ACHSM Asia-Pacific Journal of Health Management

RESEARCH ARTICLE

POTENTIAL OF UTILISING WEB-GIS TECHNOLOGY IN LOCAL HEALTH SERVICE PLANNING: A DESCRIPTIVE CASE STUDY FOR MENTAL HEALTH SERVICES PLANNING

Hannah Kenyon[1], Stewart Alford[2], Dr Rachel Sheather-Reid[1], Joshua Hanscombe[1]

1. Central Coast Local Health District, New South Wales Health, Australia
2. Kaplan Business School, Kaplan Australia

*Correspondence: stewart.alford@kbs.edu.au

ABSTRACT

BACKGROUND

The integration of Web-Based Geographical Information Systems (Web-GIS) presents a significant enhancement to current health and social services planning methods, particularly in the overly complex context of mental health service planning.

AIM

To improve accessibility to health service information and enhance situational analysis using Web-GIS.

METHODS

The study involved the collection of publicly accessible data of mental health and mental health related services. The data was collected, collated and analysed using a 6-stage cross-sectional method.

FINDINGS

Web-GIS demonstrates potential to support individual service navigation, health service planning, and overcome access issues that are often highlighted as a barrier to recovery for individuals with a lived experience of mental illness.

CONCLUSION

Web-GIS provides many opportunities for health and social service planning, specifically for health and social services in a complex situational mental health environment. This descriptive case study provides lessons learnt, opportunities for further integration and enhancement as well as the potential for interaction of Web-GIS with generative artificial intelligence.

KEYWORDS

mental health, health services planning, health service navigation

INTRODUCTION

The integration of Web-Based Geographical Information Systems (Web-GIS) presents a potential for significant enhancement to current health and social services planning methods. The service context of Mental Health intersects traditional healthcare settings (hospitals, health services), social service environments (employment support, service navigation), telehealth environment (online crisis support, text illness monitoring), psycho-social supports (recreation, men's/women's/youth specific health supports, religious organisations) as well as more novel recovery services (stepped care, psycho-social peer support, recovery colleges). Planning for new mental health services presents a significant challenge with many traditional planning techniques ideal for one service context but not the complex combination of services that exist within mental health. Within the current fast paced changes in technology there is opportunities to explore new methodologies such as Web-GIS, and the use of these technologies in providing navigational and service planning tools.

BACKGROUND

The Central Coast region of New South Wales is comprised of 180 suburbs and a population of approximately 350,000 residents within the local government area of the Central Coast Council. Prior to 2016, it was divided into two subregions North, Wyong Shire, and South, Gosford City [1-2] . Mental health (MH) issues in this region exceed the state prevalence by 3%, highlighting the critical need for developing additional mental health services [1,3].

Despite existing service directories, health service managers in this region face major challenges, such as, limited access to up to date and accurate information regarding mental health, psychosocial and mental health support services. This is a common issue identified across geographically dispersed health services [4]. Additionally, health service managers have limited information regarding the quantity and spread of mental health services (psychosocial/vocational and alike), at the local/state/national level, resulting in a significant contextual gap for service planning [5].

This approach explores the potential of Web-Based Geographical Information Systems (Web-GIS) in compiling and mapping health service data. It examines how these systems can support service navigation and provide contextual information for health service planning, particularly in implementing a Recovery College Model of Care aimed at enhancing mental health and psychosocial support.

Recovery College Models of Care take an education-based approach to support people on a MH recovery journey and overall wellbeing [6]. These services are co-designed with people with a lived experience of MH issues, or with those who care for a person with a MH issue [6]. To implement a Recovery College model that improves MH, meets the needs of the community and decreases pressure on the local health system, effective service planning is essential. Situational analysis is vital in effective service planning and involves identifying the number and locations of currently operating services, and service gaps within a region [7-10].

Web-GIS is often used to visualise spatial data in the form of interactive maps [7,11,12]. This technology is documented to be an effective tool within healthcare settings in planning the location of health infrastructure and disease surveillance [8, 14-16]. Despite this effectiveness, a gap in scientific knowledge exists when utilising Web-GIS in local-level planning, such as the planning for the type and location of health services [9]. This gap in knowledge extends to public health services managers, with limited information accessible regarding non-government MH supports, focused psychosocial supports, and novel MH support services that may be operating across a region. The existing knowledge gap and limited situational analysis data, reduces health managers and service planners capacity to implement informed decisions. The repercussions of this lack of knowledge, leads health managers to develop MH services that potentially fail to meet current and future health demands or replicate existing service offerings in a geographical region. This highlights the need for further research and emphasises the significance of this study.

PURPOSE

The purpose of this study is to explore the use of Web-GIS technology via the development of an Interactive Service Map (ISM) to improve the accessibility of health service information and enhance situational analysis. This study aims to explore if a Web-GIS technology supporting a service directory map can empower health service managers by providing a decision-making tool for designing and implementing health services.

LITERATURE REVIEW

GIS technologies are widely recognised for their capability to collect, organise, analyse, and visualize large datasets of geographical and health information [10,12,15,18-19]. They have been extensively used in identifying service gaps within health systems, optimizing health infrastructure planning to ensure equitable access to health services [12,18]. These technologies also support the identification of shortfalls, or gaps, within a region's health system including health facility supply and demand gaps, and associated health disparities [10,15]. Identifying shortfalls enables health managers and planners to optimise the planning and resourcing of health infrastructure locations to ensure populations are not geographically marginalised or disadvantaged in accessing essential health services [15,18,19]. Maina et al's study outlines a viable method for the utilisation of GIS technologies in strategic level health service planning [19]. The proposed method comprises data source identification, collection, abstraction, cleaning, and evaluation. However, a significant gap exists in utilising Web-GIS for local service level planning, specifically to inform the types and delivery methods of health services within regions, particularly in mental health contexts.

METHODS

This study involved six key stages adapted from Maina et al. [19]; data source identification, collection, extraction, Web-GIS ISM development, data evaluation, and cleaning. Data was publicly available and obtained from the secondary sources of Google and Microsoft Bing Maps. With data publicly accessible, no ethical clearance was required for this study. However, approval for the use of relevant organisational technologies and the distribution of findings was attained from the Local Health District.

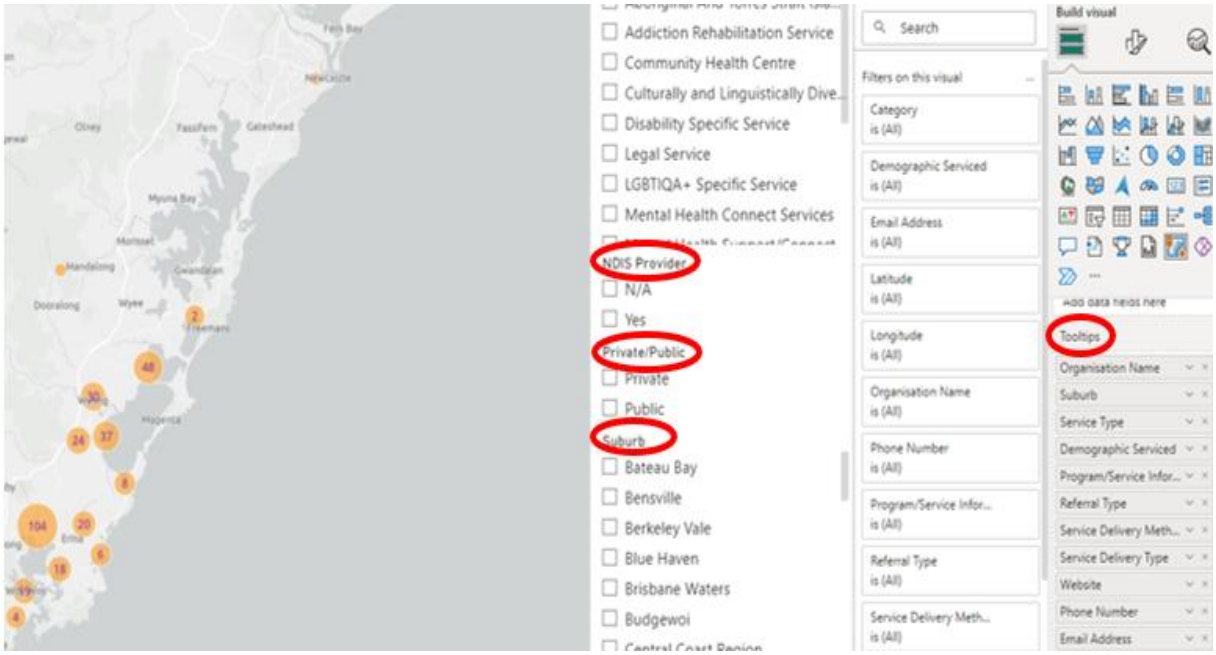
TABLE 1. METHOD FOR DEVELOPING A WEB-GIS ISM

Stages	Description
1 - Data Source Identification	Google and Microsoft Bing search engines utilised to obtain local health service information.
2 - Data Collection	Microsoft Sharepoint Application utilised to collect local health service information into a WEB-GIS database.
3 - Data Extraction	Database information categorised into overall service category, service suburb, demographic able to access service, service type, referral type, NDIS provider status, service delivery method, service delivery type, and if a publicly or privately funded.
4 - Web-GIS ISM Development	ARC-GIS mapping software within the Microsoft PowerBI application was utilised to create an ISM which enables filtering functions for service type, NDIS provider status, suburb, and services that are private or publicly funded.
5 - Data Evaluation	An automated email system was utilised, incorporating a Microsoft Forms application to verify with health service organisations and ensure the accuracy of WEB-GIS ISM data.
6 - Data Cleaning	Completed Microsoft Forms integrated into the WEB-GIS database and ISM to correct data inconsistencies and remove health services no longer operating within the Central Coast.

'Google Maps' and 'Microsoft Bing Maps' search engines were identified as primary data sources for this study. The search strings of 'Mental Health Service Central Coast', 'Psychosocial Service Central Coast', and 'Mental Health Support Service Central Coast' were input into these search engines. Data collection and extraction occurred simultaneously, with the relevant health service information obtained from search engines stored in the Microsoft Sharepoint Application. Data extraction saw stored data organised and classified into the following categories: 'overall service category', 'service suburb', 'demographic able to access service', 'service type', 'referral type', 'NDIS provider status', 'service delivery method', 'service delivery type', and if a service was 'publicly or privately funded'. Abstracted data resulted in the establishment of a Web-GIS database.

This database was connected to ARC-GIS mapping software through the Microsoft Power BI Application to produce an interactive service map (ISM). Functions, such as tooltips and slicers, were embedded into the ISM to integrated data to relevant database abstraction categories and allow end-users to filter service locations based on service type, NDIS provider status, suburb, and services that are privately or publicly funded.

FIGURE 1. TOOLTIPS AND SLICER FUNCTIONS UTILISED WITHIN THE ARC-GIS POWERBI SOFTWARE.



Data evaluation and cleaning improved the accuracy and validity of database information and the ISM. This consisted of three rounds of emails sent to services logged on the database using an automated email verification system. Emails included a Microsoft Forms link that contained abstracted database information specific to each MH, psychosocial, and MH support service. Services either verified or updated the database information via this form. Completion of the Microsoft Form enabled data-cleaning, as services corrected data inconsistencies, and services which were non-longer operating were removed from the database. Services that completed the forms were logged on the database as 'verified'.

RESULTS

The Web-GIS ISM developed in this study successfully visualised situational analysis data, highlighting 433 MH, psychosocial, and MH support service locations across the Central Coast. Of these 433 services, 323 operated in or from a physical location on the Central Coast, while the remaining 110 operated remotely via online or phone service delivery methods. Of the 433 services identified in 2022, 229 services had email addresses with 65% (148) of these services verifying the data collected from the public domain was accurate and valid.

TABLE 2. SERVICE GAPS ACROSS CENTRAL COAST IN 2022

	North District	South District	Total	Service Gap
2021 Population (ABS, 2021)	168,171	178,427	346,598 people 17,047 First Nations people	• Physically located Mental Health Support services • Psychiatry services, additional deficit in the North district • Legal services • Aboriginal Specific services • CALD services • LGBTQIA+ specific services
Mental Health Services	35 (8%)	48 (11%)	83 service locations	
	• 32 psychology & counselling services • 3 psychiatry	• 43 psychology & counselling services • 5 psychiatry		
Psychosocial Services	114 (26%)	105 (24%)	219 service locations	
	• 9 Aboriginal Specific • 14 Addiction Rehabilitation • 4 Legal • 1 CALD specific • 3 LGBTQIA+	• 6 Aboriginal Specific • 11 Addiction Rehabilitation • 1 Legal • 1 CALD specific • 3 LGBTQIA+		
Mental Health Support Services	9 (2%)	12 (2%)	21 service locations	
Operating Remotely	110 services (25%)			
Total	158 (36%)	165 (38%)	**433**	

Publicly funded services were reported to account for more than 81% (351) of services physically located within and operating remotely across the Central Coast. This study also reveals a significant difference in the distribution of privately funded services, with the South, Gosford Shire (47), home to 1.5 times more private services than the North, Wyong shire (29).

This study and the ISM identified significant service gaps, particularly in specific service types and geographic regions within the North and South districts. The ISM reveals psychosocial services account for the largest proportion (69%) of services across the Central Coast. With psychosocial services 3.5 times, and 6 times greater than the number of MH and MH support services on the Central Coast, respectively.

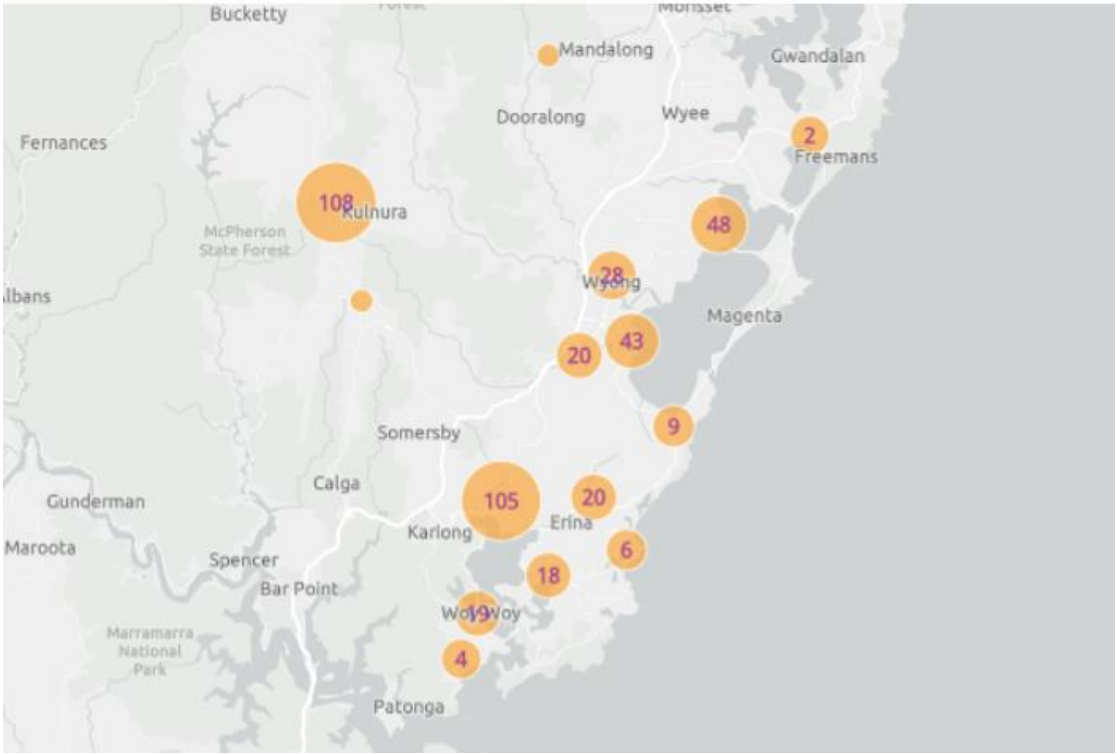
The ISM identified a significant overall gap in services physically located on the Central Coast with psychiatric (8), Culturally and Linguistically Diverse (CALD) (2), and legal services (5). Furthermore, the ISM highlights significant service gaps when comparing the northern (Wyong) and southern (Gosford) districts, with psychiatric services in the south double of those in the north. Additionally, the number of psychology and counselling services was 1.3 times greater in the South than in the North.

TABLE 3. GEOGRAPHIC DISTRIBUTION OF HEALTH SERVICE LOCATIONS ACROSS THE CENTRAL COAST.

	North District	South District	Total
Highest Suburban Density	46 (14%) of physically located services operate in Wyong	87 (27%) of physically located services operate in Gosford	133 (41%) of physically located services operate within 2 suburbs.
Lowest Suburban Density	21% of suburbs with services have only 1 physical service location.	19% of suburbs with services have only 1 physical service location.	17 (40%) Central Coast suburbs with services have only 1 service location.

A lack of physically located MH Support services was also found in this study, with 60% of MH support services on the Central Coast operating remotely via telephone or online. Additionally, the ISM visualised an uneven distribution of service locations across suburbs, with 72% of suburbs lacking a single physical MH, psychosocial or MH support service. Visualised data from the ISM reveals the highest densities of services to be in the central suburbs of Gosford and Wyong, with these 2 suburbs containing 41% (133) of MH, psychosocial, and MH support services physically located on the Central Coast. The ISM reveals an uneven distribution of services between the suburbs of Gosford and Wyong, with 87 services reported in the Gosford suburb and 46 services in Wyong.

FIGURE 2. NORTH AND SOUTH SERVICE LOCATION AND SERVICES OPERATING REMOTELY ACROSS THE CENTRAL COAST ILLUSTRATED USING WEB-GIS TECHNOLOGY.



DISCUSSION

WEB-GIS ISM: A HEALTH PLANNING TOOL

The ISM visualised MH, psychosocial and MH support service distribution and types, enabling health managers to identify disparities in the type and location of services available to Central Coast residents. By highlighting these disparities, the ISM has enhanced informed decision making for health managers regarding the equitable and effective distribution of health services and resource allocation. The Web-GIS ISM proved to be a crucial tool for health service planning across

the region, with this technology playing a pivotal role in supporting health managers to design a Central Coast Recovery College Model of Care. This technology has facilitated strategic data driven decision-making, allowing health managers to identify service partnerships for the implementation of a Recovery College Model of Care.

WEB-GIS ISM: IMPLEMENTATION OF A SERVICE DIRECTORY

One major challenge for mental health consumers is service navigation [20] with web based digital service navigation tools showing significant potential in the mental health environment [14]. A potentially added benefit of this technology would be the seeming ease of making this data publicly accessible by promoting the ISM as a web-based service directory. An unexpected outcome of a publicly accessible interactive service directory is improved service navigation for Central Coast service providers and community members. With previous health service directories utilising static methods, such as Excel Spreadsheets or paper directories, to visualise service information, data within these directories are often outdated from the point of publication [5]. The automated email verification system within this study highlights the capability of Web-GIS in overcoming the challenges faced by traditional service directories with the data validation and database feedback mechanisms improving service directory data accuracy and validity. These mechanisms emphasise the sustainability of Web-GIS technologies in the applications of service planning and service navigation tools.

STRENGTHS

Key strengths of the Web-GIS ISM included its dynamic data visualisation capabilities, which illustrates significant value when compared to traditional static data visualisation methods that are prone to quickly becoming outdated. This study highlights the potential of integrating Web-GIS technology with automated systems to support ongoing data updates and ensure accurate and valid data is available to support health managers in service planning.

LIMITATIONS

Despite its benefits, using Web-GIS requires investment for access and maintenance and training. Furthermore, integrating this technology into existing systems requires specialised technical knowledge, which can limit its widespread implementation. Additionally, reliance on public domain sources and data verification challenges posed limitations on data comprehensiveness and accuracy, as those MH, psychosocial, and MH support services without an email address were unable to be verified using the study's method. Furthermore, a challenge for the application of these technologies includes certain services requiring varying levels of confidentiality, such as domestic violence refuges and support services. Information available to health services planners, service providers, and the broader community must be at these services' discretion and a key consideration when utilising these technologies for service planning and navigation tools.

ENHANCEMENTS

For addressing the confidentiality challenge, there is potential to establish three separate fit-for-purpose Web-GIS ISM tools. The first of these with a wider scope of confidential service information to meet the needs of health managers. Additionally, this ISM tool could explore the potentials in integrating population and health demographic data via heatmap functions to aid in the planning of health services and models. A potential solution for overcoming challenges relating to publicly accessible data and service information confidentiality includes establishing two separate service directories: a service provider directory, and a community member directory. To meet differing needs, the service provider directory could contain more confidential and detailed service information, than the community member directory. These directories have the potential to be built from the same backend database, enabling sustainable data validation. Further enhancements may be to include additional national services that offer remote support such as Lifeline, Kids helpline, Suicide Callback Service, whilst these are not specific to service planning, they are essential inclusions to service directory/navigation if the scope of the tool is to be expanded.

FUTURE SCOPE

In addition to supporting future health service planning, Web-GIS has also shown potential to support individual service navigation, overcoming access issues that are often highlighted as a barrier to recovery for individuals with a lived experience of mental illness. As technology further enhances there is potential for the integration of Web-GIS with generative artificial intelligence such as; AI chat-bots to provide contact details to consumers in need, AI virtual assistance to support regular data validation, and the integration of AI tools to improve user-face portal navigation. Exploration of

the integration of these technologies offers new innovations for the health landscape such as changes to the digital health space and existing models of care.

CONCLUSION

In conclusion, this study addresses the gap in knowledge regarding the use of Web-GIS in local health service planning. The Web-GIS ISM developed supported the service planning of a Central Coast Recovery College Model of Care. This technology provided critical insights into service distribution and gaps, thereby enhancing situational analysis and decision-making for health service planners, highlighting Web-GIS technologies value in enhancing local level mental health service planning. This study explores the immense potential Web-GIS technologies have in transforming approaches to health planning and service navigation. With the potential to adapt these technologies to meet the evolving needs of communities and health planners, adoption of these technologies' puts forth a sustainable solution to providing current and valid health service information. Moving forward, the potential integration of Web-GIS with adapting AI technologies further emphasises the capabilities and sustainability of this technology within the health landscape.

ACKNOWLEDGEMENT

HK, RS-R and SA conceptualised the study, HK and JH developed and deployed the study, HK, RS-R and SA assisted in data analysis. HK was responsible for the development of the manuscript with SA and RS-R contributing to the editing and review process ensuring clarity and accuracy of the final manuscript. This study was part of HKs Masters Degree at Griffith University.

References

1. Australian Bureau of Statistics (ABS). Central Coast (NSW), 2021 Census All persons QuickStats. Canberra: ABS; 2021 [accessed 19 Mar 2023]. Available from: https://abs.gov.au/census/find-census-data/quickstats/2021/LGA11650
2. Central Coast Council. Central Coast Council area Community Profile. Central Coast Council NSW; 2021 [accessed 19 Mar 2023]. Available from: https://profile.id.com.au/central-coast-nsw
3. Central Coast Local Health District (CCLHD). Caring for the Coast Strategy 2019-2024. Central Coast Local Health District; 2018 [accessed 19 Mar 2023]. Available from: https://www.cclhd.health.nsw.gov.au/wp-content/uploads/Strategic_Plan_2019-2024.pdf
4. McGrail MR, Humphreys JS. Spatial access disparities to primary health care in rural and remote Australia. Geospatial Health. 2015;10(2). doi:10.4081/gh.2015.358
5. Wood SM, Alston L, Beks H, Mc Namara K, Coffee NT, Clark RA, et al. The application of spatial measures to analyse health service accessibility in Australia: a systematic review and recommendations for future practice. BMC Health Services Research. 2023;23(1). doi:10.1186/s12913-023-09342-6
6. Whitley R, Shepherd G, Slade M. Recovery colleges as a mental health innovation. World Psychiatry. 2019;18(2):141-2. doi:10.1002/wps.20620
7. Green A. An Introduction to Health Planning for Developing Health Systems. 3rd ed. Oxford: Oxford University Press; 2007. p. 185-200.
8. Kamel Boulos MN, Peng G, VoPham T. An overview of GeoAI applications in health and healthcare. International Journal of Health Geographics. 2019;18(1). doi:10.1186/s12942-019-0171-2
9. McLafferty SL. GIS and Health Care. Annual Review of Public Health. 2003;24(1):25-42. doi:10.1146/annurev.publhealth.24.012902.141012
10. Salinas-Pérez JA, Gutiérrez-Colosia MR, Romero López-Alberca C, Poole M, Rodero-Cosano ML, García-Alonso CR, et al. Todo Está en el Mapa: Atlas integrales de salud mental para la Planificación de Servicios. Informe SESPAS 2020. Gaceta Sanitaria. 2020;34:11-9. doi:10.1016/j.gaceta.2020.06.015
11. Abdulrahman I, Radman G. Power System Spatial Analysis and visualization using Geographic Information System (GIS). Spatial Information Research. 2019;28(1):101-12. doi:10.1007/s41324-019-00276-y

12. Firouraghi N, Kiani B, Jafari HT, Learnihan V, Salinas-Perez JA, Raeesi A, et al. The role of Geographic Information System and global positioning system in dementia care and research: A scoping review. International Journal of Health Geographics. 2022;21(1). doi:10.1186/s12942-022-00308-1
13. Franch-Pardo I, Napoletano BM, Rosete-Verges F, Billa L. Spatial analysis and GIS in the study of COVID-19. A review. Science of the Total Environment. 2020;739:140033. doi:10.1016/j.scitotenv.2020.140033
14. Calear AL, Batterham PJ, McCallum SM, Banfield M, Moore E, Johnson N, Morse AR. Designing a Web-Based Navigation Tool to Support Access to Youth Mental Health Services: Qualitative Study. JMIR Formative Research. 2024;8:e48945. doi:10.2196/48945
15. Wang F. Why Public Health Needs GIS: A methodological overview. Annals of GIS. 2020;26(1):1-12. doi:10.1080/19475683.2019.1702099
16. World Health Organization (WHO). GIS, Geospatial Solutions for Health, geographic information system, Storymap, GIS Center. Geneva: WHO; 2022 [accessed 26 Mar 2023]. Available from: https://www.who.int/data/GIS
17. Lakhani A. Which Melbourne metropolitan areas are vulnerable to covid-19 based on age, disability, and access to health services? using spatial analysis to identify service gaps and inform delivery. Journal of Pain and Symptom Management. 2020;60(1). doi:10.1016/j.jpainsymman.2020.03.041
18. Khashoggi BF, Murad A. Issues of healthcare planning and GIS: A Review. ISPRS International Journal of Geo-Information. 2020;9(6):352. doi:10.3390/ijgi9060352
19. Maina J, Ouma PO, Macharia PM, Alegana VA, Mitto B, Fall IS, et al. A spatial database of health facilities managed by the public health sector in Sub Saharan Africa. Scientific Data. 2019;6(1). doi:10.1038/s41597-019-0142-2
20. Kavanagh BE, Beks H, Versace VL, Quirk SE, Williams LJ. Exploring the Barriers and Facilitators to Accessing and Utilising Mental Health Services in regional, rural, and Remote Australia: a Scoping Review Protocol. PLoS One. 2022;17(12). doi:10.1371/journal.pone.0278606