters on the Caribbean, it is incumbent on governments and national disaster agencies to use all the tools at their disposal to manage and mitigate risk. The management of hazard risk requires comprehensive DRM systems, including prevention and mitigation, preparedness, response, recovery, and rehabilitation. The data and information gained from this study revealed that Caribbean countries are increasingly recognising the value and importance of GIM as an essential tool in DRM. The following recommendations are offered with a view to promoting the further mainstreaming of GIM into DRM.

A. Establishment and or strengthening of Spatial Data Infrastructure

Considering the institutional arrangements, financial and human resources limitations and rapid changes in technologies, countries should seek to establish and or strengthen a dedicated GIM unit under the umbrella of a national spatial data infrastructure (NSDI). The NSDI should be supported through mechanisms such as an inter-institutional working group. The functioning of this institutional arrangement can be administered through such instruments as a Memorandum of Understanding (MOU) and with the purpose of promoting inter-agency and other stakeholder collaboration on data management including data generation, access, sharing and reporting. Geospatial agencies are often the custodians of fundamental spatial data and therefore best placed for further leading this integration.

In support of the functioning of the proposed national SDI and subregional DRM priorities, countries should also examine the establishment of intergovernmental subregional coordinated approaches such as establishing a Caribbean-Subregional Geospatial Information Management facility.[65] [66] Such a facility can serve in supporting DRM priorities including:

- Support the alignment with and implementation of global GIM guidelines such as the UN-IGIF;
- Formulate, collect, analyse, curate and have timely availability of data for use by technical officers, policy and other decision makers;
- Lead the establishment of subregional standards, data sharing and data dissemination protocols for GIM and services;
- Collaborate on common subregional priorities including negotiation, evaluation and acquisition of resources and the sharing of best practices;
- Identify and deliver training, capacity building and research priorities for the Caribbean;
- Support the preparation of periodic reports on disaster related statistics for the Caribbean.[67]

B. Policy and Legislation

Effective mainstreaming of GIM into DRM activities is anchored on the establishment and implementation of GIM policies, legislation, standards and systems (UNGGIM, 2020). This will also require integration into national policies for sustainable development including:

- Establishment and or the updating of standards for data collection
- Data access and including security protocols
- Policy on use of data and information
- Metadata standards
- Cartographic standards for mapped features
- Regular updating of geospatial information and services for DRM

Designated national authorities and subregional agencies should further consider addressing policy, legislative and regulatory requirements for the use of self-monitoring, analysis and open data sharing as official data sources. This can further serve towards optimizing existing systems, maximising the use of available resources and improving data management capabilities for decision making.

C. Capacity and Education

The following recommendations are in support of building GIM capacities in DRM:

- Member countries and the subregion should seek to conduct a DRM-knowledge and skill matrix at both individual and institutional levels. Taking into consideration the vulnerabilities

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[65] The members of the proposed regional office can include for example the Caribbean Community (CARICOM), CDEMA, Caribbean Development Bank, Caribbean Community Climate Change Centre, Caribbean Institute of Meteorology and Hydrology, Organisation of Eastern Caribbean States, the University of the West Indies and other educational institutions, ECLAC, UNDRR and other UN partners, the CCRIF SPC and the private sectors.

[66] A similar proposal was made in an article published in West Indian Journal of Engineering Vol. 31 (July 2008/January 2009) Technical Paper on Incorporating Geoinformatics into Disaster Preparedness and Management Operations: A Caribbean Regional Approach. This article proposed the establishment of a Caribbean Centre for Remote Sensing and GIS Services. Link https://sta.uwi.edu/eng/wije/vol3101-02_jan2009/documents/GeoinformaticsInDisasterPreparedness.pdf, accessed December 20, 2022.

[67] See for example the Asia-Pacific Disaster Report, link: https://www.unescap.org/knowledge-products-series/asia-pacific-disaster-report, accessed December 10, 2022.

of the Caribbean, this matrix should also include early warning and assessment of climate change impacts (Spiekermann, R. et al, 2015). The results of this process can then serve to further develop training and capacity building in the use of GIM for DRM;

- Plan and have budgetary provisions for staff capacity development to ensure that training is provided at the appropriate levels to match current and emerging needs. This could be in areas of disaster risk modelling, GIS applications development, satellite data processing, global navigation satellite systems data processing, unmanned aerial vehicles mapping, database design and database management, communication and awareness raising;
- Develop and implement geographical literacy,[68] communication and awareness raising resources. Specific strategies may include using local languages, localised community-based scenarios, social media and other platforms disseminating information;
- Undertake research and development in GIM relevant for DRM in the Caribbean region. GIM should be included as part of the curriculum in DRM academic programs;
- Strengthen member States and other stakeholders' competencies in establishing NSDI and open data platforms. In consideration to the rapid advances in all fields of GIM, this will also require ongoing capacity building of senior managers and decision makers on the purpose and benefits of the use and applications of GIM in DRM;
- Explore and expand access to available regional and international GIM resources to promote interconnection, data sharing, unify and better coordinate data sources requirements for effective DRM. This can also serve to establish communities of practice for spatial data infrastructure and linkages to regional networks engaged in all DRM stages.

D. Public Private Sector Partnership

Partnership development in particular with the private sectors and academia can serve to accelerate the development of an effective GIM infrastructure.[69] These can be defined by varied business models, choice of contractual relationship, and procurement arrangements, and revenue models. The benefits of public-private partnerships (PPP) can be addressed across the following areas:

- Resource mobilisation. PPP can offer access to private capital and other data-driven system services. Partnership also serves in managing risk from "whole of society" approach (UNU, 2022);
- Technological Flexibility. PPP can provide for access to modern technology, thereby supporting improved operational efficiencies in DRM services;
- Knowledge, capacity transfers and collaboration. PPP can further support the development of local and regional capabilities and employing developmental opportunities such as sharing on best practices, south-south and triangular cooperation.

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68 Geographical literacy or geo-literacy includes the knowledge of geography, knowledge of an inter-connected world, the relationships between anthropogenic systems, their interactions with and impacts to the environment. Link: https://kidworldcitizen.org/what-is-geo-literacy/, accessed January 19, 2022.

69 UNGGIM Private Sector Network (PSN). The PSN is intended to facilitate a direct connection and communication for the private sector to work with Member States towards achieving success in global geospatial initiatives, link: http://unggim-psn.org/about.html, accessed February 15, 2023.

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Annexes

Annex 1
Survey Questionnaire: Strategies for Strengthening and Integrating Geographic Information Management Systems (GIMS) and Disaster Risk Management (DRM): Caribbean Region

Interviews conducted with GIM and disaster management professionals on addressing international, regional and national GIM strategies, policies, institutional, human resources, operative arrangements and structures supporting DRM.

- For the conduct of these interviews the following questions were used to guide on responses: What role do you believe GIM plays in DRM?
- What organizations do you believe should be leading the charge for the integration of GIM and DRM?
- What should be the role of the regional intergovernmental agencies?
- What is the role of political support especially in regard to investment in this area?
- Do you think that developmental organizations like the World Bank and the Caribbean Development Bank can serve in raising high level attention on the use of GIM for DRM?
- To the best of your knowledge which Caribbean country has successfully implemented GIS with DRM?
- In your opinion, are there regional experts who can support the successful implementation of GIS and DRM?
- What would you say is needed for us to effectively mainstream any policies of frameworks as it relates to GIS and disaster risk management?
- What do you see as the opportunities that are emerging, especially as we look digital transformation?
- What is the role of the private sector and academia?
- What would you envision as the future of GIM, the ideal future of GIM and disaster management, what would that look like and why?

Annex 2
Respondents

Name	Agency	Contact
Earl Edwards	University of the West Indies, St Augustine	Earl.Edwards@sta.uwi.edu
Alvaro Monette	Economic Commission for Latin America and the Caribbean	Alvaro.MONETT@cepal.org
Bheshem Ramlal	University of the West Indies, St Augustine	Bheshem.Ramlal@sta.uwi.edu
Cecille Blake	UN-GGIM and UNGEGN Secretariats- United Nations Statistics Division-Department of Economic and Social Affairs	blake1@un.org
Chamberlain Emmanuel	Organisation of Eastern Caribbean States	chamberlain.emmanuel@oecs.int
Ian King	United Nations Development Programme	ian.king@undp.org
Jacob Opadeyi	Disaster Risk Management- Consultant	jacob.opadeyi@gmail.com
Paul Saunders	Caribbean Development Bank	saundep@caribank.org
Renee Bab	Caribbean Disaster and Emergency Agency (CDEMA)	renee.babb@cdema.org
Ronald Jackson	United Nations Development Programme	ronald.jackson@undp.org
Tarik Dixon	Digicel Group (Private Sector)	tarik.dixon@digicelgroup.com

Annex 3
Survey Questionnaire: Use of Geospatial Technologies and Data for DRM

==

Name of respondent______________________ Official Position_________________________

Agency____ Country____________________
Telephone (Work) ___________ (Mobile) __________ Email_______________________________

Section B: Application of Geospatial Technologies

1. Which of the following National Agencies are integrated into the Disaster Risk Management (DRM) System of your country?

National Agency	Fully	Partially	Not
Physical Planning Agency			
Public Works Agency			
Land and survey Agency			
Environment Management Agency			
Utilities Agencies (Power generation and distribution)			
Utilities Agencies (Water resources management and supply)			
Utilities Agencies (Telephone and Cable)			
Social and Community Development Agency			
Protective Services (Police, Fire, Health)			
Others (Name):			

2. How frequent does your Agency use the following Geospatial Technologies and data (GST/D) products in support of Disaster Risk Management?

GST/D Products	Regularly: More than 5 times a year	Often: 2-3 times a year	Occasionally: Only when triggers by an event	Never
Flood Hazard Map				
Landslides Hazard Map				
Drought Hazard Map				
Storm surge Hazard Map				
Earthquake Hazard Map				
Volcano Hazard Map				
Land use Map				
Land cover Map				
Vulnerability Assessment				
Disaster Risk Assessment				
Damage Assessment				
Critical facilities				
Evacuation routes map				

2b. Please list below the users and uses of the Geospatial Technologies products listed in 2 above.

Name of users	List of uses

3. Kindly provide a list of Disaster Risk Management Applications/Products that were developed and use by your Agency in the past five (5) years.

List of Applications Developed

3a. Please list below the users and uses of these applications.

Name of users	List of uses

Section C: Human Resource Capacity

4. Against the level of knowledge, please indicate the number of technical staff in your Agency who are trained in the theory and application of the following Geospatial Technologies:

Human Capacity	# of staff		
	Basic	Intermediate	Advance
Use of GIS software			
Use of Remote Sensing software			
Use of Spatial Database software			
Use of GPS mapping equipment			
Use of Drone mapping system			
Preparation of hazard maps			
Vulnerability assessment			
Creating orthophotos from raw satellite images			
Georeferencing and mosaicking of images			
Satellite image analysis			
Satellite image classification			
Performing raster to vector conversion			
Processing of drone image to produce orthophoto maps			
GPS errors processing			
Database design and management			
GIS applications programming			
Metadata creation and management			
Spatial data analysis and modelling			
Map datum and map projections			
Database integration and migration			

5a. List below five (5) topmost constraints affecting staff capacity enhancement in your Agency.

5b. What are the effects of these constraints on your operations?

5c. What is your Agency's annual budget for training in Geospatial Technologies? $______________

6. How many of your staff have received Geospatial Technologies training in the last 2 years? ________

7. What is your Agency's annual budget for geospatial data acquisition and maintenance? $____

8. Which of these are challenges faced by your Agency in the effective application of Geospatial Technologies and Data?

	Challenges
	Lack of budgetary allocations
	Lack of trained personnel
	Lack of current and accurate data
	Lack of policy directives
	Internal resistance
	Lack of Support from other Government Agencies
	Others (list)

Section D: Policy and Standards

9. In the table below, kindly indicate the availability or otherwise of the following policies and standards in support of Geospatial Technologies and Data in your Agency.

Policy/Standards	Yes/No
Metadata standards	
Data access and confidentiality policies	
Data backup policy	
Data sharing policy	
Cartographic standards	
Process mapping policy	
Data dictionary standards	
Data maintenance policy	

10. In the table below, kindly indicate the availability or otherwise of the following policies and standards in your Agency in support of Disaster Risk Management.

Policy/Standards	Yes/No
Hazard mapping policy/regulations	
Vulnerability assessment policy/regulations	
Damage assessment policy/methods	
Disaster management plan	
Disaster mitigation plan	
Evacuation management plan/policy	
Contingency planning and policy	
Others (List)	

Section E: Geospatial Technologies

11. Do you have a dedicated Geospatial Technologies computer room / facility?

12. Does your Agency have Geospatial Technologist on staff who could provide technical support?
Yes: ____ No: ___.

12a. If yes, please list the type of technical support provided.

____

13. Do you have a budget for technical support? Yes: ____ No: ___.

13a. If yes, what is your current annual budget? $ _______________________

14. Using the table below, kindly provide a list of computer hardware (Servers, Storage, Personal Computers, Workstations) used by your Agency in the performance of geospatial analyses or Disaster Risk Management functions.

Type (Server, Storage, Personal Computer, Workstation)	Brand/model	Year acquired	Number of units	CPU (type and number)	RAM	Operating System	Capacity (Gb)

15. Using the table below, kindly provide a list of specific geospatial technologies used by your Agency in the performance of geospatial analyses.

Equipment	Brand/Model	Year of acquisition	Number of units
Digitizers			
Scanners			
Printers			
Plotters			
Digital camera			
Digital video recorder			
GNNS (GPS)			
Drones Mapping Technology			
Smart Phones			
Other (list)			

16. Using the table below, kindly provide a listing of computer software used by your Agency in the performance of geospatial analyses.

Name of software/Application	Version and year of acquisition (is it under warranty)	Type (Standalone, Client-Server, Web-based)	DB platform (if any)	Operating system (if centralized, please specify both server and client OS)	No. of users	Main uses

17. What is the primary computer Database Management System (DBMS) used by your Agency?

18a. Which of the following issues are currently confronting the effective use of your Database?

	Yes	No
Maintaining the database system and its datasets		
Inputting data and updating the database		
Browsing and querying the database		
Obtaining reports from the database		
Importing or exporting data to or from the database		
Others		

18b. If yes, please provide details.

19. Do you have any problems related to inaccurate or dated geospatial data? Yes__ No__

20. Is your Database Management System a relational database? Yes__ No__

21a. Does your staff have difficulties in using the database? Yes__ No__

21b. If yes, please provide details.

22. In the table below, please list the types of datasets stored in the database, any issues or problems related to the data. Please indicate, if data meets your Agency current and future requirements.

Types of Data in the database	Issues and Problems	Does the database meet Current Requirements?	Does the database meet Future Requirements?

23. In the table below, please list the spatial analyses/queries that are produced by the database system and any issues or problems related to these options. Please indicate if the current requirements are being met and any future requirements.

Spatial Analysis	Issues and Problems	Does the analysis meet Current Requirements?	Does the analysis meet Future Requirements?

24. In the table below, please indicate any issues or problems related to the data needs listed below. Indicate if the current system requirements are being met and any future requirements.

Data Needs	Issues and Problems	Do the Data Needs meet Current Requirements?	Do the Data Needs meet Future Requirements?
Importing Data			
Exporting Data			
Map projection			
Map datum			
Fields used for searches			
Vendor support			
System Access			
Customizations to be implemented by staff			

25. Which of the following Geospatial application in DRM do you consider would efficiently support the activities performed by your Agency?

Disaster Risk Management Applications	Yes/No
Hazard Mapping	
Vulnerability Assessment	
Disaster Risk Assessment	
Land use/Land cover mapping	
Critical facilities	
Evacuation routes	
Others (List)	

SECTION F: SWOT ANALYSIS

What are the strengths of your Agency's capacity to apply Geospatial Technologies and Data for Disaster Risk Management?
What are the weaknesses of your Agency's capacity to apply Geospatial Technologies and Data for Disaster Risk Management?
What opportunities are inherent in your Agency's capacity to apply Geospatial Technologies and Data for Disaster Risk Management?

What are the threats to your Agency's capacity to apply Geospatial Technologies and Data for Disaster Risk Management?

What specific recommendations would you make towards improving/ mainstreaming the applications of Geospatial Technologies and Data in your Agency?

SECTION G: Characteristics of Geospatial Data

The availability of geospatial data in your Agency

	Yes, it's available	No, it's available)
Administrative Boundaries Data		
Coastline		
Parishes/Districts		
Geographic Name of Places		
Community boundaries		
Natural Resources Related Data		
Geology		
Elevation contours and points		
Digital Elevation Model		
Soils		
Rivers/Streams/Watercourses		
Water bodies: Lakes/Lagoons		
Roads – Major and minor		
Land Cover Map		
Rainfall data		
Locations of Rain Gauges		
Beaches		
Environmentally Sensitive Sites		
Wind direction data		
Anthropogenic Related Data		
Buildings		
Census Layers		
Political Districts		
Government Buildings		
Recreational /Tourist Facilities		
Educational Facilities		
Health Facilities		

	Yes, it's available	No, it's available)
Land Use		
Airports/airfields/airfields/runways		
Banks and Financial Centres		
Waste management sites		
Dams and Ponds		
Electrical generating plants		
Water tanks / reservoirs		
Police stations		
Fire stations		
Prisons		
Population centers		
Seaports		
Electricity lines		
Water supply lines		
Emergency operations facilities		
Emergency Shelters		
Place of worship		
Markets and shopping Centres		
Historic /Archaeological sites		
Hazard-related Data		
Flood Hazard Zones		
Flood incident inventory		
Landslide hazard zones		
Erosion hazard map		
Earthquake epicenters		
Geological Fault lines		
Volcanic centers		
Hurricane tracks		
Storm surge		
Building Damage History		
Infrastructure Damage History		
Remotely Collected Data		
Aerial Photos		
Satellite Imageries		
Light Detection and Ranging (LiDAR)		

Which of this best characterise the quality of your geospatial data and information current available to your Agency?

	Yes	No
Inaccuracy		
Low spatial resolution (More than 1:25,000)		
Very old dataset (more than 5 years old in urban areas)		
Incomplete dataset (lack national coverage)		

Lacks relevant attribute data for spatial analysis		
Not available in digital format		
Lack of metadata		
Not freely available (must be purchased)		
Has map projection issues		
Has geodetic reference datum issues		

Thank you for your assistance.
Please return completed questionnaire by email to Jacob Opadeyi
Email: Jacob.Opadeyi@outlook.com

Annex 4
List of Respondents National Agencies

Country	Name	Position	Agency	Email Address
Barbados	Damien Griffith	Programme Officer	Department of Emergency Management	deminfo@barbados.gov.bb
British Virgin Islands	Melanie Daway	Technical Planning Officer	Department of Disaster Management	mdaway@gov.vg
Grenada	Davron Phillip	Information Technology Officer	National Disaster Management Agency	davronphillip@hotmail.com
Guyana	Allana Walters	Mitigation & Recovery Manager	Civil Defence Commission	allana.walters@cdc.gy
Jamaica	Ryan Wallace	Spatial Planner	Manchester Municipal Corporation	rwallace_planner@yahoo.com
Sint Maarten	Johann Sidial	GIS Officer	Ministry of Public Housing, Spatial Planning, Environment and Infrastructure	johann.sidial@sintmaartengov.org
St. Kitts and Nevis	Oureika Lennon-Petty	Planning Officer	National Emergency Management Agency	oureika.lennon-petty@gov.kn
The Bahamas	Suzane Russell	GIS Analyst	Bahamas National GIS Centre	suzanerussell@bahams.gov.bs
Trinidad and Tobago	Brett Lucas	GIS Specialist	Office of Disaster Preparedness and Management	blucas@mns.gov.tt
Turks and Caicos Islands	Mike Clerveaux	Deputy Director (a.i)	Department of Disaster Management and Emergencies	mclerveaux@gov.tc

Annex 5
Training needs pre-assessment in-line survey: Caribbean Study and Subregional Workshop for Professionals on The Applications of Geospatial Technologies and Data for Disaster Risk Management Tentative Date: September 2021

How do you rate your knowledge of the use of the following tools for disaster risk management?	Below average	Average	Fair	Good	Very good
Knowledge of geographic information systems (GIS)	O 1	O2	O3	O4	O5
Knowledge of spatial analysis tools	O 1	O2	O3	O4	O5
Knowledge of satellite remote sensing	O 1	O2	O3	O4	O5
Knowledge of global navigation satellite systems (GNNS or GPS)	O 1	O2	O3	O4	O5
Unmanned aerial vehicle (Drone technology)	O 1	O2	O3	O4	O5
Processing of satellite imageries	O 1	O2	O3	O4	O5
Database design and management	O 1	O2	O3	O4	O5

Annex 6
Examples of National agencies using GIM including DRM policy and legislation containing GIM content

Table A1
National agencies using GIM and including referenced policy and legislation supporting DRM

Country	Ministries and Agencies using GIM to Support DRM (selected)	DRM policy and legislation with GIM content (selected)
The Bahamas	Ministry of Environment and Natural Resources - National Geographic Information Systems Centre, the Geospatial Advisory Council and the Bahamas Spatial Data Infrastructure Program - Department of Meteorology - The Bahamas Environment, Science and Technology Commission National emergency Management Agency-Cabinet Office Department of Land and Surveys-Office of the Prime Minister Department of Physical Planning-Ministry of Works and Utilities Department of Fisheries-Ministry of Agriculture and Fisheries The Bahamas National Statistical Institute- Ministry of finance	-Bahamas Spatial Data Infrastructure Act, 2014 (No. 9 of 2014) -The Bahamas National Geographic Information Systems Center- GIS Policy
Barbados	- Barbados Government Information Service - Government of Barbados- Department of Emergency - Barbados-Coastal Zone Management Unit	The Barbados Comprehensive Disaster Management (CDM) Country Work Programme (CWP) 2019 – 2023
Grenada	Ministry of National Security, Home Affairs, Public Administration, Information and Disaster Management - National Disaster Management Agency - National Disaster Management Advisory Council Ministry of Finance, Planning, Economic Development, Physical Development, Public Utilities and Energy of Grenada - The Central Statistics Office Ministry of Agriculture and Lands: Lands Use Division	-Grenada Strategic (investment) Program for Climate Resilience (2011) -Country Document on Disaster Risk Reduction for Grenada (2014)
Guyana	Office of the Prime Minister, Civil Defence Commission Guyana Lands & Surveys Commission Guyana Forestry Commission Guyana Environmental Protection Agency	National Integrated Disaster Risk Management Plan and Implementation Strategy for Guyana (2013). Additional DRM related Policy Documents are at the Guyana-Civil Defence Commissions e-page at: https://cdc.gy/document-library/
Jamaica	Ministry of Local Government and Rural Development- Office of Disaster Preparedness and Emergency Management Ministry Of National Security Ministry of Education, Youth Ministry of Health Ministry of Economic Growth and Job Creation - Land Information Council of Jamaica - National Environment & Planning Agency	Jamaica Disaster Risk Management Act, No 1 of 2015 Vision 2030 Jamaica - National Development Plan The National Emergency Response Geographic Information Systems Team (NERGIST) Operating Guidelines

Country	Ministries and Agencies using GIM to Support DRM (selected)	DRM policy and legislation with GIM content (selected)
	- National Spatial data Management Division - National Water Commission Ministry of Agriculture and Fisheries Ministry of Local Government and Rural Development Ministry of Housing, Urban Renewal, Environment and Climate Change University Of Technology- Jamaica University Of the West Indies (Mona)	
Saint Kitts and Nevis	Ministry of Sustainable Development- Department of Physical Planning and Environment. St. Kitts and Nevis-National Emergency Management Agency	Saint Kitts and Nevis: Natural Hazard Mitigation Policy and Plan (2001. Additional DRM related Policy Documents are at the St Kitts and Nevis- Disaster Management Department, e-page at: https://ndmd.kn/partners/
Sint Maarten	Ministry of Public Housing, Spatial Planning, Environment and Infrastructure- Sint Maarten The Sint Maarteen Disaster Management Organisation	Sint Maarten's National Recovery and Resilience Plan (available at: https://nrpbsxm.org/wp-content/uploads/2019/08/NRRP.pdf
Trinidad and Tobago	Ministry of National Security – Office of Disaster Preparedness and Management Ministry of Agriculture, Land and Fisheries Ministry of Planning and Sustainable Development - Central Statistical Office - Environmental Management Authority -Institute of Marine Affairs Ministry of Works and Transport- Coastal Protection Unit Ministry of Public Utilities - Trinidad and Tobago Meteorological Services - Water and Sewerage Authority and Water Resources Agency Ministry of Local Government and Rural Development The Seismic Research Centre- University of the West Indies, St. Augustine	-Trinidad and Tobago is the Disasters Measures Act -Chapter 16:50 (Act 47 of 1978). -Trinidad and Tobago-National Development Strategy (2016-2030) -Additional DRM related Policy Documents are at the Trinidad and Tobago-Office of Disaster Preparedness and Management website: https://odpm.gov.tt/node/159
Turks and Caicos	The Department of Disaster Management and Emergencies	Turks and Caicos, Disaster Relief Management Plan (2018). Additional Documents are available at: The Turks and Caicos Islands Government- Department of Disaster Management and Emergencies- link: https://www.gov.tc/ddme/library/plans

Source of data: Based on surveys conducted by ECLAC in 2021 and additional information obtained from desk study.

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