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Leveraging spatial data infrastructure for disaster risk reduction

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Abstract

The systematic review approach revealed that location-based decision making allows for structured approach to prioritization of disaster response and recovery by disaster management practitioners. The Yokohama Strategy called for the use of information across national, regional and international scales for Disaster Risk Reduction (DRR), while Priority Action 1f of the Sendai Framework called for the use of "real time access to reliable data, make use of space and in situ information, including geographic information systems (GIS), and use information and communications technology innovations to enhance measurement tools and the collection, analysis and dissemination of data." The bibliometric review of the role of SDI in the management of natural disasters revealed that interest is shifting from mark-up languages and sensors to web services and data integration. The efficiency of operational SDI driven DRR is a function of the availability of relevant and up-to-date information. Though there are technological limitations in developing countries in Africa, there is an urgent need to increase uptake and implementation of SDIs drawing lessons from the SDI-East Africa and the global community.

Keywords: Spatial Data Infrastructure; Disaster Management; GIS, Early Warning Systems; Hydrometeorology

1. Introduction

Spatial Data Infrastructure (SDI) provides a platform where a large variety of users can produce, access, retrieve, and share spatial data and related information in a collaborative and convenient way (Nyangau, 2004). This infrastructure is primarily based on the products of Geographical Information Systems (GIS), as well as earth observation sciences such as Photogrammetry and Remote Sensing (RS), which provides large volumes of geographic data and services. According to Bwambale et.al (2022), GIS is an emerging technology that provides for the collection, processing, storage, analysis and visualization of location-based information, for the purpose of decision-support. It relies on elements such as hardware, software, communication networks, set methods and practitioners in the modelling of spatial entities (Strain et al., 2006; Zlatanova et al., 2014).

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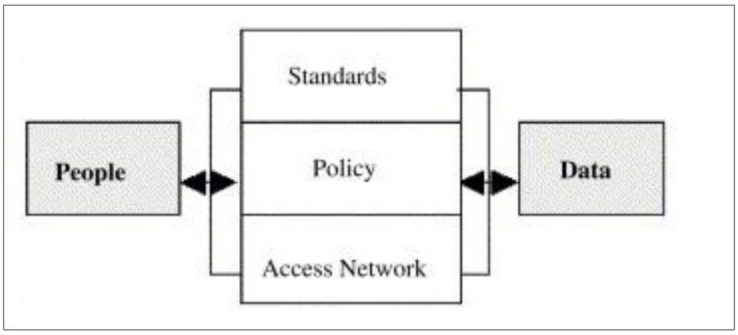

Figure 1 Spatial Data infrastructure Components, (Strain et al., 2006: 4)

Disasters are often a function of two principal parameters namely exposure to a hazard and vulnerability of the community, which both have spatial and temporal components. Exposure and vulnerability to a hazard are often referred to as determinants of risk because they have a direct influence over the risk that a community is placed under (Amber Sayed, 2014; Cardona et al., 2012). Despite being a term commonly used in literature around disaster management, the term exposure has had differential definitions based on the unit of measurement. Exposure has been defined geographically (Gruebner et al., 2015), property and damage (Sasaki et al., 2019), and lastly post-disaster hardship (Bakic & Ajdukovic, 2021). Society, in its interaction with the changing physical world, shapes disaster risk by transforming physical events into hazards of different intensities or magnitudes through social processes. These processes increase the exposure and vulnerability of population groups, their livelihoods, production, support infrastructure, and services at a spatial scale (Yordanov et al., 2020).

As outlined in the guiding principles of the Sendai Framework for Disaster Risk Reduction (2015-2030), DRR is the responsibility of central governments acting alongside key national authorities and associated stakeholders. Spatial data plays a pivotal role at the different stages of DRR through activities such as hazard modelling and risk mapping, location based early warning systems and response and recovery. As a result of large amounts of spatial data being collected by multiple organizations, it is inevitable that duplication of data, also known as data redundancy, will come into effect, as the same datasets are stored by each organization's data warehouse. This not only results in inconsistencies in data but also affects the effectiveness of which disaster risk reduction operations are carried out. Storage space is consumed, increasing the size and complexity of databases and also affecting the critical and timeous nature of disaster response.

Spatial Data Infrastructure (SDI) acts as an integrating technology that combines data collected from different disaster practitioners into one single data warehouse. It facilitates and coordinates the interchange of spatial data between a diverse set to government and non-governmental organizations (Chen et al., 2011; Tumba & Ahmad, 2014). The cost/benefit of this is seen through the collect once, use many times (COUMT) concept postulated by Joukes et.al (2016), whereby spatial data that can be collected by once by a disaster practitioner but can be used many times thereafter by other players in disaster risk reduction.

In order for any SDI to be effective there is a vital interplay that needs to occur between the various components. People are responsible for transaction processing through accessing, analyzing and visualizing spatial data stored within a database. Through this transaction processing decisions can then be made with regards to disaster preparedness, response and mitigation. However, all transactions require spatial data relating to the hazard, exposure and vulnerability, all of which require data as a critical component. The relationship between people and data use, data access, data accuracy and data security is governed by a set of rules, policies and standards. SDI can be dichotomized into two approaches, the first being a user-data approach where the form and function of the SDI is centered on the interaction of users and the data held within. The second data-centric approach is hinged on standards, policies and network. The aim of this paper is to investigate how SDI has been adopted in the management of disasters across the different spatio-temporal scales, and to highlight the implications, constraints and components associated with its utilization. As the system around SDI matures there is need to have an understanding of how elements of SDI relate to the stages of the DM cycle. Literature on SDI and DM will be analyzed and discussed in order to proffer approaches for its implementation.

1.1 Spatial Data in the Sendai Framework

The Sendai Framework for Disaster Risk Reduction 2015-2030 was adopted at the United Nations Third World Conference on Disaster Risk Reduction in Sendai, Japan in 2015. Among the priorities of actions identified was the need to ensure that information regarding disaster risk reduction needed to be multi-sectoral, inclusive and accessible to foster better decision-making at the various levels of society (Niekerk et al., 2020). To this end, the Sendai Framework places emphasis on collaboration across sectors at local, national, regional and international levels under its priorities for action. In order to achieve this goal, it is pivotal that spatial information be collected in accordance with the needs of different categories of users. The hierarchy concept of SDIs (Figure 2) places local and national spatial data warehouses at the bottom 4 tiers that have the widest bases. This is because there is a plethora of spatial information that can be collected at the lower tiers. These serve as building blocks supporting the provision of high-resolution spatial data to decision makers at higher levels in the hierarchy.

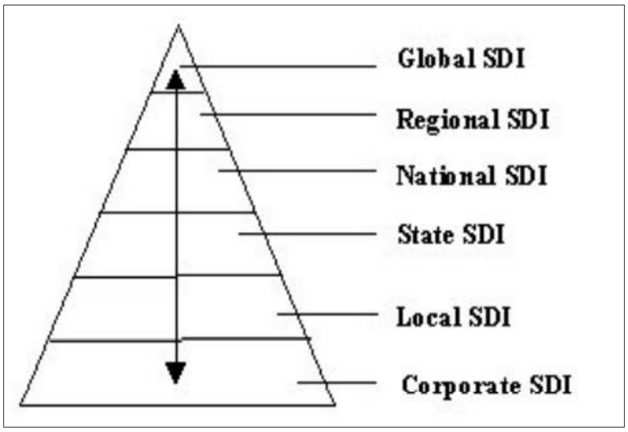

Figure 2 hierarchy concept of SDIs, (Rajabifard & Williamson, 2001: 6)

Priority Action 1f of the Sendai Framework calls for the use of "real time access to reliable data, making use of space and in situ information, including Geographic Information Systems (GIS), and use information and communications technology innovations to enhance measurement tools and the collection, analysis and dissemination of data." At the global level, there is need for international cooperation especially through the transfer, access and sharing of spatial data for the purposes of communication and other disaster related services(United Nations, 2015).

1.2 SDI in Disaster Management: The Global North

Agencies such as the United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER), the Infrastructure for Spatial Information in the European Community (INSPIRE) and the Global Monitoring for Environment and Security (GMES) have provided an international and operational network for the collaborative use of remote sensed data to support each stage of the disaster management cycle at the international scale (Lollino et al., 2015). Global efforts have been coordinated by the United Nations Geographic Information Working Group (UNGIWG) and the United Nations SDI initiative, facilitating inter-agency collaboration in the fields of GIS and cartography. Policies and standards from the UNGIWG formed in 2000 have often cascaded down to member states pursuing NSDI programs as many relief organizations conform of the postulates of the global body.

A key facet of successful SDI initiatives has been the reliance on Service-Oriented Architecture (SOA), which puts greater emphasis on data, policies and standards. Service-Oriented Architecture allows for multiple applications running on different technologies to communicate with each other, creating an interoperable environment for multi-agency access (Naseer et al., 2015). The adoption of standards set by the Open Geospatial Consortium (OGC), INSPIRE, and GEMS has facilitated the exchange of geographic information and services between disaster practitioners at national, regional and international levels (Makanga & Smit, 2010).

1.3 SDI in Disaster Management: The Global South

The Zambezi Basin is largely the principal location of the flood incidents affecting SADC countries such as Zambia, Malawi, Zimbabwe and Mozambique. According to Zambezi Water Commission ZAMCO (2019) floods on the Zambezi River are recurring disasters posing an increasingly severe challenge to agricultural livelihoods due to increased frequency and intensity; the overall effect being on household adaptive capacities and preparedness levels. According to CRED & UNISDR (2015), the overwhelming majority of natural disasters are derived from hydro-meteorological phenomena such as floods, copious storms and tropical cyclone events. These phenomena affect a wide range of communities causing the largest amount of economic damage among all the different typologies of hydro-meteorological phenomena. Other use cases for GIS in DRR include the Jangwani floodplain assessment in Tanzania (Al-Hanbali et al., 2022; Kwayu, 2019),Okavango Delta modelling in Botswana (Matlhodi et al., 2019; Wolski & Murray-Hudson, 2006) and flood risk assessments in different parts of Zimbabwe (Manyangadze et al., 2022; Mudavanhu, 2015; Nharo, 2016; Sibanda & Matsa, 2020).

Other efforts to map flood risks were carried out in the Muzarabani and Tsholotsho Districts, Zimbabwe. In Zimbabwe, floodplain management and risk analysis was still at its infancy because the country was considered as a 'flood safe' zone until the cyclone Eline induced floods of 2000-2001(Sibanda & Matsa, 2020). This line of thought was evidenced by the presence of numerous structural flood mitigation measures in the country such as weirs and dams which had very little spatial considerations. There after flood risk assessment have been carried out by a number of national and international originations such as UNOCHA, IOM, WFP and Oxfam. In some cases flood risk mapping was carried in order to better understand the risk, exposure and vulnerability communities faced with regards to flood hazards in response to the Sendai Framework for Disaster Risk Reduction 2015-2030. Social vulnerability was mapped across 29 wards within the Muzarabani District Zimbabwe resulting in the creation of risk maps highlighting cold and hotspots for flood damage (Mavhura et al., 2017).

Geospatial techniques have been identified as the panacea to future potential devastations caused by flood induced hazards in the SADC region (Di Baldassarre et al., 2010).

2. Materials and Methods

In finding the relevant literature, the following results were obtained from a Scopus search: 11,297 document results from the Boolean search criteria TITLE-ABS-KEY (spatial AND data AND infrastructure) AND PUBYEAR > 1993 AND PUBYEAR > 1993. This was then filtered based using only the keywords: "spatial data infrastructure", resulting in the list being narrowed down to only 373 document results. The electronic search results and citation data was extracted as a delimited text file in comma separated values (.csv) format, whose contents were cleaned and parsed using Microsoft Excel 2016's XLSTAT plugin.

These electronic search results were then used as input for the Mann-Kendall non-parametric test to determine if a trend could be identified in the number of journal articles being published around the concept of SDI.

The rationale behind this was the fact that this non-parametric trend test would reveal the existence or absence of any inherent trends, as well as the direction of the trend, without altering or re-computing the original the dataset. The underlying assumption that was derived from the Technology Acceptance Model was that with an increase in uptake, there would be a similar increase in research around the topic. Bibliometric analysis and spatiotemporal analysis of the publications around the theme of Spatial Data Infrastructure would also be facilitated through the systematic review of electronic search results and literature.

Queries were processed on the EM-DAT platform to derive information on the number of disasters that have occurred between 1994 and 2023 across the world. This information was then used to compare the number of journal articles published and the frequency of occurrence of disaster in the countries of interest. The Pearson Correlation Coefficient (r) results would yield information on the existence of a linear correlation, its magnitude (-1 to +1) and direction (negative or positive).

3. Results and Discussion

3.1 Bibliometric Analysis of Publications on Spatial Data Infrastructure

The bibliometric analysis whose fundamental purpose is to identify relationships between authors, fields, keywords and themes was carried out through the use of the java based VOS viewer software version 1.6.18 released by Nees Jan van Eck and Ludo Waltman (2022). Visualization of Similarities (VOS) review software functions for tasks that involve generating, visualizing and exploring bibliometric interactions between different journal articles around a specified topic. As seen on the word cloud in Figure 3, there were a number of linkages between keywords found around the theme of Spatial Data Infrastructure. This visualization is also a gravity model or distance-based map of linkages with the keywords with the higher frequency of occurrence being found nearest the core theme 'spatial data infrastructure' and the least linkages being found at the periphery.

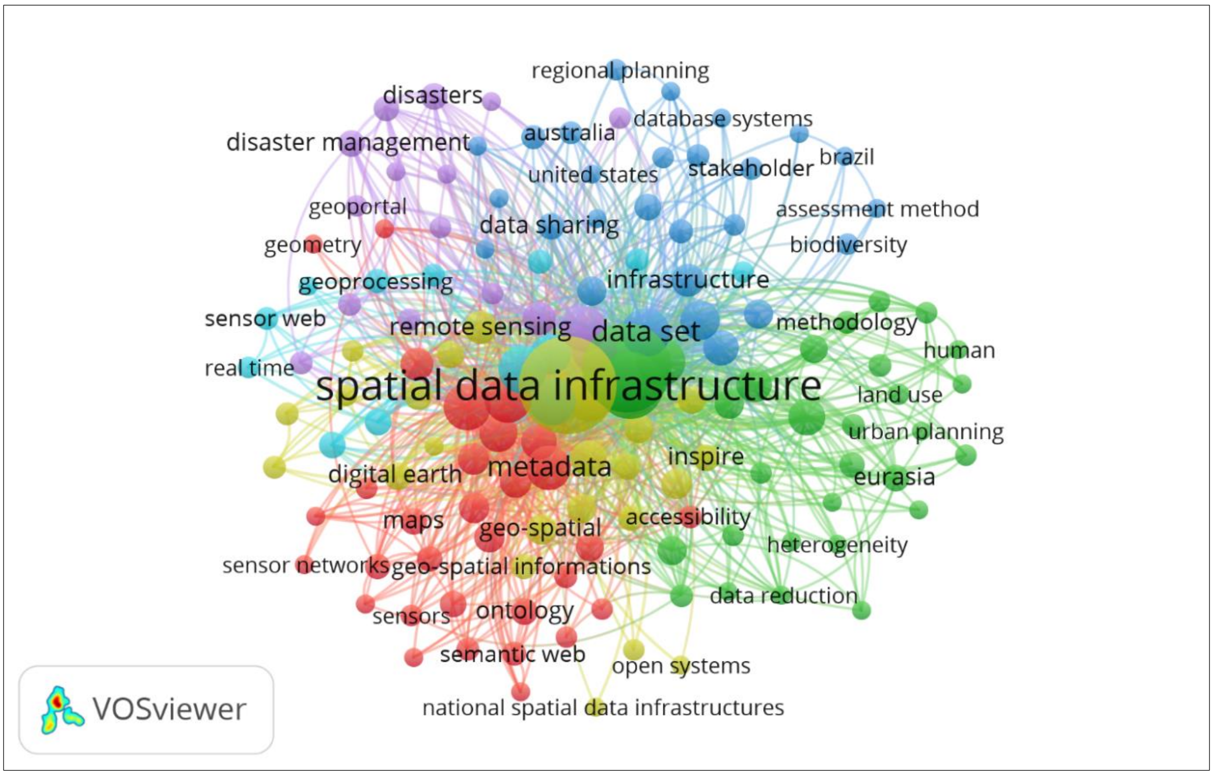

Figure 3 Bibliometric Analysis of Literature around Spatial Data Infrastructure

3.2 Temporal Analysis of Publications on Spatial Data Infrastructure

Along with the passage of time, so too was the transformation of keywords that were used around the theme of spatial data infrastructure. It is evident that over time the discussion around SDI has shifted from data related protocols such as **xml**, **sensors** and **data integration** in the early 2000s to more recently applied discussions around SDI in **regional planning**, **web services**, **stakeholders** and **sensor web**.

From the literature extracted from the Scopus database it was observed that between the year 1994 and 2023, there were 373 publications that investigated Spatial Data Infrastructure worldwide. A non-parametric test in the form of a Mann-Kendall test (table 1) was performed to determine whether there existed any spatiotemporal trends in the number of articles produced around the area of Spatial Data Infrastructure. The underlying hypothesis being that as time progressed, so too would be the global interest around the subject of Spatial Data Infrastructure thus a positive trend in the number of publications. The Mann-Kendall results were as follows:

Table 1 Mann-Kendall trend test / Two-tailed test (Year)

Kendall's tau	**-0.471**
S	-171.000
Var(S)	2508.333
p-value (Two-tailed)	0.001
Alpha	0.05
The p-value was computed using an exact method.	

Since the computed p-value of 0.001 was lower than the significance level alpha=0.05, it was concluded that a temporal trend existed in the production of journal articles related to SDI.

Sen's slope: -0.75 Confidence interval: [-0.888,-0.667]

The Sen's slope value of -0.75 further supported the Mann-Kendall result that indeed a trend existed, and that the trend was in the negative direction.

3.3 Spatial Analysis of Publications on Spatial Data Infrastructure

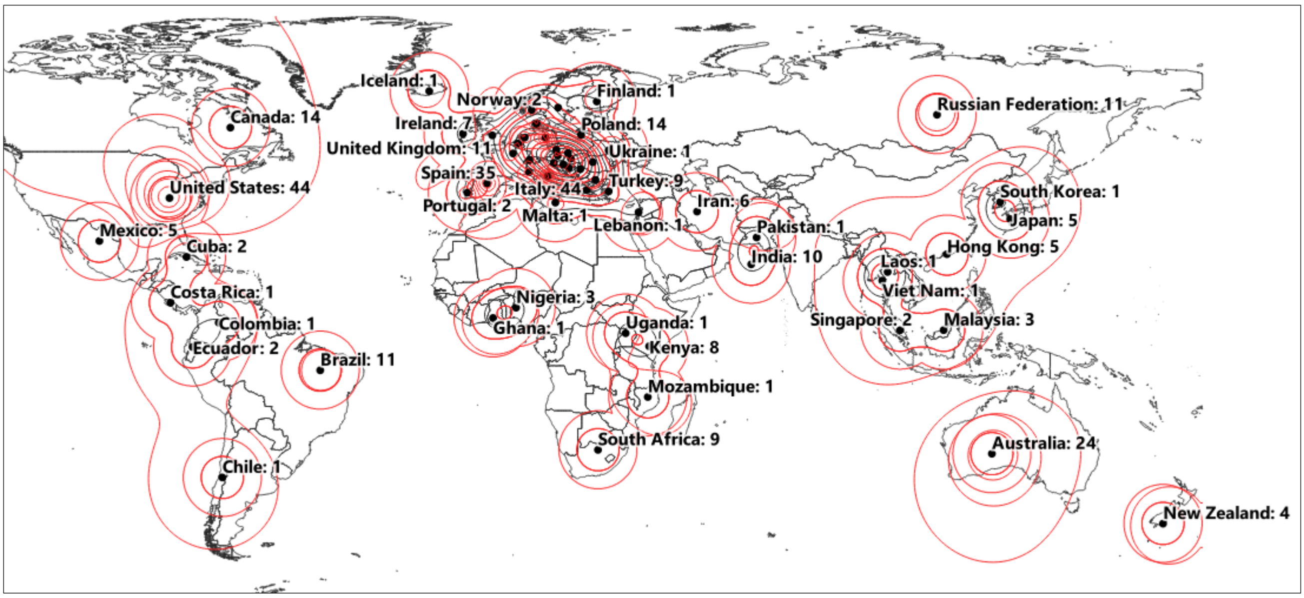

Figure 4 Spatial Distribution of articles on Spatial Data Infrastructure from 1994 to 2023

These articles were heterogeneously distributed, with the greater number of publications being shared between the Americas and Europe. Countries belonging to the LEDC cohort such as Uganda, Ghana, Mozambique, and Costa Rica form the bottom of the list all with less than 10 publications around the topic of Spatial Data Infrastructure.

3.4 Spatial Approach to Disaster Risk Management: From North to South

According to EM-DAT, China has experienced over 730 disasters since 1994. In response to the Wenchuan earthquake in China in 2008, geospatial information was solicited from China's National SDI which provided essentials in data acquisition, cartographic support and ad-hoc spatial decision support through the different stages of the disaster situation (Chen et al., 2011). This allowed for a deeper understanding of risk, through spatio-temporal visuals on the area affected by both primary and secondary disasters. The number of publications around SDI and DRR averages around 29 publications between 1994 and 2023 in the north compared to the global south as illustrated in figure 4. Despite the negligible correlation ($r^2 = 0.02$) between disaster occurrence and publication there is an upward trend line supporting the notion that the frequency of disasters motivates research around spatial data. Data as an economic resource is a view primarily held in the global north due to the demand for geographically related goods and information products. In addition, due to the high number of disasters occurring (n=2136 from 1994-2023) there has been an increased need to understand the nature of hazard risk.

Africa is home to a number of emerging countries that have experienced a high number of disasters such as Mozambique (96), South Africa (96), Nigeria (120) and Kenya (108) where concepts around geospatial information systems and spatial data infrastructure are relatively new, hence the relatively low number or articles around SDI. In most countries, GIS and information management was introduced through interventionist investments where international organizations such as UNECA, UNDP, WFP and World Vision would bring new technologies to make their work easier at the local and national level.

Despite having a large number of international relief and development agencies operating in the global south, the adoption and implementation of SDI has had limited success. This can be attributed to the lack of a 'lead agency' to provide coordinating mechanisms for all other partners. Every agency has its own internal strategic and operational decision-making processes, leading to varied levels of cohesion. Countries such as Mozambique and Kenya have high disaster incidences and low accumulation of knowledge owing to factors such as relatively low internet usage/penetration rates. The divided attention in national priorities is seen where a downward trend (r^2=0.04) exists between the publication of academic literature and the occurrence of disasters. Countries in the global south are often subject to conflict and civil unrest, and this plays a part in the delayed implementation of SDI. Factors such as national priorities and programs have direct influence over capital flows, human resource development, governance and infrastructure. Data availability, accessibility, quality, documentation and dissemination remain critical issues that are still in the hands of central governments across the global south.

In countries such as South Africa, Somalia, Nigeria and Egypt SDI initiatives exist but under the guise of information management systems such as the FAO-Somalia Water and Land Information Management and SADC Regional Remote Sensing Unit (Von Hagen, 2007). However, these entities are top-down and are not backed by legislation and thus cannot be adopted as National SDIs by the respective governments possibly because SDI approaches are driven by interventionists rather than political ambitions. While there is still room for improvement, SDI-East Africa has demonstrated the feasibility of implementing SDI using the bottom-up approach(Makanga & Smit, 2010).

3.5 Future Prospects

Through the crafting of the Zimbabwe National Geospatial and Space Agency (ZINGSA) in 2018 and the launch of ZimSat-1 in 2022, the country has joined over 11 African countries that include Algeria, South Africa, Nigeria, Ethiopia and Egypt who have, since 1998, purposefully developed and deployed satellites as part of a national agenda. This has been supported at regional and continental levels with the SADC Regional Platform for Disaster Risk Reduction of 2011, and the African Union Space Policy of 2016. The adoption of policies regarding SDI should not neglect to explicitly identify the lead agency that will be responsible for coordinating the multiple stakeholders that are often involved in DRR activities. Relative success in the implementation of SDI has been experienced in situations where stakeholders find commonality in their information needs in disaster response. It is far easier for stakeholders to work in unison at a technological level rather than attempting to change institutional interests and biases. Shortcomings are often exposed during the hyper-critical disaster response phase, in which is a time-sensitive operation requiring informed decision making (Hashmi et al., 2021).

4. Conclusion

As figures for extreme events and vulnerable populations increase, more work is required to improve our approach to disaster risk reduction. Spatial data resources have been seen to play a key role in decision-making during the response phase of a disaster situation. Despite the limitations in developing countries within Africa, there is an urgent need to increase uptake and implementation of SDIs drawing lessons from the SDI-East Africa and the global community. This can be through the use of Free and Open Source Software for GIS (FOSS4G) and Open Geospatial Data, leveraging on the work currently being done by organizations currently involved in data creation and coordination at the corporate level.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors report there are no competing interests to declare.

References

[1] Al-Hanbali, A., Shibuta, K., Alsaaideh, B., & Tawara, Y. (2022). Analysis of the land suitability for paddy fields in Tanzania using a GIS-based analytical hierarchy process. *Geo-Spatial Information Science*, *25*(2), 212–228. https://doi.org/10.1080/10095020.2021.2004079

[2] Amber Sayed, S. (2014). Flood Disaster Profile of Pakistan: A Review. *Science Journal of Public Health*, *2*(3), 144. https://doi.org/10.11648/j.sjph.20140203.11

[3] Bakic, H., & Ajdukovic, D. (2021). Resilience after natural disasters : the process of harnessing resources in communities differentially exposed to a flood. *European Journal of Psychotraumatology*, *12*(1). https://doi.org/10.1080/20008198.2021.1891733

[4] Cardona, O. D., Van Aalst, M. K., Birkmann, J., Fordham, M., Mc Gregor, G., Rosa, P., Pulwarty, R. S., Schipper, E. L. F., Sinh, B. T., Décamps, H., Keim, M., Davis, I., Ebi, K. L., Lavell, A., Mechler, R., Murray, V., Pelling, M., Pohl, J., Smith, A. O., & Thomalla, F. (2012). Determinants of risk: Exposure and vulnerability. *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation: Special Report of the Intergovernmental Panel on Climate Change*, *9781107025*, 65–108. https://doi.org/10.1017/CBO9781139177245.005

[5] Chen, J., Han, G., Chen, L., Zhao, Y., Jin, S., & Wang, F. (2011). Integrated geospatial information service for disaster management in China's Wenchuan earthquake. *Gi4DM 2011 - GeoInformation for Disaster Management*.

[6] CRED, & UNISDR. (2015). The Human Cost of Weather-Related Disasters 1995-2015. 151, 10–17.

[7] Di Baldassarre, G., Schumann, G., Bates, P. D., Freer, J. E., & Beven, K. J. (2010). Cartographie de zone inondable: Un examen critique d'approches déterministe et probabiliste. *Hydrological Sciences Journal*, *55*(3), 364–376. https://doi.org/10.1080/02626661003683389

[8] Gruebner, O., Lowe, S. R., Sampson, L., & Galea, S. (2015). The geography of post-disaster mental health : spatial patterning of psychological vulnerability and resilience factors in New York City after Hurricane Sandy. *International Journal of Health Geographics*, 1–13. https://doi.org/10.1186/s12942-015-0008-6

[9] Hashmi, A., Ahmad, M. A., & Nawaz, M. A. (2021). The Role of Coordination, Decision Making and Special Data Infrastructure on the Disaster Management in Pakistan: Moderating Role of Information System. *Review of Applied Management and Social Sciences*, *4*(1), 79–91. https://doi.org/10.47067/ramss.v4i1.100

[10] Kwayu, D. M. (2019). Examining the Nature of a Floodplain Using GIS Open Data: A Case Study of Jangwani Floodplain Terrain in Dar Es Salaam, Tanzania. *Journal of Geography and Earth Sciences*, *7*(2), 15–25. https://doi.org/10.15640/jges.v7n2a2

[11] Lollino, G., Manconi, A., Guzzetti, F., Culshaw, M., Bobrowsky, P., & Luino, F. (2015). Engineering geology for society and territory – volume 5: Urban geology, sustainable planning and landscape exploitation. *Engineering Geology for Society and Territory - Volume 5: Urban Geology, Sustainable Planning and Landscape Exploitation*, *5*, 1–1400. https://doi.org/10.1007/978-3-319-09048-1

[12] Makanga, P., & Smit, J. (2010). A Review of the Status of Spatial Data Infrastructure Implementation in Africa. *South African Computer Journal*, *45*(October 2008), 357–365. https://doi.org/10.18489/sacj.v45i0.36

[13] Manyangadze, T., Mavhura, E., Mudavanhu, C., & Pedzisai, E. (2022). Flood inundation mapping in data-scarce areas: A case of Mbire District, Zimbabwe. *Geo: Geography and Environment*, *9*(1), 1–15. https://doi.org/10.1002/geo2.105

[14] Matlhodi, B., Kenabatho, P. K., Parida, B. P., & Maphanyane, J. G. (2019). Evaluating land use and land cover change in the Gaborone dam catchment, Botswana, from 1984-2015 using GIS and remote sensing. *Sustainability (Switzerland)*, *11*(19). https://doi.org/10.3390/su11195174

[15] Mavhura, E., Manyena, B., & Collins, A. E. (2017). An approach for measuring social vulnerability in context: The case of flood hazards in Muzarabani district, Zimbabwe. *Geoforum*, *86*(December 2016), 103–117. https://doi.org/10.1016/j.geoforum.2017.09.008

[16] Mudavanhu, C. (2015). The impact of flood disasters on child education in Muzarabani District, Zimbabwe. *Jamba: Journal of Disaster Risk Studies*, *6*(1), 1–8. https://doi.org/10.4102/jamba.v6i1.138

[17] Naseer, A., Aldoobi, H. I., & Alkazemi, B. Y. (2015). A service-oriented architecture for GIS applications. ICSOFT-PT 2015 - 10th International Conference on Software Paradigm Trends, Proceedings; Part of 10th International Joint Conference on Software Technologies, ICSOFT 2015, 151–155. https://doi.org/10.5220/0005556501510155

[18] Nharo, T. (2016). Modeling Floods in the Middle Zambezi Basin Using Remote Sensing and Hydrological Modeling Techniques. July, 85.

[19] Niekerk, D. Van, Coetzee, C., & Nemakonde, L. (2020). Implementing the Sendai Framework in Africa : Progress Against the Targets (2015 – 2018). *International Journal of Disaster Risk Science*, *11*(2), 179–189. https://doi.org/10.1007/s13753-020-00266-x

[20] Nyangau, S. . (2004). Towards a National Spatial Data Infrastructure (Nsdi): Inventory and Evaluation of Existing Geospatial Datasets and Systems in Kenya. April.

[21] Rajabifard, A., & Williamson, I. P. (2001). Spatial data infrastructures: concept, SDI hierarchy and future directions. *Proceedings of GEOMATICS*, 10.

[22] Sasaki, Y., Aida, J., Tsuji, T., Koyama, S., Tsuboya, T., & Saito, T. (2019). Pre-disaster social support is protective for onset of post-disaster depression : Prospective study from the Great East Japan Earthquake & Tsunami. *Scientific Reports*, 1–10. https://doi.org/10.1038/s41598-019-55953-7

[23] Sibanda, N., & Matsa, M. (2020). Flood Disaster Preparedness and Response in Zimbabwe. *International Journal of Disaster Response and Emergency Management*, *3*(2), 35–47. https://doi.org/10.4018/ijdrem.2020070103

[24] Strain, L., Rajabifard, A., & Williamson, I. (2006). Marine administration and spatial data infrastructure. *Marine Policy*, *30*(4), 431–441. https://doi.org/10.1016/j.marpol.2005.03.005

[25] Tumba, A. G., & Ahmad, A. (2014). Geographic Information System and Spatial Data Infrastructure: A Developing Societies' Perception. *Universal Journal of Geoscience*, *2*(3), 85–92. https://doi.org/10.13189/ujg.2014.020301

[26] United Nations. (2015). Sendai Framework for Disaster Risk Reduction 2015-2030. 69th session of the General Assembly. *World Conference on Natural Disaster Reduction*, *08955*(June), 24.

[27] Von Hagen, C. (2007). Towards a spatial data infrastructure for somalia using open source standards. *Journal of Spatial Science*, *52*(1), 157–169. https://doi.org/10.1080/14498596.2007.9635110

[28] Wolski, P., & Murray-Hudson, M. (2006). Flooding dynamics in a large low-gradient alluvial fan, the Okavango Delta, Botswana, from analysis …. *Hydrology and Earth System Sciences*, *10*, 127–137.

[29] Yordanov, V., Brovelli, M. A., Carrion, D., Barazzetti, L., Francisco, L. J. A., Comia, H. R., & Caravela, M. I. (2020). Capacity building for disaster management in Mozambique through teaching public participatory gis and spatial data infrastructure. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences - ISPRS Archives*, *54*(3/W1), 151–158. https://doi.org/10.5194/isprs-archives-XLIV-3-W1-2020-151-2020

[30] ZAMCOM. (2019). *Zambezi Watercourse 2018-2040* (Issue April).

[31] Zlatanova, S., Ghawana, T., Kaur, A., & Neuvel, J. M. M. (2014). Integrated flood disaster management and spatial information: Case studies of netherlands and India. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences - ISPRS Archives*, *XL–8*(1), 147–154. https://doi.org/10.5194/isprsarchives-XL-8-147-2014

Authors short Biography

	**Tatenda Manyuchi** Tatenda has been working as a lecturer and chairperson for the Department of Geoinformatics and Environmental Conservation at Chinhoyi University of Technology, Zimbabwe. Currently Tatenda is pursuing his PhD looking at spatial data infrastructure for disaster risk reduction.
	**Philip Taru:** Philip's academic journey includes notable positions at the University of the Witwatersrand and the University of the Free State in South Africa, where he was active from 2013 to 2016, as well as at Bindura University of Science Education in Zimbabwe. His work has been published in reputable journals, addressing critical issues such as the nutritional compositions of Japanese quail, rural geo-tourism development in South Africa, and the ecological implications of invasive species.
	**Geofrey Mukwada**: Geofrey obtained his PhD at the University of the Witwatersrand in 2006 and worked as a postdoctoral research fellow in the Department of Geography and Postgraduate Research Division at the University of the Western Cape. Geofrey's research primarily revolves around natural resource management, climate change and rural livelihoods.