[DA-036] GIS&T and Public Policy

Abstract

Public policy is the formal and informal guiding principles that are used by governments and other decision-making entities to guide our everyday lives. Geographic Information Science and Technology (GIS&T) has had an impact on the public policy process since GIS&T's earliest beginnings in the 1960s. Advances in the development and availability of both geospatial technology and geospatial data paralleled a growing use of data-driven rational planning and decision-making models in policy making at all levels of government. Today more than ever, successful public policy depends on high-quality data and the technology that communicates its meaning effectively. Beyond the rational application of scientific or systematic methods, public policy is about values and how values affect, and are affected by, policies. This requires delivery of credible information in a transparent, understandable form not only to decision makers responsible for adopting policy, but also to various categories of stakeholders whose behavior will be impacted in some way by the policy's implementation. GIS&T continues to play an important role in that endeavor, including making value conflicts more seeable and knowable. Included in the entry is a summary of the public policy process and its participants, followed by a brief overview of how GIST's role in public policy has evolved over the last 50 years. The entry concludes by outlining a sample of real-world applications and presenting a discussion of related issues and future considerations.

Keywords: decision support, local government, multi-criteria decision analysis, policy analysis, public participation GIS, public policy, spatial data infrastructure, state government, suitability analysis

Author & citation

Hamerlinck, J. D. and Ramasubramanian, L. (2021). GIS&T and Public Policy. The Geographic Information Science & Technology Body of Knowledge (2nd Quarter 2021 Edition), John P. Wilson (ed.). DOI: 10.22224/gistbok/2021.2.9.

This entry was first published on June 28, 2021. No earlier editions exist.

Explanation

1. Definitions
2. Introduction
3. What is Public Policy?
4. Historical Context and Recent Trends
5. Contemporary Examples
6. Related Considerations
7. Summary

1. Definitions

Public policy: the formal and informal guiding principles that are used by governments

and other decision-making entities to guide our everyday lives. Public policies are designed to give practical relevance to societal values, and are translated into laws, rules, regulations, standards, and guidelines.

Policy actors: participants (individuals, groups or organizations) who play various roles – directly or indirectly, formally or informally - in the public policy process. Examples include decision makers with responsibility for adopting policy, and various categories of stakeholders including 'target groups' whose behavior is required to change as a result of policy implementation, and 'end beneficiaries' directly affected by the issue being addressed and the subsequent policy response.

Policy analysis: the process of identifying and comparing potential policy options for addressing a problem in order to choose the most effective, efficient, and feasible option to implement. GIS&T can be used to evaluate the spatio-temporal aspects of policy options through the combined analysis of multiple location- and non-location based criteria.

Policy implementation: enacting and applying an established policy (e.g., statutes, rules and regulations, executive orders, etc.). GIS&T may be used in a wide range of ways in policy implementation, including: (a) educating people or groups affected by the new policy; (b) carrying out supporting administrative operations; and (c) monitoring and/or enforcing the policy as needed.

2. Introduction

The field of Geographic Information Science and Technology (GIS&T) has had an impact on the public policy process since GIS&T's earliest beginnings in the 1960s. Advances in the development and availability of both geospatial technology and geospatial data paralleled a growing use of data-driven rational planning and decision-making models in policy making at all levels of government (Calkins 1991). Today more than ever, successful public policy depends on high-quality data and the technology that communicates its meaning effectively. Beyond the rational application of scientific or systematic methods, public policy is about values and how values affect, and are affected by, policies. This requires delivery of credible information in a transparent, understandable form not only to decision makers responsible for adopting policy, but also to various categories of stakeholders whose behavior will be impacted in some way by the policy's implementation. GIS&T continues to play an important role in that endeavor (Fleming 2005), including making value conflicts more seeable and knowable.

An exploration of GIS&T in public policy can take many directions. This entry highlights the various roles that GIS&T can play in the policy process in the USA. The entry begins with a brief overview of the public policy process, including an outline of key characteristics of public policy development and the various participants and the roles they may play. Next a historical context for GIS&T in public policy is provided followed by a review of recent and current trends. Though not exhaustive in covering the many public policy jurisdictions and stages of policy development in which GIS&T is employed, a sample of representative examples is next provided to demonstrate the breadth of applications in the domain. The entry concludes with a discussion of pertinent issues that practitioners should be aware of and a summary of major points and thoughts for further consideration.

3. What is Public Policy?

Public policy may be defined as “the combination of basic decisions, commitments, and actions made by those who hold or influence government positions of authority” (Gerston 2010, p. 7). Put another way, public policy refers to the formal and informal guiding principles that are used by governments and other decision-making entities to guide our everyday lives. Public policies are designed to give practical relevance to societal values, and are translated into laws, rules, regulations, standards, and guidelines.

Key characteristics of public policy development include the following:

- Made in response to some sort of problem that deserves some sort of government response
- Made in the ‘public interest’
- Interpreted and implemented by public and private actors who have different motivations, and therefore will bring different interpretations of problems and solutions
- Oriented toward a goal or desired state
- Ultimately made by governments, even if the ideas come from outside government or through the interaction of government and nongovernmental actors (Birkland 2020).

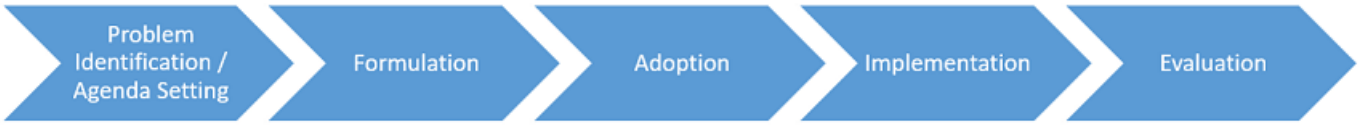


Figure 1. The policy process. Adapted from Anderson (2015). Source: authors.

Figure 1 illustrates the major stages of the policy process, from identifying problems or issues to policy formulation and adoption, implementation, and evaluation (or monitoring). This general process applies whether policy development is happening nationally or internationally (e.g., climate change mitigation, energy transition), or in a state/province (e.g. wildlife management, transportation) or a local administrative setting (e.g., housing, land use). Results of policy monitoring and evaluation provide feedback which often leads to new problem identification and/or a reformulation (modification) of the original policy.

While public policy is ultimately made by governments, non-government entities such as private companies (e.g., healthcare providers, insurance companies), educational institutions (school districts, universities), and not-for-profit organizations (conservation or community development groups) also may make policy and many are avid users of geospatial data and geospatial technology.

Participants in the policy process (i.e., policy actors; Knoepfel 2010) include policy makers (often elected officials or public servants), and policy analysts who not only advise policy makers on policy alternatives and selection, but also evaluate implemented policies based

on measures of success. Other participants in the policy process may be involved in policy advocacy and policy research (Anderson 2015; Patton, Sawicki and Clark 2013).

4. Historical Context and Recent Trends

Geographers have noted that "'public policymaking… is exquisitely geographic [and] spatial patterns, relationships and structures are at the heart of policymaking" (Wilbanks 1985, p. 7). Policy scholars concur, acknowledging that "most policy issues have spatial dimensions" (Patton, Sawicki and Clark 2013, p. 116).

While there are several different narratives that shape the historical evolution of the GIS&T field, most GIS historians would agree that the management of land and water resources was an early driver of the development of GIS technologies and accompanying spatial-analytical methods (Foresman 1998). The purpose for a "systematic" and "rational" approach to identifying vulnerable or sensitive landscapes was an early attempt to shape national and regional policy making. Prominent examples of approaches to this work using GIS technology and spatial methods include the Canada Geographic Information System's role in operationalizing the Canada Land Inventory (Thie 2008), and the overlay methods central to Ian McHarg's vision for ecological planning in Design with Nature (Steiner et al. 2019).

The United States Census Bureau also helped advance the growth of GIS technologies and analytical methods with the development of geographic base files and encoding systems, including the Topologically Integrated Geographic Encoding and Referencing (TIGER) system created for the 1990 census. The ability to map and spatially analyze census data expanded research to support public policy development, implementation, evaluation and monitoring. For example, urban scholars were able to use data to conduct indicators-based research that revealed socio-spatial disparities. As data and technologies became more accessible and affordable, GIS advocates worked to support policy advocacy by conducting research in partnership with community groups and nonprofit organizations (Ramasubramanian, 2010).

In the 1990s, GIST applications in public policies continued to align with the rational decision-making framework long central to decision science and public administration theory. Calkins identified three major categories of GIS use in public policy: (1) the use of GIS to determine where and when public policies are needed [i.e., policy development]; (2) analysis to assist in the formulation of public policies [i.e., policy analysis]; and (3) analysis to determine the extent to which public policies are successful and have achieved the goals and objectives intended [i.e., monitoring] (Calkins 1991, p. 234). (To this list, we would add a 4th category, that is the use of GIS as a tool for carrying out a policy, i.e. GIS for policy implementation.)

Two decades later, Bailey (2010) identified three major trends in GIS&T as they related to public policy applications:

- democratization of GIS technology;
- convergence of GIS with geo-visualization technology;
- improved accessibility to geospatial information (Bailey 2010, p. 1309).

According to Bailey (2010), democratization of GIS technology can be interpreted as making technology more accessible, more affordable, and easier to use. The Public Participation GIS community exemplified this trend then (Ramasubramanian 2010), and now is further enabled by cloud-based GIS applications and mobile platforms (Sieber et al. 2016). The convergence of GIS with geo-visualization technology has continued to advance, from dynamically-linked maps and charts in planning support systems to a significant increase in 3D-based sophistication involving both visual display and attribute query and symbolization. Accessibility to geospatial information also continues to improve as centralized coordination of spatial data infrastructures, particularly at the state and local levels in the United States, support a wide range of public policy work (O'Malley 2019), while the open data movement more broadly supports this on a global scale (Avtar et al. 2020). The impact of map-based dashboards in providing spatio-temporal information to support public health decision making during the COVID-19 pandemic cannot be overstated (Wissel et al. 2020).

5. Contemporary Examples

Today, the use of GIS in public policy development and implementation can be found in a diverse range of settings, within and across global, national, regional, state/province, and local scales. The following examples provide a sample of the breadth of these applications, highlighting various GIS&T roles at different stages in the policy process. For curriculum development purposes, other applications could be chosen to reflect similar ranges of applications, policy development stages, and geographic scales / jurisdictions. (For example, see Instructional Assessment Question #1.)

5.1 Policy Development and Analysis: COVID-19 Pandemic

Scale: global / national / state

The JHU-CSSE COVID-19 Dashboard (Figure 2) is an example to demonstrate how GIS can anchor the integration and display of large volumes of data, updated at near-real time, from across the world to inform and educate the public about a dynamic phenomenon like Coronavirus. The team at Johns Hopkins University aggregates the "most comprehensive publicly available datasets" related to the pandemic. The US map provides county-level analyses and end users can aggregate data across counties according to their needs. These information products - depicting trends in increases or decreases in COVID-19 cases - inform public health policies related to, for example, business closures and face covering requirements. The dashboard is a resource for users around the world to track the outbreak, although the Global Map unintentionally reveals the challenges of working in data-poor environments because of gaps and missing data.

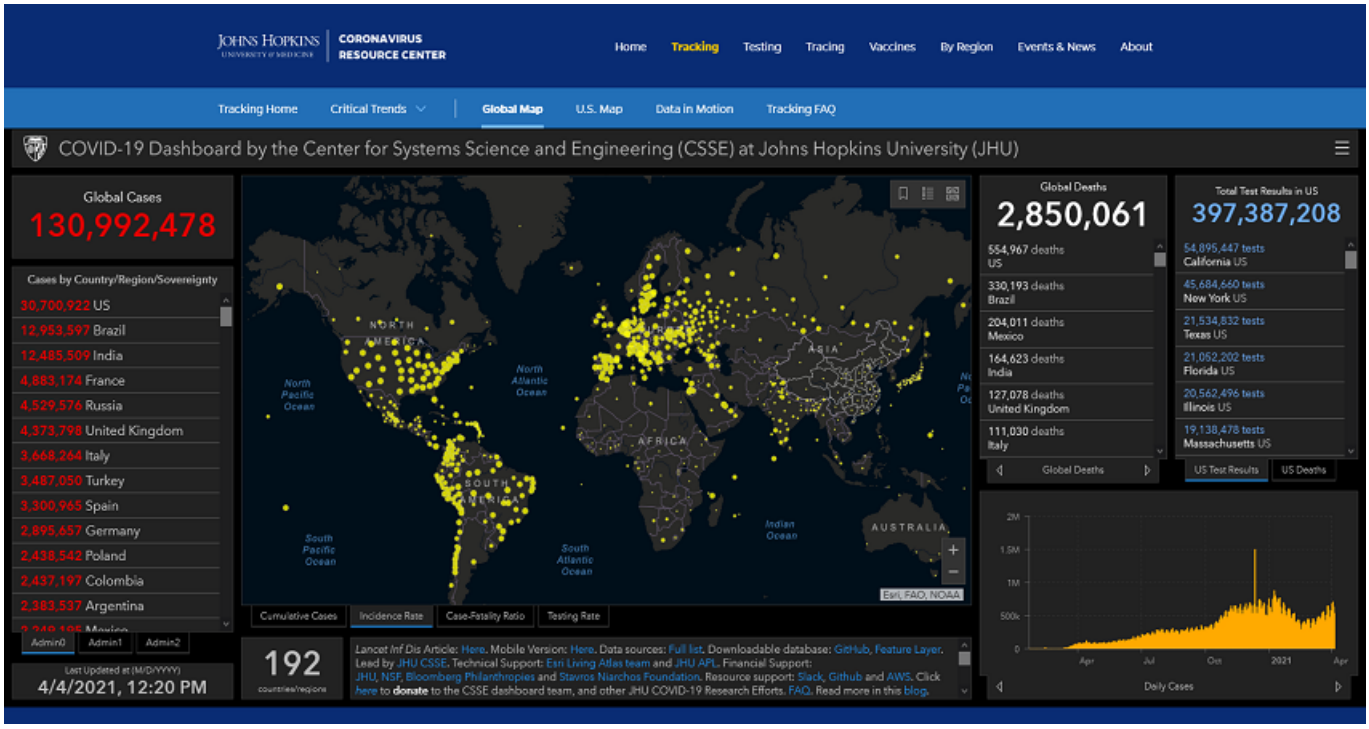


Figure 2. COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University. Source: authors.

5.2 Policy Implementation: Sage Grouse Protection

Scale: state

The Wyoming Sagebrush One-Steppe Application supports implementation of the State of Wyoming (USA) Governor's Executive Order guiding land use development in designated core areas of habitat for the Greater Sage-Grouse. The executive order delineates core population areas for Greater Sage-Grouse breeding and seasonal habitat, restricting certain development activities in those special management areas (Figure 3). Development proposers utilize an online mapping system to submit information on potential habitat impacts for proposed activities within 'core areas' to determine mitigation requirements. Development locations and associated impacts are tracked within a spatial database for the duration of each project's lifecycle. Mitigation requirements vary across space and by project magnitude.

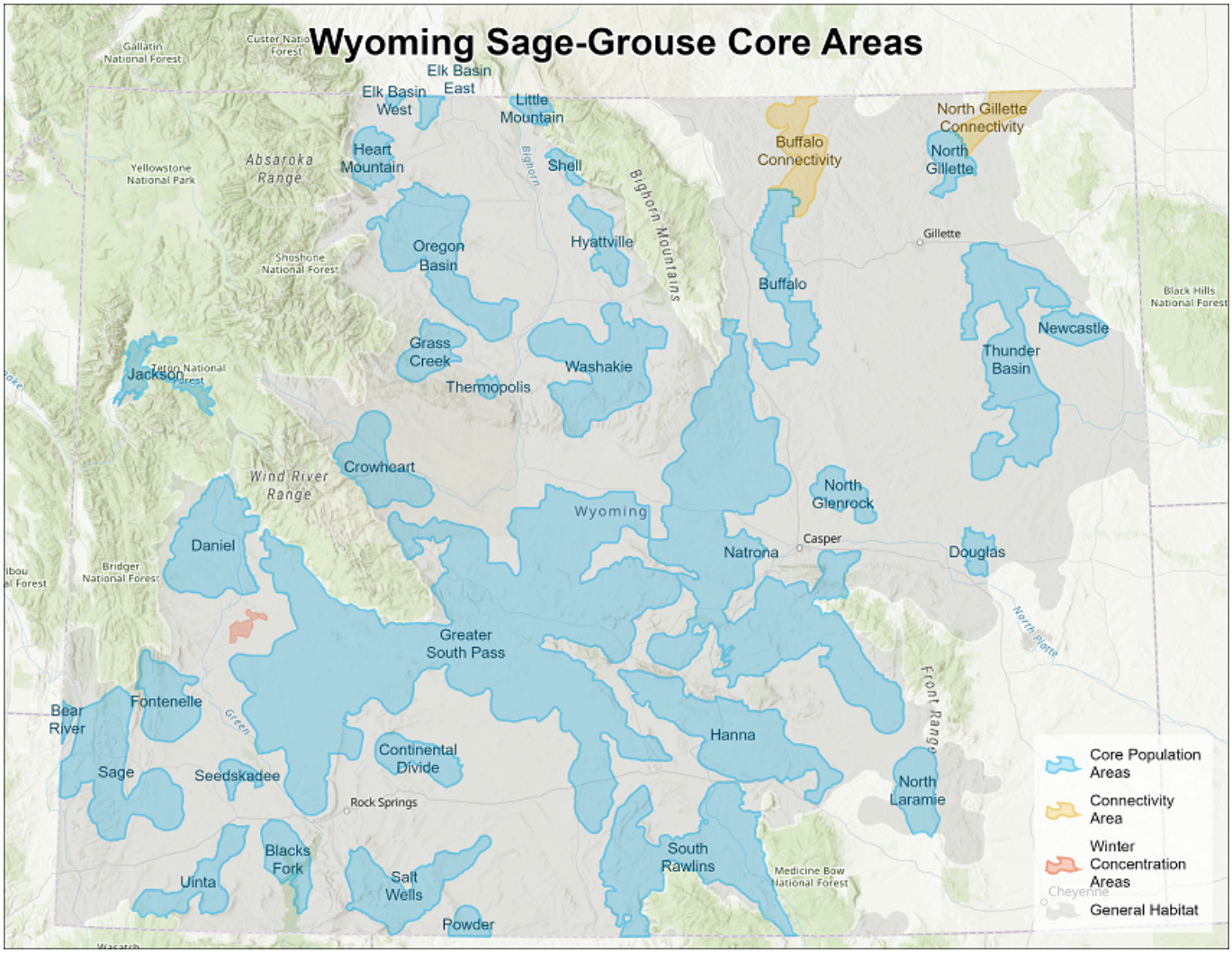


Figure 3. Wyoming Sage-Grouse Core Management Areas as defined by Wyoming Governor Executive Order 2019-3. Source: authors.

5.3 Policy Implementation: Land Use Regulations

Scale: local

The City of Baton Rouge - East Baton Parish (Louisiana, USA) GIS Data Portal GIS Data Portal ("EBRGIS portal") is an open data geospatial resource providing authoritative geospatial data for planning and analysis, field mobility, operational awareness, and citizen engagement. Many of the site's web mapping applications and dashboards are designed to support policy implementation. For example, the Planning and Land Development web application communicates information about zoning, conditional uses, and proposed developments currently under review (Figure 4).

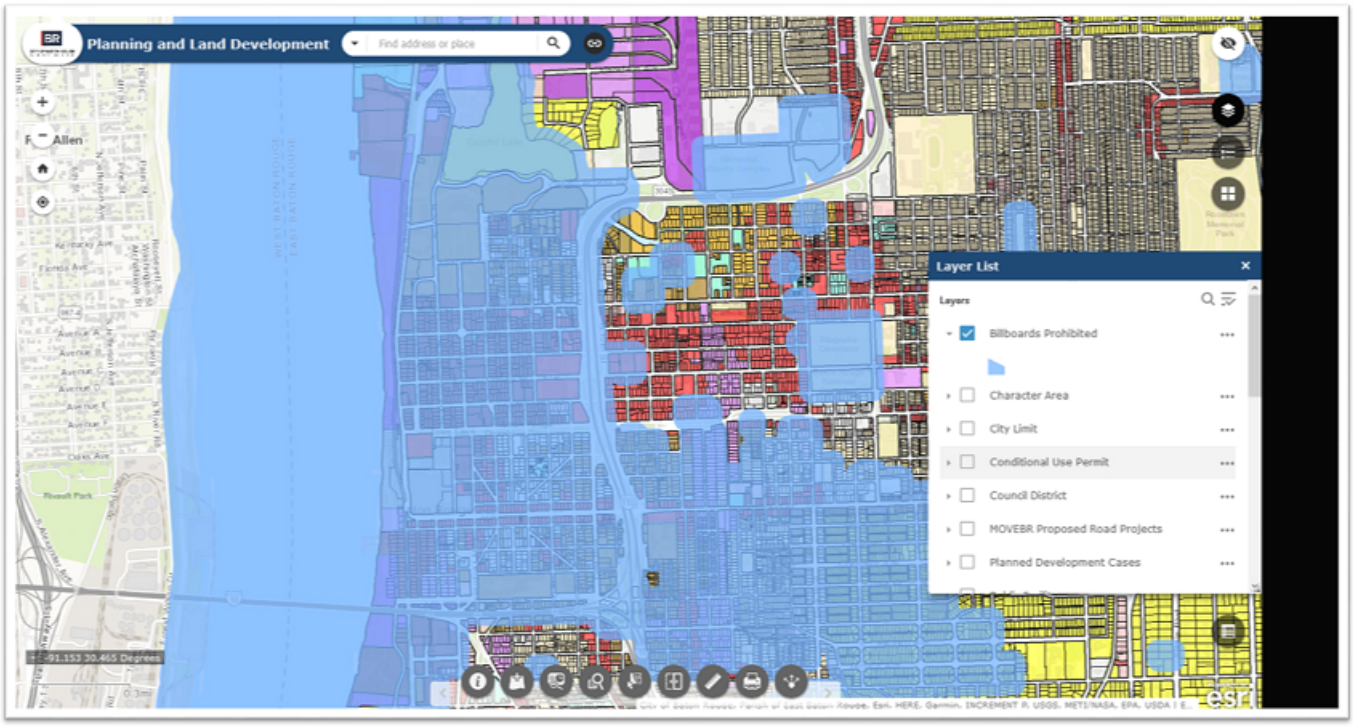


Figure 4. EBRGIS Portal Planning and Land Development web application, displaying geographic extent of policy on billboard sign restrictions. Source: authors.

5.4 Policy Monitoring: Elections

Scale: global / national / state

The Elections Performance Index compares election administration policy and performance in different states and in different elections. This project aims to support data driven evaluation of election performance, identify problem areas, and address them. The goal is to allow users to evaluate elections based on data related to a range of variables, for example related to the electoral environment, the electoral infrastructure, the administration of in-person voting and voting by mail. The data can be used to measure the impacts of policy changes or changes in usual election practices. Voter education is an added benefit (Figure 5).

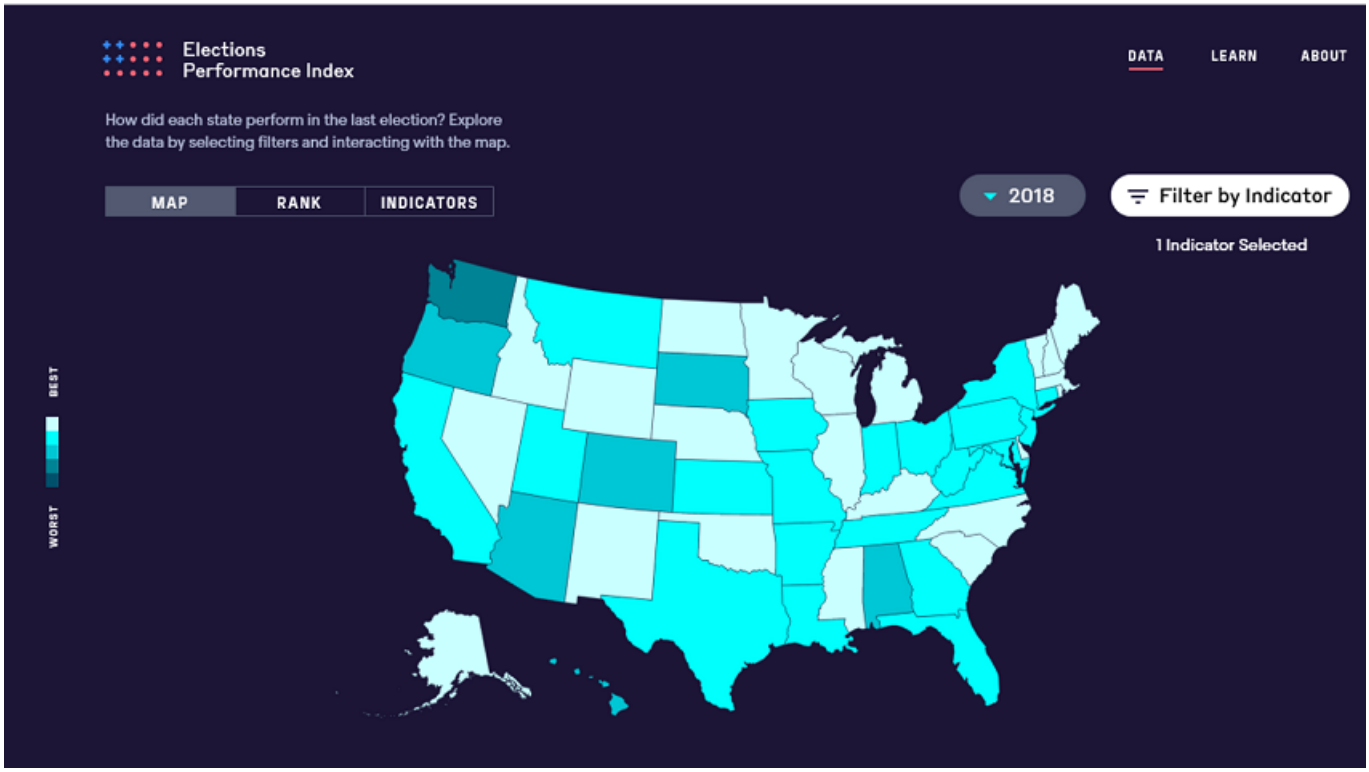


Figure 5. Elections Performance Index dashboard, displaying the degree to which citizens were deterred from voting because of problems with registration or absentee ballots in 2018 state elections. Source: authors.

6. Related Considerations

Three topics for consideration in applying GIS&T in the public policy process include the importance of supporting spatial data infrastructure, the need to appropriately determine and communicate uncertainty about data inputs and outputs, and the legal and ethical context in which the application is occurring. While only briefly outlined here due to space considerations, readers are encouraged to consult the accompanying references for more in-depth consideration of these topics.

6.1 Spatial Data Infrastructures

Spatial data infrastructures support ready access to geographic information necessary for policy work. SDIs accomplish this through: organizational coordination promoting awareness and implementation of common data policies; promulgation of data standards; and through provision of effective mechanisms for the development, sharing, discovery and access of geospatial data and technologies (Masser, Rajabifard, and Williamson 2008).

6.2 Communicating Uncertainty

The importance of communicating uncertainty in map products generated in support of policy implementation grew from work on error propagation in spatial modeling that began in the mid-1980s (Heuvelink, Burrough and Stein 1989; Spear, Hall and Wadsworth 1996). Today, specific research at the intersection of uncertainty communication and public policy decisions occupies a small but important body of literature, including applications in

groundwater vulnerability (Rader and Janke 1998), epidemiology (Kleinschmidt, Kazembe and Morris 2005), urban planning (Quinn, Schiel and Caruso 2015), and climate change (Vajjhala and Nackoney 2008; Bell et al. 2014).

6.3 Legal and Ethical Considerations

The body of knowledge associated with GIST and the law has advanced significantly over the last 25 years. Legal topics most likely to intersect with public policy applications include product liability (e.g., if a datasets used in policy determination or implementation are later found to be inaccurate) and restrictions on public access to geospatial data (potentially impacting quality and credibility of policy analysis, or impeding transparency and reproducibility) (Obermeyer and Pinto 2008; Croswell 2019).

7. Summary

Beginning in the 1960s, the evolving relationship between GIS&T and public policy developed with gradual advances in geospatial data availability and increased ease-of-use in software applications. Initial efforts were driven by large-scale efforts related to modernization of natural resource inventories and census data products, following a rational planning model for decision making. In the late 1980s and 1990s, the application of geospatial technologies for public policy making accelerated with the democratization (access to) of data, the arrival of personal computers, and demands for efficiency that enabled systems-oriented local government managers to use GIS to support policymaking (Huxhold, 1989, Huxhold and Levinsohn, 1995). In the United States, such advances were further enabled both directly and indirectly by federal policy guidelines that required the introduction of equity considerations in federal policymaking (Woolridge and Bilharz 2017).

As critiques of the societal impacts of GIS grappled with the relationship of GIS and democratic values in policymaking impacts (Haque 2001), the field of public participation GIS emerged to extend the application of GIS in policy making to wider range of policy actors (Obermeyer 1998). Today, geospatial data, software and services are ubiquitous and relatively invisible within the policymaking apparatus, because data analysis at different spatial scales is now feasible at the push of a button in a Web browser. Policy makers, advocates for special interests, and members of the public can better understand the local and regional impacts of policies - as the examples in Section 6 demonstrate.

New, critical needs for GIS&T in the public policy process continue to emerge, as exemplified by the recent COVID-19 global pandemic (Wang 2020). For this integration to continue to mature, a need exists to ensure that students of planning, public administration, and management gain fluency in GIS software and geospatial data analytics as part of their academic training (Steif 2022); an education and training gap exists (Obermeyer, et.al 2016) and this is cause for some concern. Similarly, geographic information scientists and geospatial data analysts will benefit from better understanding the policy making process and the types of relationships that may exist between the various policy actors involved.

References

Anderson, J.E. (2015). Public Policymaking: An Introduction, 8th ed. Cengage Learning.

Avtar, R., R. Aggarwal, A. Kharrazi, P. Kumar, and T.A. Kurniawan. (2020). Utilizing geospatial information to implement SDGs and monitor their progress. Environmental Monitoring and Assessment, 192 (1): pp. 1-21.

Bailey, K. (2010). GIS in public policy. In: Encyclopedia of Geography, edited by Barney Warf. Sage Publications: Thousand Oaks, CA, pp. 1308-1311.

Bell, J., M.I. Saunders, J.X. Leon, M. Mills, A. Kythreotis, S. Phinn, P. J. Mumby, C. E. Lovelock, O. Hoegh-Guldberg, and T.H. Morrison. (2014). Maps, laws and planning policy: Working with biophysical and spatial uncertainty in the case of sea level rise, Environmental Science & Policy, Volume 44: 247-257,

Birkland, T.A. (2020). An Introduction to the Policy Process: Theories, Concepts, and Models of Public Policy Making, 5th ed. Routledge.

Calkins, H.W. (1991). GIS and public policy. In: Maguire, D.J., Goodchild, M.F., Rhind D.W. (Eds.), Geographical Information Systems. Volume 2: Applications. Longman Scientific, Essex, pp. 233-245.

Croswell, P. L. (2019). The GIS Management Handbook, 2nd Edition. Frankfort, Kentucky: Kessey-Dewitt Publications.

Fleming, C, ed. (2005). The GIS Guide for Local Government Officials. Redlands, CA: ESRI Press.

Foresman, T. W. (Ed.). (1998). The History of Geographic Information Systems: Perspectives from the Pioneers. Upper Saddle River, NJ: Prentice Hall.

Gerston, L.N. (2010). Public Policy Making: Process and Principles, 3rd ed. Routledge.

Haque, A. (2001). GIS, Public Service, and the Issue of Democratic Governance. Public Administration Review, 61(3): PP. 259-265.

Heuvelink, G.B., P.A. Burrough, and A. Stein. (1989). Propagation of errors in spatial modelling with GIS. International Journal of Geographical Information System, 3(4), pp.303-322.

Huxhold, W. E. (1991). An Introduction to Urban Geographic Information Systems. New York: Oxford University Press.

Huxhold, W. E. & Levinsohn, A. G. (1995). Managing Geographic Information System Projects. Oxford University Press.

Kleinschmidt, I., Kazembe, L., and Morris, N. (2005). Certainty and uncertainty in maps: Why we need errors maps. Epidemiology, 16 (5): p S74.

Knoepfel, P., Larrue, C., Varone, F., and Hill, M. (2011). Public Policy Analysis. Bristol: The Policy Press.

Masser, I., Rajabifard, A. and Williamson, I. (2008). Spatially enabling governments through SDI implementation. International Journal of Geographical Information Science, 22(1), pp.5-20.

O'Malley, M. (2019). Smarter Government: How to Govern for Results in the Information Age. Redlands, CA: ESRI Press.

Obermeyer, N. J. (1998). The Evolution of Public Participation GIS. Cartography and Geographic Information Systems, 25(2), pp. 65-66.

Obermeyer, N. J., & Pinto, J. (2007). Managing Geographic Information Systems, 2nd Edition. New York, NY: Guilford Press.

Obermeyer, N. J., Ramasubramanian, L., and Warnecke, L. (2016). GIS Education in U.S. Public Administration Programs: Preparing the Next Generation of Public Servants, Journal of Public Affairs Education, 22 (2), pp. 249-266

Patton, C.V., Sawicki, D. S., and Clark, J. J. (2013). Basic Methods of Public Policy Analysis and Planning, 3rd edition. Boston: Pearson.

Quinn, B., Schiel, K. and Caruso, G. (2015). Mapping uncertainty from multi-criteria analysis of land development suitability, the case of Howth, Dublin, Journal of Maps, 11:3: pp. 487-495.

Rader, C. P. and Janke, J. D. (1998). Decision-making with conflicting cartographic information: the case of groundwater vulnerability maps. Cartographic Perspectives, 29: pp. 35-47.

Ramasubramanian, L. (2010). Geographic Information Science and Public Participation. Heidelberg: Springer Verlag.

Sieber, R. E., Robinson, P. J., Johnson, P. A., and Corbett, J. M. (2016). Doing public participation on the geospatial web. Annals of the American Association of Geographers, 106(5): pp. 1030-1046.

Spear, M., J. Hall, and R. Wadsworth. (1996). Communication of uncertainty in spatial data to policy makers. In Mowrer, H. T., R.L. Czaplewski, and R.H. Hamre, Eds. Spatial Accuracy Assessment in Natural Resources and Environmental Sciences: Second International Symposium. May 21-23, 1996.

Steif, K. (2022). Public Policy Analytics: Code & Context for Data Science in Government. CRC Press.

Steiner, F., R. Weller, K. M'Closkey, and B. Fleming, eds. (2019). Design with Nature Now. Cambridge, Massachusetts: Lincoln Institute of Land Policy.

Thie, J. (2008). Canadian Geographic Information System (CGIS). In: K.K. Kemp, ed. Encyclopedia of Geographic Information Science. Thousand Oaks, CA: SAGE Publications, Inc.: pp. 18-19.

Vajjhala, S.P. and Nackoney, J. (2008). The New Cartography of Climate Change. Resources, No. 170: pp. 16-19.

Wang, F. (2020). Why public health needs GIS: A methodological overview. Annals of GIS, 26(1): pp.1-12.

Wilbanks, T. J. (1985). Geography and Public Policy at the National Scale. Annals of the Association of American Geographers, 75(1): pp.4-10.

Wissel, B.D., P. J. Van Camp, M. Kouril, C. Weis, T. A. Glauser, P.S. White, I.S. Kohane, and J.W. Dexheimer. (2020). An interactive online dashboard for tracking COVID-19 in U.S. counties, cities, and states in real time. Journal of the American Medical Informatics Association, 27(7): pp. 1121–1125.

Wooldridge, B. and Bilharz, B. (2017). Social Equity: The Fourth Pillar of Public Administration. In: Farazmand A. (eds) Global Encyclopedia of Public Administration, Public Policy, and Governance. Springer, Cham.