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The Use of GIS for Land Use Planning: Recommendations for PPGIS in the United States

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Abstract

GIS (Geographic Information Systems) provide the ability to present multifaceted data in a clear and understandable manner, enabling various stakeholders to be informed and actively participate in discussions about future changes to land use. The use of GIS allows for the analysis of complex spatial and temporal data, aiding in community planning and development, resource conservation, and efficient land utilization. While GIS resources have become more accessible in recent years, land use planners in the US have not fully utilized this tool in regards to engaging the public and gaining their feedback in the planning process. In contrast, European countries like Finland and Poland continuously use PPGIS (Public Participation Geographic Information Systems) and publish their processes frequently. A literature review of PPGIS publications from 2015-2023 provides an overview of the limitations of PPGIS and the barriers for use, including lack of participation and limited funding. A review of the literature, as well as an analysis of the impact of the COVID pandemic, are used to determine best practices for incorporating PPGIS into land use planning processes in the US. Recommendations for improving the use of PPGIS in the US include utilizing training programs, active participation in community meetings, and using multiple methods to engage the public.

Introduction

GIS (Geographic Information Systems) can be used to assist land use planners and decision makers by illustrating data through clear visualizations, allowing for a deeper analysis of information. An additional benefit is the ability to display the results in a way that is easy for the general public to understand, allowing for multiple groups of stakeholders to become educated on the planning process and engage in meaningful conversations regarding future changes. While GIS resources have become easier to access in recent years, planners in the United States are not utilizing this tool to its fullest extent. US government organizations, such as the National Park Service and the National Forest Service, have a wide variety of GIS tools and resources on their webpage, but lack processes for engaging the public in the planning process or publishing their research. Many countries in Europe, particularly Finland and Poland, have focused on providing the public with tools and opportunities to give input to land use planning through GIS, known as PPGIS (Public Participation Geographic Information Systems). Despite the evidence that PPGIS has been found as a meaningful land use planning process, the US lacks in research and

participation in this progression.

The benefits of using GIS include the ability to analyze complex spatial and temporal data which can assist with the planning and development of communities, conservation and management of resources, and efficiently using land. When GIS is used by planners in the US, they tend to use a top-down approach in which decisions are made from higher levels of administration and communicated to employees and the public. Instead, involving local community members and stakeholders in the decision-making process by using PPGIS could allow for more active engagement and ideas in the planning process.

Background

Research on PPGIS effectiveness has been robust, particularly in recent years (Bąkowska-Waldmann & Kaczmarek, 2021; Buendía et al., 2019; Denwood et al., 2022; Kantola et al., 2023; Morse et al., 2020; Prado, 2021; Rall et al., 2019). Yet the US has not been among the many countries to publish research on this subject, surmising the notion that it is not actively engaged in this process for land use planning. The lack of uniformity of PPGIS approaches, uneven data quality, limited participation, and the dearth of work to integrate feedback into planning decisions have been found to be barriers for organizations to implement PPGIS (Brown & Kytta, 2014). While these issues may still exist, recent research on why the US is not more actively engaged in PPGIS has not been conducted. In addition, changes in society due to the COVID pandemic have not been analyzed to determine if these challenges have worsened or improved the ability for US organizations to utilize PPGIS in their land use planning decisions.

Europe's social structure and limited access to environmental resources due to dense population agglomerations could be related to its continuous use of PPGIS, particularly as Finland and Poland frequently fund these studies (Bąkowska-Waldmann, 2023; Jankowski et al., 2022; Kantola et al., 2023). In Finland, the Land Use and Building Act specifically states that the aim is to "...ensure that everyone has the right to participate in the preparation process, and that planning is high quality and interactive, that expertise is comprehensive and that there is open provision of information from on matters being processed" (Land Use and Building Act, 1999). In contrast, US researchers have noted its lack of participation from public participants in the process as a barrier to PPGIS. Participation on internet based PPGIS studies have shown about a 13% rate, while paper-based PPGIS research shows an average of 30% participation (Brown et al., 2004; Brown 2005; Brown & Reed, 2009; Brown, 2012; Clement & Cheng, 2011; Nielsen-Pincus et al., 2010).

Paper-based studies have also shown that more information is provided by these participants (i.e. 43 places mapped compared to 18) than those who complete activity online (Pocewicz et al., 2012). Limited participation may be due to the lack of involvement participants feel in the planning process, as their small role in providing information lacks the collaboration aspect they desire (Brown & Kytta, 2014). However, these studies all took place before the COVID pandemic, in which a shift to online and remote work became necessary. This research will review PPGIS studies from 2014-2023 to better assess recent changes and further understand the impact COVID has had on PPGIS moving forward.

Method

A review of PPGIS publications from 1998-2013 (Brown & Kytta, 2014) gave an overview of the research being completed with this method and gave an overview of the reasons why governments and NGOs have lagged in their support PPGIS, including the lack of incentives to use PPGIS, delivery pressure, difficulty with gaining public participation, limited ease or access to high quality data, and issues with participants understanding the information provided. This study picks up where they left off, with a review of publications from 2015-2023. Other reviews have been completed throughout the years, but they have primarily focused on best practices, research method design or focusing on other variables (ie relationship between altitude and suicide) (Brown, 2017; Brown et al., 2022; Johnson et al., 2022). The focus of this review is to identify publications to assist with understanding why, despite PPGIS being widely utilized globally, it is not a common practice in the US.

Results

Table 1 outlines the research on PPGIS from 2015-2023. The table shows Finland, Poland and Sweden as the main contributors to research in this field. The US only completed two published studies during this time period, even though this country has tools and resources available for use. Finland, Poland and Sweden do receive funding from government organizations to pursue the mission of including the public in the planning process, but the US has resources available through the National Forest and the National Park systems. Research during this time period shows the issues with lack of public participation, low quality of participation, and challenges with utilizing technology.

Table 1. PPGIS Studies from 2015-2023

Year	Country	Topic	Publication
2023	Finland	PPGIS use by organizations	Kantola, S., Fagerholm, N., & Nikula, A. (2023). Utilization and implementation of PPGIS in land use planning and decision-making from the perspective of organizations.
2023	Poland	Reliability of data obtained from residents	Bąkowska-Waldmann, E. (2023). Residents' experiential knowledge and its importance for decision-making processes in spatial planning: A PPGIS based study.
2023	Taiwan	Using telecoupling PPGIS for remote locations	Kacaw, L., & Tsai, B. W. (2023). The application of PPGIS to telecoupling research: A case study of the agricultural landscape transformation in an indigenous village in Taiwan.
2022	Finland and Poland	Urban planning	Jankowski, P., Forss, K., Czepkiewicz, M., Saarikoski, H., & Kahila, M. (2022). Assessing impacts of PPGIS on urban land use planning: Evidence from Finland

			and Poland.
2022	UK	Research methods/data sets	Denwood, T., Huck, J. J., & Lindley, S. (2022). Effective PPGIS in spatial decision-making: Reflecting participant priorities by illustrating the implications of their choices.
2022	Sweden	Recreation areas	Lehto, C., Hedblom, M., Öckinger, E., & Ranius, T. (2022). Landscape usage by recreationists is shaped by availability: Insights from a national PPGIS survey in Sweden.
2022	Hungary	Cultural ecosystem services	Valánszki, I., Kristensen, L. S., Jombach, S., Ladányi, M., Filepné Kovács, K., & Fekete, A. (2022). Assessing relations between cultural ecosystem services, physical landscape features and accessibility in Central-Eastern Europe: A PPGIS empirical study from Hungary.
2021	Nordic regions	Participation	Kantola, S. (2021). The participation of citizens in land use planning and decision-making in Northern areas—the potential of PPGIS in increasing interaction.
2021	Poland	Participation	Bąkowska-Waldmann, E., & Kaczmarek, T. (2021). The use of PPGIS: Towards reaching a meaningful public participation in spatial planning.
2021	Mexico	Mapping for environmental justice	Prado, C., Colectivo Salud y Justicia Ambiental, & Red de Ciudadanos para el Mejoramiento de las Comunidades. (2021). Border environmental justice PPGIS: Community-based mapping and public participation in eastern Tijuana, México.
2021	Spain	Online PPGIS	Buendía, A. V. P., Albert, M. Y. P., & Giné, D. S. (2021). Online Public Participation Geographic Information System (PPGIS) as a landscape and public use management tool: A case study from the Ebro Delta Natural Park (Spain).
2020	Finland and Faroe Islands	PPGIS best practices	Nikula, A., Turunen, M., Bogadóttir, R., Markkula, I., Kantola, S., & McDonagh, J. (2020). PPGIS for a better understanding of peoples values: Experiences from Finland and the Faroe Islands.
2020	Mexico	Planning for rising sea levels	Morse, W. C., Cox, C., & Anderson, C. J. (2020). Using public participation geographic information systems (PPGIS) to identify valued landscapes vulnerable to sea level rise.

2019	Budapest	Connections to cultural ecosystems	Valánszki, I., Jombach, S., Kovács, K. F., Abualhagag Ahmed, A., Mendez Garzón, F. A., & Balha, G. (2019). Cultural ecosystem services and local identity—a ppGIS case study from Budapest metropolitan region.
2019	Germany	Urban green infrastructure planning	Rall, E., Hansen, R., & Pauleit, S. (2019). The added value of public participation GIS (PPGIS) for urban green infrastructure planning.
2019	Spain	Protected areas and parks	Buendía, A. V. P., Pérez Albert, M. Y., & Serrano Giné, D. (2019). PPGIS and public use in protected areas: A case study in the Ebro Delta Natural Park, Spain.
2018	Australia	Planning of multi-use trails	Wolf, I. D., Brown, G., & Wohlfart, T. (2018). Applying public participation GIS (PPGIS) to inform and manage visitor conflict along multi-use trails.
2018	Norway	Participation	Engen, S., Runge, C., Brown, G., Fauchald, P., Nilsen, L., & Hausner, V. (2018). Assessing local acceptance of protected area management using public participation GIS (PPGIS).
2018	Finland	Waterways and recreations area	Engen, S., Runge, C., Brown, G., Fauchald, P., Nilsen, L., & Hausner, V. (2018). Assessing local acceptance of protected area management using public participation GIS (PPGIS).
2017	Sweden	Online PPGIS	Babelon, I., Ståhle, A., & Balfors, B. (2017). Toward Cyborg PPGIS: Exploring socio-technical requirements for the use of web-based PPGIS in two municipal planning cases, Stockholm region, Sweden.
2017	US/ Australia	Research methods in PPGIS/Sampling groups	Brown, G. (2017). A review of sampling effects and response bias in internet participatory mapping (PPGIS/PGIS/VGI).
2016	Finland	Older adult participation	Gottwald, S., Laatikainen, T.E., & Kytä, M. (2016). Exploring the usability of PPGIS among older adults: Challenges and opportunities
2016	US	Online PPGIS	Tang, Z., & Liu, T. (2016). Evaluating Internet-based public participation GIS (PPGIS) and volunteered geographic information (VGI) in environmental planning and management.
2016	Australia	Marine parks	Strickland-Munro, J., Kobryn, H., Brown, G., & Moore, S. A. (2016). Marine spatial planning for the future: Using Public Participation GIS (PPGIS) to

			inform the human dimension for large marine parks.
2015	Global	Research methods/ best practices review	Brown, G., & Fagerholm, N. (2015). Empirical PPGIS/PGIS mapping of ecosystem services: A review and evaluation.

Research during this time period highlighted the changes made as a result of the shift to remote working and changes to norms of socialization during the COVID pandemic. Since COVID, a study of 23,547,688 seniors (65 years and older) in the United States found the pandemic caused a 60.2% increase in technology usage among this group (Li et al., 2021). Seniors are known to actively participate and offer valuable insights in PPGIS research, showcasing their exceptional ability to remember historical changes in the community. It is crucial to find ways to sustain their involvement in such projects. The introduction of technology in PPGIS surveys led to a decline in data quality and reduced participation from seniors. Although more seniors have embraced technology during the COVID pandemic, it is essential to recognize and address any challenges they may face to ensure their continued engagement in these studies.

Discussion

Involving stakeholders in the planning process is crucial as it allows users of the area to share their feedback on various aspects like accessibility, cleanliness, congestion, and availability of site information (Buendía, Albert, & Giné, 2021). However, a challenge arises in reaching a diverse audience to gather their perspectives. Utilizing technology to engage participants has resulted in issues with data collection and has created difficulties for certain users, such as older adults, who may struggle with technology when providing feedback. European countries, such as Finland, Poland and Sweden, tend to receive more government funding than the US for PPGIS, as public participation is written mandated via legislation, to assist with these types of issues. It is important for US planners to utilize resources available, such as free or inexpensive training through ESRI, ArcGIS free software, resources from National Park and National Forest systems, and community forums through PPGIS.net.

To address issues with access to the public, displaying visual representations in public spaces like libraries, schools, community centers, and transit hubs enables the public to engage in person and closely examine the planning options. Additionally, disseminating information in these locations about focus groups or meetings for gathering detailed insights can also aid in reaching a broader audience and assisting those facing technological hurdles.

An array of resources accessible to the public consists of data provided by the National Park Service and National Forest Service. This assortment encompasses raster and enterprise data, climate and air quality data, data pertaining to cultural resources, detailed maps, as well as a database housing forest inventory information. Additionally, the Environmental Protection Agency (EPA) furnishes data available to the public covering aspects such as air quality, water quality, waste management, and various other environmental factors. Most states have GIS portals offering similar region-scale datasets. Free software options for generating maps to visualize data are available through ArcGIS, and individuals can partake in training programs offered by ESRI at an affordable rate

to acquire the skills necessary for creating maps efficiently.

Conclusion

PPGIS plays a crucial role in facilitating the presentation of complex data in a comprehensible manner, allowing for informed decision-making and active involvement of stakeholders in land use discussions. While the accessibility of GIS resources has increased, there is a need for greater utilization, particularly in the US, to engage the public effectively in the planning process. European countries like Finland and Poland lead in using PPGIS due to their legislation and funding opportunities, but the US has access to resources to combat financial constraints. Recommendations for enhancing PPGIS implementation in the US involve utilizing ESRI training programs, improving community engagement by displaying visuals in areas the public frequently visits, leveraging resources like National Park Service, EPA and National Forest System data, and using free software such as public ArcGIS packages. Such steps are instrumental in improving accessibility and promoting public engagement in land use planning processes.

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