

Geospatial data sharing: Understanding intergovernmental emergency response data-sharing activities

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In this paper, we extend the study of multilateral geospatial data-sharing mechanisms for humanitarian disaster response and present quantitative analysis on compiled activities for the study period of 2000 to 2024. We comparatively analyze changing dynamics of intergovernmental geospatial data sharing in quantitative terms, such as by mechanisms, countries, geographical regions, time, level of economic development, and hazard type. We observe that for the duration of 25 years, the range of countries which requested geospatial data through multilateral geospatial mechanisms has increased and the overall frequency of requests has increased at an accelerated pace within the past few years. We also observed changing and unique dynamics of the data requests within and between regions and level of economic development. The Asia region recorded the largest number of data requests during the study period and was the most engaged with all referenced mechanisms. Requests from the lower-middle income-level profile countries increased consistently in most years during the study period. The hazard type meteorological and hydrological was most frequently requested among all levels of economic development, but not commensurate to the number of reported disasters. This paper contributes to the existing literature of not only extending the study time frame for quantitatively examining geospatial data sharing for disaster response using publicly accessible resources but also highlighting key regional dynamics.

Keywords: Data sharing, disaster, Earth observations, emergency, intergovernmental, multilateral

1. INTRODUCTION

Geospatial data has been recognized and adopted as a key information tool to support disaster response (for the purposes of this paper, disasters include natural disasters and man-made disasters). Timely provisioned informational assets derived from geospatial data, such as annotated maps, give responders access to bird's eye view to assess impact and situations, and ultimately the necessary responses to disasters. In light of this, there have been many iterations of international initiatives and implementations to further the adoption and availability of geospatial data for humanitarian purposes by ways of sharing data through multilateral mechanisms with nuanced instantiations, structures, and processes. It has been more than two decades of operations for some of the first and initial mechanisms and there has been significant progress of activities.

This paper focuses on providing quantitative insights on multilateral geospatial data sharing for humanitarian activities and exploring the dynamics of the sharing. We detail active mechanisms, processes and roles, analysis of activities, and discussions on findings. The insights are based on data gathered from publicly shared and verifiable documentation from each mechanism, such as published annual reports, online websites and dashboards, newsletters, and academic papers. The data collected from multiple sources are further curated to provide a generalizable quantitative comparison.

2. DISASTER RESPONSE GEOSPATIAL DATA SHARING

In this section of the paper, we briefly describe the disaster management cycle and present and detail currently active and publicly documented disaster response geospatial data-sharing mechanisms and a generalized framework.

2.1 Disaster management cycle

Fig. 1¹ illustrates the cyclical nature of disaster management and how the steps are interconnected. Disaster is a serious disruption of the functioning of a community or a society that triggers a response, meaning actions taken directly before, during, or immediately after a disaster to save lives, reduce health impacts, ensure public safety, and meet the basic subsistence needs of affected people [2]. This is followed by recovery, understood as the restoring or improving of livelihoods, health, and the economic, physical, social, cultural, and environmental assets, systems, and activities of an affected community or society. Mitigation then refers to lessening or minimizing the adverse impacts of a hazardous event, while preparedness consists of the knowledge, capacities, and measures developed in advance to anticipate, respond to, and recover from disasters more effectively. Because risk is never fully eliminated, these stages are interconnected and recurrent, feeding back into preparedness for the next hazardous event and potential disaster.

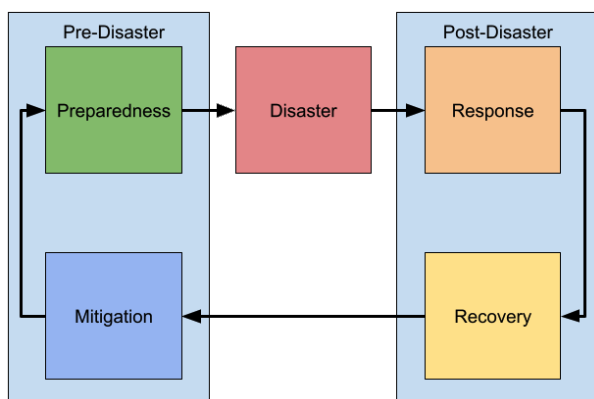


Figure 1 – Diagram of the disaster management cycle

Therefore, management of disaster situations can be characterized into three intuitive and distinct larger stages: pre, during, and post-disaster. Geospatial data, such as analytical maps, annotated with satellite data can be an effective informational asset and tool when managing disasters. For example, maps can be used for situational awareness, impact assessment, prediction and early warning, respectively. For the purposes of this paper, we focus our analysis and discussions on geospatial data sharing at the immediate instance or responding to disasters and excluding early warning.

¹ Adapted from sources by the United Nations Office for Disaster Risk Reduction [1]

2.2 Multilateral geospatial data-sharing mechanisms

Table 1 lists quick facts on multilateral geospatial data-sharing mechanisms that are currently active, as of 2025. It should be noted that the names of mechanisms have changed over time in continuation of development and activities.

Currently, there are multiple multilateral geospatial data-sharing mechanisms that are active and publicly documented (in alphabetical order): Copernicus Emergency Management Service (EU-EMS), Regional Space Applications Programme for Sustainable Development in Asia and the Pacific (RESAP), International Charter ‘Space and Major Disasters’ or Disaster Charter (IDC), Sentinel Asia (SA), United Nations Office for Outer Space Affairs’ United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UNOOSA/UN-SPIDER or UN-SPIDER), and United Nations Institute for Training and Research’ United Nations Satellite Centre (UNITAR/UNOSAT or UNOSAT). They are “mechanisms” in which geospatial or satellite data is shared among its members or network for humanitarian response and relief in emergency situations including natural and man-made disasters. It should be noted that the extent of records from each mechanism in regards to details of instances of geospatial data requests and sharing is varied. In the next section, we provide short details of their foundation and current operations.

Table 1 – Table of multilateral geospatial data sharing mechanisms

Mechanism Name	No. of Members (countries/agencies)	Founding/ Operational Year	Disaster Scope
Regional Space Applications Programme for Sustainable Development	34 members	1994	Natural
International Charter ‘Space and Major Disasters’	17 agencies	2000	Man-made & Natural
United Nations Satellite Centre		2001	Man-made & Natural
Sentinel Asia	20 countries	2005	Natural
United Nations Platform for Space-based Information for Disaster Management and Emergency Response		2006	Man-made & Natural
Copernicus Emergency Management Service	92 countries	2012	Man-made & Natural

2.2.1 United Nations initiatives

There are multiple United Nations-led projects and programmes that contribute as mechanisms to the sharing of geospatial data for emergency response. The active mechanisms are RESAP, UNOSAT, and UN-SPIDER. They have varied histories, mandates, and functions but share a common goal on sharing geospatial data.

RESAP was programmatically and formally regularized at the proceedings of the Ministerial Conference on Space Applications for Development in Asia and the Pacific convened in September 1994 [3, 4] to support the Asia Pacific region and United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) members. It is governed by a network, Intergovernmental Consultative Committee, which convenes to review programme implementation, as well as to provide policy and technical guidance on space applications for achieving sustainable development, and it cooperates broadly on space applications following the iterative Asia-Pacific Plan of Action on Space Applications [5] including sharing information on natural disasters². The programme documents and reports its implementations through summary reports and resolutions from plenary meetings.

UNOSAT was programmed in 2001 as the United Nations Operational Satellite Applications Programme funded by the United Nations Office for Project Services (UNOPS) [6] and recognized as the United Nations Satellite Centre in 2021 [7, 8]. UNOSAT is now the satellite applications program of UNITAR. UNOSAT acts as a centralized service provider and analysis hub, with its core activities including rapid mapping, damage assessments, risk reduction planning, and training. UNOSAT supports partner organizations through on-demand activations and long-term engagement, and is frequently involved in IDC activations on behalf of UN agencies. It maintains an open-access portal for sharing analysis products and situational maps and publishes regular activity reports.

UN-SPIDER was programmed in 2006 as a programme implemented by the UNOOSA. With resolution 61/110 [9, 10], the General Assembly established a programme to provide universal access to space-based information and services relevant to disaster management for the full disaster management cycle. The programme is mandated to follow an implementation framework [11] among dispersed offices (Beijing, Bonn, Vienna; later Geneva) that each lead in a range of prescribed activities from awareness, compilation of information, outreach, and liaison.

2.2.2 International Charter 'Space and Major Disasters'

The IDC or Disasters Charter is a non-binding charter operationalized in November 2000 [12]. It is a multilateral cooperation initiative between national space agencies following the resolution of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III) [13] in 1999, in which space agencies would provide satellite data after disasters to requesters [14, 15]. The initiative is non-binding as the

requests for and provisions of satellite data are provided on a voluntary basis, but they follow a standardized protocol and roles. The activities of the IDC are guided by a board of which each member is represented and implemented by an executive secretariat which is chaired by a member agency on a 6-month rotational basis [16, 17]. As of April 2025, it has 17 charter members with 270 satellites provisioning data to 143 countries [18] in disaster cases from natural scenarios, such as floods and earthquakes, to man-made scenarios, such as oil spills [19]. The mechanism publicly shares its activities through an online website and publications of annual reports.

2.2.3 Sentinel Asia project

The SA project is an initiative first proposed and endorsed during the Asia Pacific Regional Space Agency Forum (APRSAF) in 2005 and operationalized in 2006 [20, 21, 22]. It is a collaboration between two regional intergovernmental organizations, Asian Disaster Reduction Center (ADRC) and APRSAF, with each focusing on disaster management and space respectively to form a Joint Project Team (JPT) and implement the SA project together to share and utilize satellite data for natural disaster response [23, 24]. The initiative is also voluntary and follows a particular protocol but it is regionally focused. The project maintains an engagement with IDC. For example, since 2010, requests from SA could be forwarded to the network of IDC in cases where satellite data is not available within the SA network. The Japan Aerospace Exploration Agency (JAXA) is the secretariat and manages operations and coordination of satellite data and is led by its steering committee which is elected and chaired on an annual basis. As of April 2025, it has 107 members from 30 countries with 10 satellites provisioning data to 37 countries for natural disaster response [25]. It is a key geospatial data-sharing mechanism addressing critical requests in the disaster-ridden Asia Pacific region. The mechanism publicly shares its activities through an online website and publications of annual reports.

2.2.4 Copernicus emergency management service

The Copernicus Programme is the current naming of the Earth observation initiative funded and supported by the European Union Space Programme that is managed by the European Commission (EC), and within it there is the Emergency Management Service (EMS). The service has been in operation since 2012 and provides various mapping services including rapid mapping for disaster and emergency response [26]. The Copernicus's rapid mapping function is a continuation of precursor projects within its former Global Monitoring for Envi-

²

It shares on average 30 to 50 Gbs of satellite data per year.

ronmental Security (GMES) [27]. Serial projects were instantiated to increase European capacity for Earth observation services including capability for provisioning post-processed geospatial products for disaster and humanitarian response purposes and sharing satellite data for both man-made and natural disasters. The satellite data used by the mapping services are from the Sentinel missions and Copernicus contributing missions. The Copernicus Emergency Management Service mechanism, as well as its precursor projects, publicly shares its activities through an online website and dashboard.

2.2.5 Summary

Each mechanism has notably different initiations, modalities, outreach, and areas of work to support its members. For example, the IDC was first instantiated as a collaboration between national space agencies for the international disaster community, and the SA project was first instantiated as a collaboration between two regional communities each from space and disaster management. However, it should be stressed that whilst there are differences between mechanisms, all of them provide access to geospatial data at zero cost to its beneficiaries.

2.3 Disaster data-sharing framework

In this section of the paper, after reviewing documentations of mechanisms on their operational processes and procedures, we detail and generalize the post-disaster data-sharing framework in terms of network and process. The disaster data-sharing framework can be largely divided into two: process and network.

2.3.1 Data-sharing process

The post-disaster data-sharing process is in four general steps, as shown in Fig. 2: (1) activation, (2) data acquisition, (3) data processing, (4) data product sharing.

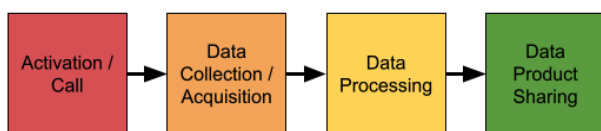


Figure 2 – Diagram of the disaster management cycle

The first step activation is a trigger mechanism in which a request is formally made. The request is reviewed for validity and can be accepted or rejected based upon the request details. If and when the request is accepted, the second step data collection/acquisition happens and validated request details including specific areas of interest or study are forwarded to a network of parties that can

capture and/or provision data. In the third step, the collected data is processed and analyzed to identify impact from the disaster, such as damage assessments. In the last step, the analytics are compiled into easily readable products such as reports or maps that are distributed to those in need, such as field responders. Each mechanism functions with varying degrees of nuances of the process. For example, RESAP participates on step 1 in which it coordinates during the calling of data requests and gathers and forwards specifications of the data request.

2.3.2 Data-sharing network

The data-sharing process is complemented by a network composed of multiple roles with each fulfilling a unique task or step and is geographically distributed.

2.3.2.1 Roles

The roles in the data-sharing network can be intuitively characterized into the following: requesters, on-duty officer, project manager, data provider, and data analyser. The requester is the party which is requesting satellite data from the on-duty officer and is the end user of data products such as maps and analysed imageries. The on-duty officer is the party which receives and validates requests for satellite data and nominates the project manager. The project manager coordinates the activities of data sharing by identifying detailed needs and specifications from the requester to data provider, sharing acquired data to data analyser, and sharing analysed data products to the requester. The data provider shares satellite data according to the needs and specifications identified by the project manager. The data analyser utilizes acquired satellite data to produce data products, such as maps, from studying impact of disasters.

3. DATA GATHERING AND CURATION

We gather data from a desk review of publicly available sources of the above-mentioned intergovernmental data-sharing mechanisms. The publicly available sources which are referred to are reports such as annual publications and observation analysis reports, and online platforms that show the availability of geospatial data as well as its resultant derivative post-processed and analysed products, such as annotated maps. Although activities of the mechanisms are publicly documented, each mechanism has varying degrees of published information. Table 2 below details information sources published by the mechanisms³.

³ RESAP and UN-SPIDER is omitted from the data gathering as its records of activities on instances of data sharing are limited in comparative numerical form.

Table 2 – Table of multilateral geospatial data-sharing mechanisms

Mechanism Name	Source	Info. Name	Citations
Copernicus	EC	Emergency Mapping Service News	[28] [29]
		Emergency Observation Annual Publications Monthly News	[30] [31] [32]
Sentinel Asia	JAXA	Publications Newsletters	[33] [34]
	ADRC	Annual Meeting Reports	[35]
Disasters Charter	ESA	Charter Geobrowser Tool Charter Annual Report Charter Newsletter	[36] [37] [38]
UNOSAT	UNITAR	Products	[39]

The data that is gathered and curated for the purposes of this report are more related to aspects of data sharing, such as instantiations of the underlying disasters but also of data requests such as activations and acquisitions.

3.1 Primary data

The primary data is related to the nature of the geospatial data requests made to each mechanism. This data is studied to understand changes in data requests over time, such as to identify trends and shifts. It should be noted that each record of geospatial data requests to mechanisms is taken as a unique instantiation⁴ and includes instantiations with Global Unique Disaster Identifier (GLIDE) codes but also other code references. Table 3 below details the gathered data variables.

Table 3 – Table of primary data variables gathered

Data Variable(s)	Detail
Activation number	The reference code for the data request
Activation date and time	When the activation was made
Requested country or area	Where was the requested country or area

3.2 Supplementary data

The supplementary data is related to the context of the geospatial data request, such as the profiles of observed countries or areas in terms of geographical region and economic development, as well as reported cases of disasters. This data is used in comparison with primary data to better understand geospatial data requests. Table 4 below details the gathered supplementary data variables.

Table 4 – Table of supplementary data variables gathered

Data Variable(s)	Source
Emergency Events Database (EM-DAT)	Centre for Research on the & Epidemiology of Disasters [40]
Hazard Information Profiles (2025)	United Nations Office for & Disaster Risk Reduction (UNDRR) [41]
Income Profile (2022)	World Bank [42]
Region (M49 standard)	United Nations Statistics Division [43]

⁴ Data requests as referrals and/or transference to and from between mechanisms are taken as is.

4. ANALYSIS OF ACTIVITY

In this section of the paper, we showcase aggregated activities of the intergovernmental geospatial data-sharing mechanisms by dissecting the data gathered and curated.

4.1 Activations by country or area

For the duration of 2000 to 2024, 2 788 requests to observe 186 countries or areas were made to the mechanisms. This means 75 per cent of 248 countries or areas (M49 standard) have been observed and/or requested for data. The countries or areas that were most frequently requested were the Philippines, Indonesia, and Vietnam, as shown in Fig. 3. The three countries combined accounted for 14.95 per cent of all data requests. In addition, as shown in Fig. 5, a large proportion of countries or areas of approximately 47.8 per cent had been requested for six or less instances.

We also observe that there is an increasing trend when studying the number of countries or areas requested per year. For example, as shown in Fig. 4, for the year 2024, there were a total of 90 unique countries or areas that requested data. The two years with the largest increases in the rolling count of unique countries requesting data were in years 2007 and 2005, with 25 and 15 additional countries respectively requesting data that have never requested data with the referenced mechanisms. The number of countries or areas requesting data per year has increased with the two years 2007 and 2024 having recorded the largest increases from its previous years of 22 and 18 respectively. As a result, over the duration of 25 years, the number of countries requesting data per year have been growing at a Compound Annual Growth Rate (CAGR)⁵ of 19.72 per cent per year.

4.2 Activations by region

When studying the number of data requests by region, we note several notable observations: 1) Asia and Europe regions historically requested data most frequently; 2) each mechanism is requested more frequently than others in certain regions; and 3) mechanisms are not uniformly active in all regions.

The Asia and Europe regions were most frequently requesting for data from the mechanisms. As shown in Fig. 6, more than half of the data requests were from the two regions during the period 2000 till 2024 in aggregate. It should be noted that the Europe region requested data most frequently in the earlier years but requests from the Asia region surged starting as early as in 2003 and quickly overtook it, as shown in Fig. 7.

⁵ Growth rates are indicative due to high interannual variability.

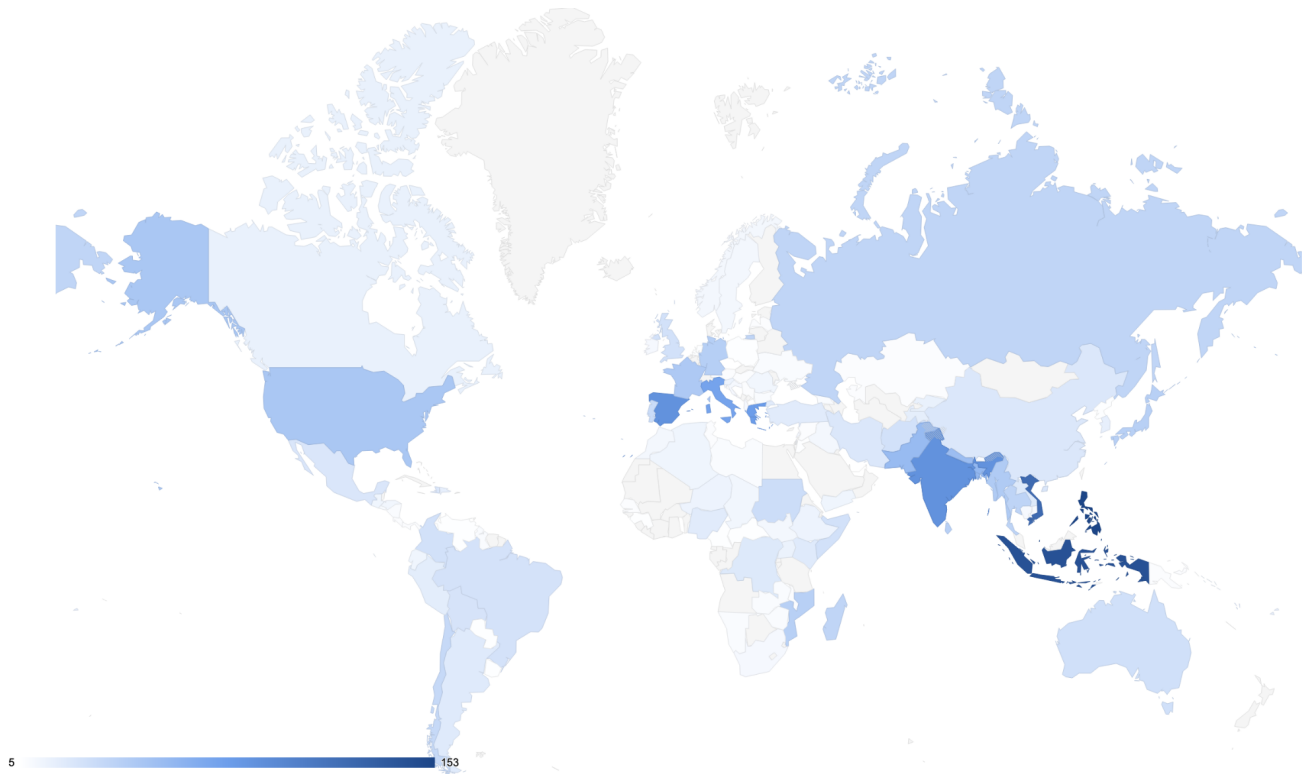


Figure 3 – Number of data request by country greater than 4 for the duration of 2000-2024

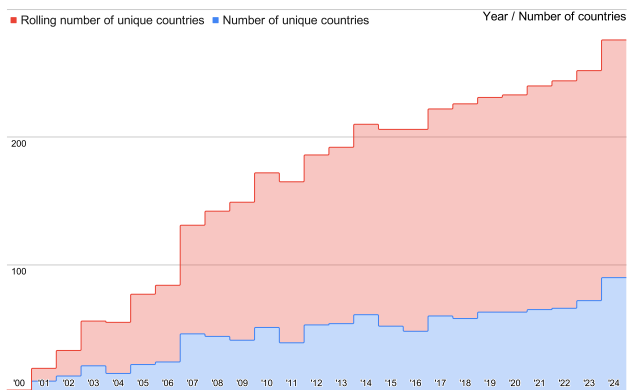


Figure 4 – Number of data requests by countries or areas per year

We take a closer look at the dynamic changes to the data requested by regions. As shown in Fig. 8, when taking a look at the share of data requested by regions over time and within each region by mechanism over time, we can observe the differing levels of outreach of each mechanism, as well as engagement by regions and following the instantiation of the mechanisms. For instance, during the earlier years, IDC and UNOSAT had more shares of the outreach and engagement with most regions. With the exception of Europe (and limitedly in Oceania), the combined total share of data requested to the IDC and UNOSAT for the duration of 2000 to 2024 was more than half of the total from all regions. On the other hand, the requests to Copernicus and Sentinel Asia were focused on the Europe and Asia regions respectively, as shown in Fig. 8. Copernicus has contributed to all five

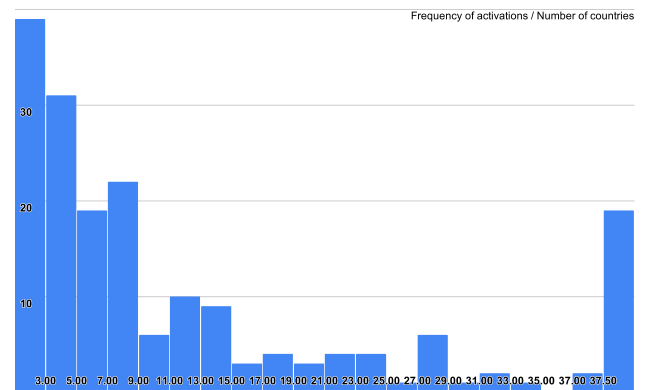


Figure 5 – Histogram of data requests

regions but heavily contributed to the Europe region by maintaining an average share of requests per year of 68 per cent for the duration of its active years of 2012 to 2024. Sentinel Asia has contributed to two regions but has also heavily contributed to the Asia region by maintaining an average share of requests per year of 95.17 per cent for the duration of its active years of 2007 to 2024.

In all regions, data requests were fluctuatingly distributed between the mechanisms. Distinctly in the Europe region, the data requests to the mechanisms starkly shifted from the mechanisms IDC and UNOSAT to Copernicus starting in 2012. Moreover, the most engaged region is the Asia region with it not only having the most number of data requests but also requests to all mechanisms.

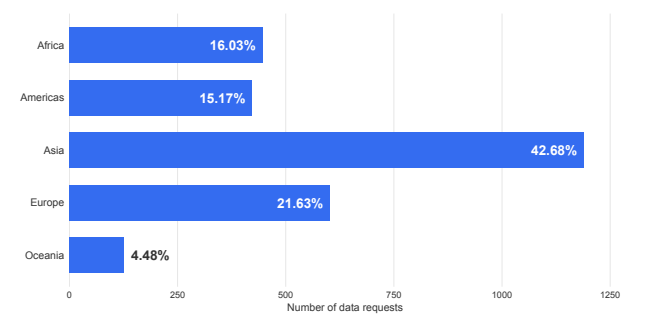


Figure 6 – Total share of data requests by region (M49) for 2000-2024

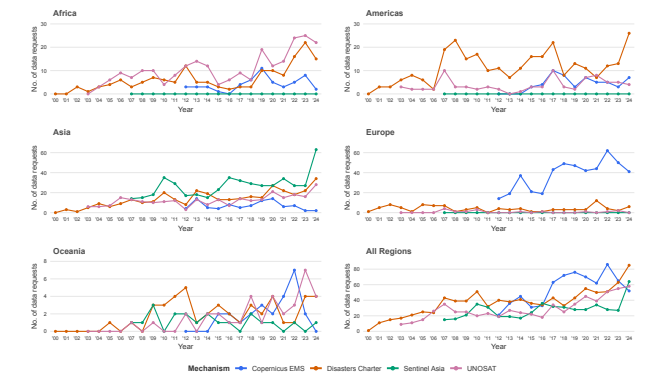


Figure 7 – Number of data requests by region (M49) and mechanism

4.3 Activations by mechanism

When studying the total number of data requests to all mechanisms in aggregate by year, from 2000 till 2024, we can observe that there is an increasing trend. For instance, in 2000 there was a total of one request but by 2024 there were 259 within one year, as shown in Fig. 7. The CAGR of the number of data requests during the last 25 years was 26.05 per cent per year.

We can observe that the increasing trend is complemented by approximate troughs of acceleration/elevation and changes to diversity/composition. There are 3 distinct troughs in the increasing trend, 2000-2006, 2007-2016, and 2017-2024, as shown in Fig. 7. The number of requests distinctly increased with each trough whereby the years that define the first year of the troughs 2000, 2007, and 2017 record unusually higher percentage increases of data requests. The CAGRs for each trough are 17.70, 1.10, and 1.70 per cent per year respectively.

We can also observe that the shares of the data requested to each mechanism are dynamically changing over time. As shown in Fig. 9, data requested to the IDC was the largest share of 33.4 per cent of the total. For the duration from 2000 till 2024, the average share of data requests by mechanism per year by decreasing order was IDC, Copernicus, UNOSAT, and Sentinel Asia with their respective CAGRs being -3.75, -2.28, 2.86, and -1.94 per cent per year during their active years.



Figure 8 – Share of data requests within each region by mechanism

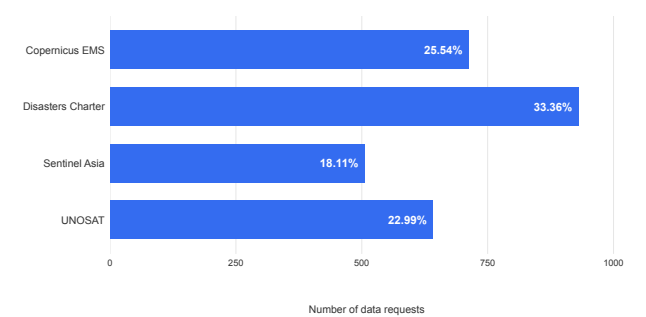


Figure 9 – Total share of data requests by mechanism for 2000-2024

4.4 Activations by economic development

We compare data requests with measures of economic development of the requested countries or areas to understand whether scales of economic prosperity and/or activity had an impact on changes to the frequency of data requests. We use the indicator income level designated to each country for a measure of economic development.

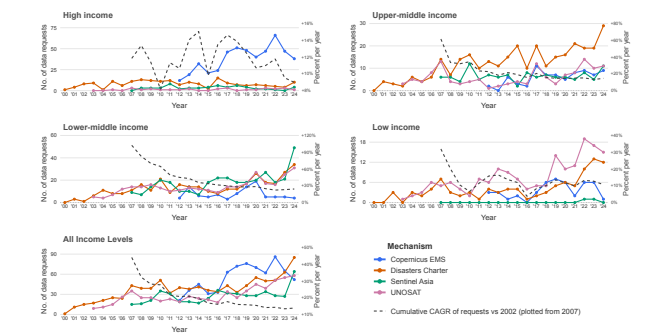


Figure 10 – Number of data requests by income level

For the duration of 2000 to 2024, number of data requests have been increasing in all income levels. However, as shown in Fig. 10, the increasing trend is noted with varied dynamics over the years. The income levels of requested countries or areas in aggregate from largest to smallest percentage shares were lower-middle/LM (38.38), high/H (27.69), upper-middle/UM (22.60), and low/L (11.33)⁶. When further taking a look at the changes

⁶ According to the World Bank, the percentage of countries in the income categories are H (36.9), UM (25.3), LM (25.3), and L (12.4).

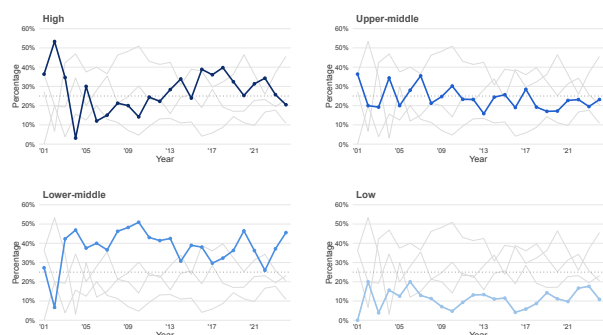


Figure 11 – Share of data requests by income level (WB)

to shares of data requests by income level over time, we observe that fluctuations remained relatively low for the low and upper-middle incomes, as shown in Fig. 11. The income levels in the order of highest to lowest standard deviation of the number of data requests recorded were high (7.35), lower-middle (6.85), upper-middle (5.60), and low (3.47) income levels.

Also, when observing the 25-year average CAGRs of the number of data requests in the order of highest to lowest was high (34.21), lower-middle (23.85), upper-middle (14.87) and low (10.32) income levels. In addition, as shown in the dotted lines and secondary y-axes in plots in Fig. 10, the growth rates are converging. But the lower-middle income level recorded the highest cumulative CAGR of the number of data requests since 2002 till 2024 among all income levels of 24.22 per cent per year.

4.5 Activations and reported disasters

We compare data requests with the number of disasters. The data on disasters is gathered from the Emergency Events Database (EM-DAT) [40] which is a global database on natural and technological disasters that provides comprehensive data on the occurrence and impact of disasters globally. We use the EM-DAT dataset as a consolidated proxy list of disasters occurring globally as reported. At first glance of figures 12 and 14, there is a large gap between the number of data requests and the number of reported disasters with the number of data requests being significantly lower than the number of reported disasters.

When taking a closer look at the number of data requests and reported disasters over time in Fig. 12, we can observe that the number of disasters is fluctuating between 867 (in 2000) and 497 (in 2018) reported cases. However, in comparison, the number of data requests is increasing with increasing proportion to the number of disasters. For instance, as shown in Fig. 12, in 2000 the share of data requests to disasters was 0.12 per cent but by 2024 the share of data requests to disaster was 43.17 per cent. The CAGR of the share of data requests to disasters during

the last 25 years was 26.74 per cent per year. Therefore, at the global level, the coverage rates of data requests (or interchangeably as the proportion/ratio of data requests by reported disasters) have been increasing with the number of disasters remaining relatively stable.

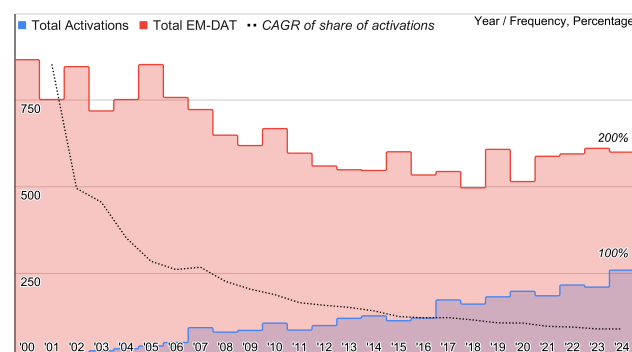


Figure 12 – Number of data requests and reported disasters (left axis) and compound annual growth rates of the share of data requests (right axis)

We further disaggregate the data by region to understand the relationship between data requests and disasters at a more granular regional level. As shown in Fig. 14, for the duration of 2000 to 2024, the regions with the highest to lowest coverage rate by simple averages are Oceania (42.65 per cent), Europe (33.83), Asia (21.32), Americas (14.02), and Africa (13.32). Most notably, the coverage rates for Oceania have been increasing since 2006 and for Europe 2011. In addition, the CAGRs of coverage rates of data requests to disasters by region were respectively Europe (19.02 per cent), Asia (18.30), Africa (14.06), Oceania (13.90), and Americas (10.32). Therefore, each region has been experiencing differing levels of coverage rates with Oceania maintaining the highest average coverage rate but with Europe and Asia recently closely trailing.

4.6 Activations by hazard type

We study the data by hazard type. The delineation of hazard types is provided by the UNDRR's Hazard Information Profiles (2025) [41] which categorizes disasters into up to three degree levels of hazards (type, cluster, and specific). We observe the activations by the first degree level and it categorizes disasters into 7 types: 1) biological, 2) environmental, 3) extraterrestrial, 4) geological, 5) meteorological and hydrological, 6) societal, and 7) technological.

From studying the number of data requests by hazard type and reported disasters by hazard type, we note several points arising from the observations that the number of data requests are increasing for all hazard types but in varying degrees. From Fig. 13, we observe that the hazard types most frequently requested for data were (in descending order) meteorological and hydrological

(63.49 per cent of total), geological (17.58), environmental (12.70), technological (3.05), societal (2.87), biological (0.32), and extraterrestrial (0.00). Most notably, the hazard types meteorological and hydrological, geological, and environmental recorded CAGRs of respectively 17.11 per cent (2001-2024), 15.54 per cent (2000-2024), and 10.07 per cent (2003-2024) per year. The data requests with hazard types biological, extraterrestrial, societal, and technological were sporadic and infrequent.

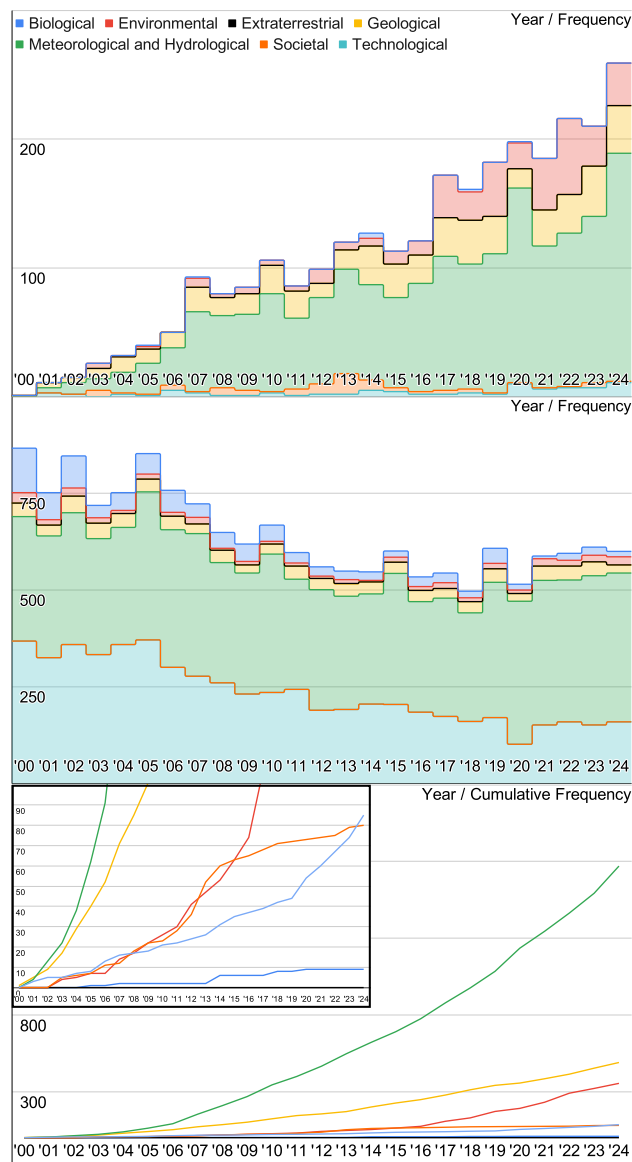


Figure 13 – Top: Number of data requests by hazard type (UNDRR); Center: Number of reported disasters by hazard type; Bottom: Cumulative number of data requests by hazard type

From Fig. 13, we observe that the hazard type most frequently reported as disasters was also meteorological and hydrological by recording 51.32 per cent of the total disasters for the duration of 2000 to 2024. However, among the hazard types, the frequency of technological disasters reported decreased gradually and significantly over the years, from 42.45 per cent of the total number of reported disasters in 2000 to 26.5 per cent in 2024.

At the same time, the frequency of meteorological and hydrological hazard type increased from 37.14 per cent in 2000 to 64.17 per cent in 2024. Therefore, not only is the hazard type of meteorological and hydrological the most frequently requested data but also the most frequently reported as disasters.

We further disaggregate the data by region in Fig. 14^{7, 8} and show the proportion or ratio (coverage rate) of data requests over reported disasters in each region by hazard type. Overall, the ratios are increasing over time for all hazard types but with nuances.

The changes in how frequent data is requested for different hazard types is more visually pronounced when further considering the cumulative frequency of data requests by hazard type in Fig. 13. Most notably are the higher ratios for environmental hazard types recorded in Europe starting 2013. Until 2013, the ratios for the environmental hazard type in Europe was averaging 26.25 per cent. By 2016, the cumulative frequency of data requests for environmental hazard types surpassed societal and the average of the ratios increased to 358.94 per cent during 2013 to 2024. In addition, data requests for technological hazard types increased sharply starting in 2020 whereby the cumulative frequency of data requests for technological hazard types surpassed societal in 2024. These changes could suggest a shift towards more applications of geospatial data for environmental and technological disasters among regions.

In addition, with the exception of Europe, all regions recorded the geological hazard type as the highest average ratio. The average of the ratios for the geological hazard type in regions Africa, Americas, Asia, and Oceania were respectively 75.98, 58.75, 68.73, and 46.83 per cent for 25 years. This could suggest that the geological hazard type is the most frequently requested data relative to the frequency of how often it is reported as compared to other hazard types.

The findings above are also consistent when observing the number of data requests by income level and hazard type in Fig. 15. For the duration of 25 years, the high income-level countries most frequently requested data for the meteorological and hydrological and environmental hazard types of respectively 54.92 and 32.90 per cent of all data requests from high income-level countries. The upper and lower-middle income-level countries requested data for the meteorological and hydrological and geological hazard types significantly more often than

⁷ There are outlier cases or time frames in which ratios are significantly higher. Namely for Europe after 2019 which recorded ratios for the environmental hazard type in 2019 (2800 per cent), 2022 (1350 per cent), and 2024 (1050 per cent).

⁸ The hazard types extraterrestrial and societal are omitted from the heatmap as there are no data requests in response to extraterrestrial disasters/hazards and there are no EM-DAT records of societal (There are approx. 80 data request for societal).

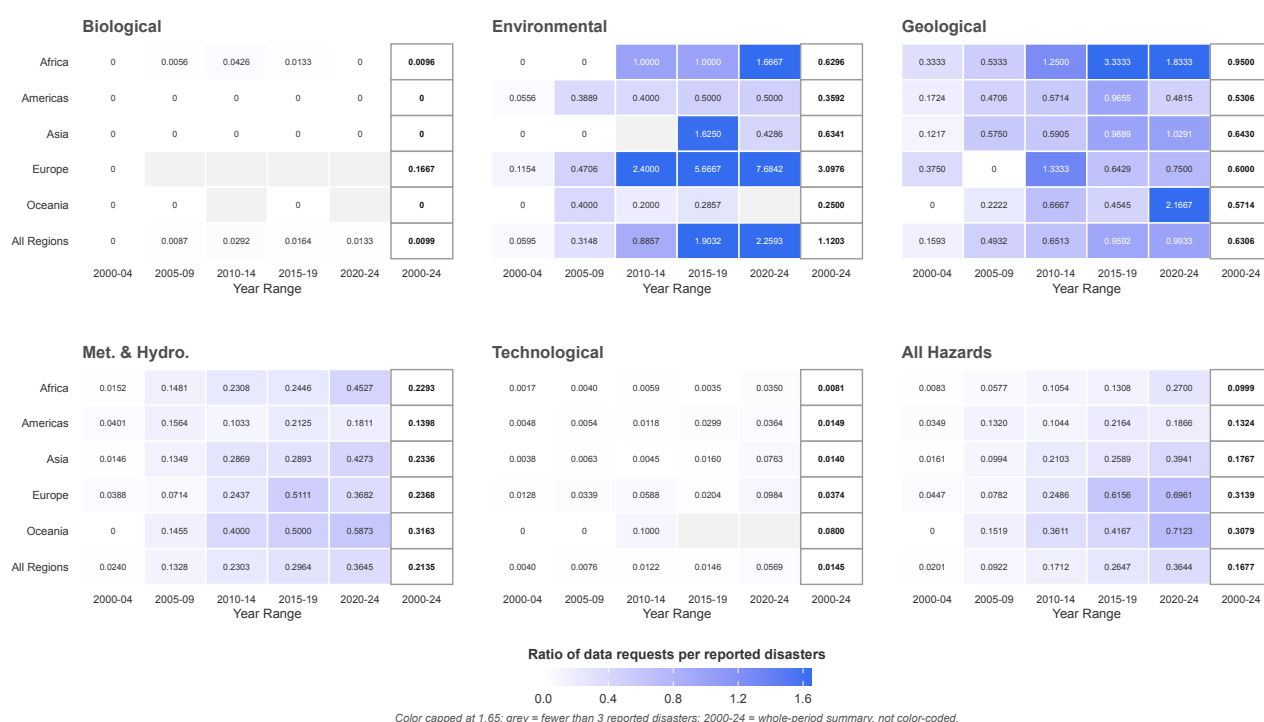


Figure 14 – Ratio of data requests over reported disasters within each region by hazard type



Figure 15 – Number of data requests within income levels by hazard type

other hazard types. upper-middle income countries requested data for meteorological and hydrological and geological hazard types of 53.72 and 31.38 per cent respectively and for lower-middle income countries was 72.68 and 17.49 per cent respectively. Lastly, the low income-level countries most frequently requested data for the meteorological and hydrological and geological hazard types of 72.78 and 12.34 per cent respectively. Data requests for meteorological and hydrological hazard type transcended all income levels in terms of frequency.

5. INTERPRETATION/DISCUSSION

In this section of the paper, we will interpret the identified trends and changes from the compiled data and present explanations and points of discussions for future development of geospatial data sharing activities.

5.1 Operational framework

From observing changes to data requests to mechanisms over time, we can observe that the initial and foundational operational framework of geospatial data sharing instantiated with the Disasters Charter in 1999 has been proliferated to the initiations of additional mechanisms in 2001 (UNOSAT), 2006 (Sentinel Asia), and 2012 (Copernicus). This can be characterized by following similar and generalizable operational data sharing procedures and processes amongst the mechanisms. The proliferation of the operational framework signifies the strong demand and utility of satellite data but also the importance of crafting an effective process and procedure to match and supply the demand. It should be noted that the current status of operational geospatial data-sharing framework for emergency response remains largely at the post-disaster stage of the disaster management cycle and for acute disasters.

5.2 Regional perspectives

The proliferation was complemented by several positive and negative points of observation for geospatial data-sharing activity in regards to regions and mechanisms. As shown in Section 4.1, initiations of mechanisms not only increased the number of countries as active participants

to geospatial data-sharing but they also increased the number of activities by data requests or activations.

However, it should be further noted that the data requests were heavily focused on specific regions and mechanisms remained regionally focused despite years of operations. As shown in sections 4.2 and 4.3, data requests from Africa and Americas remained proportionately low despite their evident large landmasses and mechanisms remain engaged in specific regions even over long periods of operations, seemingly Sentinel Asia with Asia and Copernicus with Europe. This could signify the potential siloing of geospatial data-sharing activities segregated into regions.

5.3 Maturity of geospatial data sharing

The comparison of quantified activities also suggest that the demand, supply, or awareness for geospatial data is increasing. For instance, there is a large gap between the number of data requests and the number of reported disasters with the number of data requests being significantly lower than the number of reported disasters. However, there is a general increasing trend for both to fill the gap. For instance, in 2000 there was a total of one data request and 250 reported disasters but by 2024 there were 259 data requests and 400 reported disasters, as noted in Section 4.5 and shown in Fig. 12. The CAGR of the number of data requests during the last 25 years was 26.05 per cent per year and the CAGR of the number of reported disasters during the last 25 years was 3.28 per cent per year.

The proliferation of activity was also accented with sharp and accelerated paces and convergences in regards to time periods and income levels. As shown in sections 4.1 and 4.4, we can distinctly identify certain time periods of acceleration in earlier and most recent years. But also in regards to income levels of countries, the focused growth was in countries with lower-middle income levels. This could signify with empirical evidence that not only is geospatial data-sharing activity maturing with coinciding actions such as incentivization, deregulation and regulation (in response to absence of regulation), and research but there could exist a market demand base characteristic in which higher income and lowest income levels are not a target market and rather middle income-level countries are.

5.4 Growth potential in segments

The quantitative analysis of the data requests suggest that there is still a large growth potential for geospatial data-sharing activities. This is again primarily evidenced by the gap between the number of data requests and

the number of reported disasters but also that a majority (more than 50 per cent) of countries or areas that have individually requested data was less than seven times over the last 25 years and there have been 186 countries or areas that have requested data over the last 25 years when 90 were requested in 2024. It should be noted that up until now the data requests have been heavily focused on specific levels of economic development, regions, mechanisms, and hazard types. For example, there is a marked increase in data requests of meteorological and hydrological hazard type from countries of all income profiles. But this increase is lower than expected when considered commensurate with the number of reported disasters with that hazard type. Whilst, the hazard types environmental and geological recorded significantly higher ratios of data requests relative to the number of reported disasters with geological recording higher ratios consistently over time. The Oceania region has historically recorded higher ratios of data requests to reported disasters than other regions despite its smaller total number of data requests and reported disasters. With the exception of the Copernicus mechanism, all three other mechanisms are reporting recent increases in data requests from the meteorological and hydrological hazard type. When accounting for these historical and quantitative realities, there is a need to strategically and sensitively approach observed dynamics and trends to identify specific target areas and engagements in order to further develop geospatial data-sharing activities and fill the gap.

5.5 Limitations

We should note that there are limitations to this study for the nature of geospatial data sharing. There exist additional intergovernmental and/or multilateral mechanisms as those with similar humanitarian disaster and/or emergency relief characteristics [44, 45] as those mentioned above that have limited public disclosures and therefore are not only difficult to track but not publicly referenceable and viewable. Therefore, data and information on this additional geospatial data-sharing is not referenced and the list of mechanisms may not be exhaustive in this study. However, for purposes of analysis, the numbers of such non-publicly referenceable geospatial data sharing, relative to the mechanisms mentioned above in aggregate, is also limited in scale such as frequency and numbers such that it does not materially impact the overall result and conclusion of this study.

In addition, in order to execute this study, we had to aggregate and disaggregate data from multiple sources with varying degrees of granularity and standardization. For instance, the data on data requests from the mechanisms were aggregated from multiple sources such as annual reports and online platforms. The consolidated

list of disasters was also further disaggregated by region, economic development, and hazard type for analysis. Therefore, there could be limitations to the accuracy and consistency of the data gathered and curated for this study. However, considering the lengthened time scale and the large number of data points of the gathered data, we can assume that the overall trends and patterns identified in this study are still valid and present an accurate account of the referenced intergovernmental geospatial data-sharing mechanisms and activities.

5.6 Conclusion

The purpose of this paper was to serve as a presentation of preliminary compilation and studying the changing dynamics within geospatial data-sharing activities. The compilation quantified activities at the global level and analysis identified unique changes within denominated themes such as time, region, economic development, and hazard types. It contributes to the existing literature by providing an extended empirical and behavioral account of geospatial data-sharing activities for emergency response based on publicly verifiable sources.

The identified unique observations are that: 1) geospatial data-sharing activities for emergency response have been increasing and accelerating recently during the study period; 2) activities were focused to specific countries or areas and regions with the majority of countries or areas requesting less than seven times; 3) each mechanisms' outreach and network is focused to specific regions with the Disasters Charter and UNOSAT mechanisms being engaged with all regions; 4) annual CAGRs of the share of data request from the lower-middle income-level countries or areas have remained positive in most years except for the years 2002 and 2022; 5) the geological hazard type is the most frequently requested data relative to how often it is reported; and 6) Europe has since 2012 recorded higher ratios of data requests to reported disasters for the environmental hazard type.

It should be noted that deeper empirical investigation beyond studying geospatial data-sharing activities alone would yield additional insights into the development of the geospatial sector beyond its current form.

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