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Advancing Health Policy Using a Geographic Approach

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1 Introduction

In 2017, San Diego County, California had the largest Hepatitis A outbreak in the US since the vaccine became available in 1996. Obtaining early measurements on the rapid spread of the disease prompted the county public health officer to declare a local public health emergency for Hepatitis A. This decision helped the county to shed light on an important problem and divert resources to address the concern promptly. Further analysis identified pockets of high-risk populations and prompted strategic interventions like sidewalk sanitation, mobile vaccination teams to reach highest risk people, and placement of handwashing stations in targeted areas of the county. Consideration of place was a key aspect of every decision.

Have you ever stopped to listen for references to place in everyday conversations? If so, you probably realize that words like *location*, *place*, and *where* come up frequently. In fact, the word *place* is the 107th most commonly used word in the English language and *where* is the 110th [1]. There is meaning in that—place matters. It's a part of everything we do and nearly every dataset that we collect and analyse. But despite the ubiquitous

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nature of location in our data and our lives, it is a variable that, in my view, we still under-utilize in health and health policy decisions.

One type of policy decision that is impossible to make without the benefit of location intelligence is the fair distribution of resources. Policymakers may unintentionally miss the critical distinction between fair versus equal distribution of health promoting assets in a community. Without understanding geographic differences in social determinants of health and population needs, leaders may choose to equally distribute diabetes education centres in a community that only has pockets of uncontrolled diabetes, or place senior day-care centres in a grid-like pattern despite certain areas having a predominantly younger demographic. It is far more useful and cost effective to place resources in the areas where people need them (equitable not equal). More importantly, fair and equitable distribution of resources is a key factor in mitigating health inequities and improving population health outcomes. Using geography to make these kinds of policy decisions is both ethical and economical.

How then, do we put geography to use in health policy decisions? Nowadays, technology provides the simplest answer—we use a geographic information system (GIS). A GIS lets us visualize, question, analyse, and interpret data to understand relationships, patterns, and trends [2]. It is a system like any other information system but with the addition of geographic references in the data. But that one simple addition packs a boat load of value.

So, what is the value proposition for GIS in real terms? A location perspective helps us to easily view and interpret vast amounts of data and forces us to think differently about what we're seeing. Those insights improve decision-making, ensuring that we allocate the right resources to the right people in the right places. Employing GIS to target and tailor action plans increases efficiency, accuracy, and productivity, reduces costs, and enhances communication, collaboration, and information access [3].

In the sections that follow, I will review the development of place-based decision-making in health. In *The evolution of geography in health*, I describe the spatial approach to important questions; in *What is where?* I articulate the kinds of questions that GIS can answer; in *Why is it there?* I focus on the decision support that results in *Why do I care?*. To put it all together, I'll step through an example of how we can apply GIS to all aspects of a major health challenge, homelessness. I'll conclude with some advice on how to make GIS happen in your organization so that you too can realize all of the benefits that geography has to offer.

2 The Evolution of Geography in Health

Historical evidence indicates an acknowledgement of the relationship between health and place going back to at least 400 BCE with the Father of Medicine himself, Hippocrates. In his writings, *On Airs, Waters, and Places* [4] Hippocrates begins the treatise with the following:

Whoever wishes to investigate medicine properly, should proceed thus: in the first place to consider the seasons of the year, and what effects each of them produces for they are not at all alike, but differ much from themselves in regard to their changes. Then the winds, the hot and the cold, especially such as are common to all countries, and then such as are peculiar to each locality. We must also consider the qualities of the waters, for as they differ from one another in taste and weight, so also do they differ much in their qualities. In the same manner, when one comes into a city to which he is a stranger, he ought to consider its situation, how it lies as to the winds and the rising of the sun; for its influence is not the same whether it lies to the north or the south, to the rising or the setting sun. These things one ought to consider most attentively.

Later in his writings, Hippocrates described how specific environmental conditions influence health outcomes.

One very *early adopter* exploited the innate relationship between health and place to improve decision-making. The great Persian physician, Al Rhazes (AD 900), was ahead of his time in many ways, but particularly in his spatial thinking skills. It was said that Al Rhazes was asked to site a new hospital in Baghdad. To make a recommendation, he hung slabs of meat in various places around the city. With regular monitoring of putrefaction, he identified the slab of meat that spoiled at the slowest rate. That location, he hypothesized, must have the healthiest ambient environment and thus settled his recommendation [5].

Early contributions notwithstanding, it took nearly 800 years before place and health were sourced together in a map. That map was developed in 1694 and documented quarantine zones for plague in the Bari province of Italy [5, 6]. It seemed to be a real turning point in the history of visualization to improve communication. Over the next 225 years, public health officials used maps to understand and track infectious diseases like yellow fever, cholera, and the 1918 influenza pandemic [6, 7]. Unfortunately, in the early 1900s, such visualizations fell dormant in a period known as the Modern Dark Ages of Visualization [8].

By 1950, three major advances revitalized data visualization. John W. Tukey in the US developed the science of information visualization for statistics, Jacques Bertin in France provided a theoretical foundation for information visualization, drawing on his experience as a cartographer and geographer, and computers made large volume data processing and graphic form development possible [8]. These works underpinned the creation of computerized GIS in 1960 by Roger F. Tomlinson of Canada. The advent of computerized mapping opened a world of potential for decision support and public policy-making. Early applications of GIS in health made use of simple visual representations of disease and health information, like guinea-worm surveillance data in 1993 by the World Health Organization, to support eradication efforts [9].

Today, technological advances in GIS are changing the game. A GIS not only empowers organizations to visualize, analyse, and interpret data, it also handles mobile data collection, real-time analytics, and three-dimensional visualizations to name a few. These advances change the game because GIS moves from a helpful tool in the arsenal to a framework on which entire workflows can run. In other words, the breadth of a GIS platform is now catching up to the ubiquity of location in our lives.

3 What Is Where?

The first step in using geography to drive insight and policy decisions lies in answering the simple question *What is where?* In our daily lives, it's perfectly natural to query where things are located in the world. We tend to ask this question in two ways. The first kind of query is location focused and asks the question such as *What is at...?* Such questions are common to getting to know a place. For example, when we move to a new town, we may wish to know what kinds of local resources and community assets exist in the town. What does the built or natural environment look like in the new neighbourhood? Is the landscape mature? Are there pavements for pedestrians to keep safe from traffic? The second query type answers the conditional question, *Where is it...?* In this case, the question originates from a desire to locate a certain type of feature, like a school or a market. Placing things in geographic space brings them into immediate perspective.

In health geographics, we operationalize *What is where?* by developing and maintaining foundational data resources. These are data resources that become reference materials for analysis or information products. For example, health organizations may collect and update data on infrastructure assets such as

hospital facilities, programme locations, pharmacies, or substance use treatment centres. This is a valuable first step in geo-enabling a health information system. Having a clear picture (i.e. a map) about where key assets exist will not only help direct people to those facilities, but also helps a provider visually determine where potential gaps exist within their network. Consider a disaster situation, having foundational data available in advance makes it possible to quickly guide impacted populations to known shelter locations or to manage the surge on local health-care facilities.

In addition to capital assets, thematic data can also be foundational. That content will, of course, depend entirely upon the organizational mission. For example, a national government initiative on reducing the burden of diabetes may use diabetes prevalence data to map where diabetes exists across the country and visually compare the variation from one place to another, discerning broad patterns in the data (Fig. 15.1).

Comparative views, like those in Fig. 15.1, can highlight stark differences in health status, like the low prevalence of diabetes in Colorado against the very high prevalence in the south-eastern part of the US. We can glean different kinds of information when data contain a temporal component in addition to the spatial variation. In other words, we can answer the question

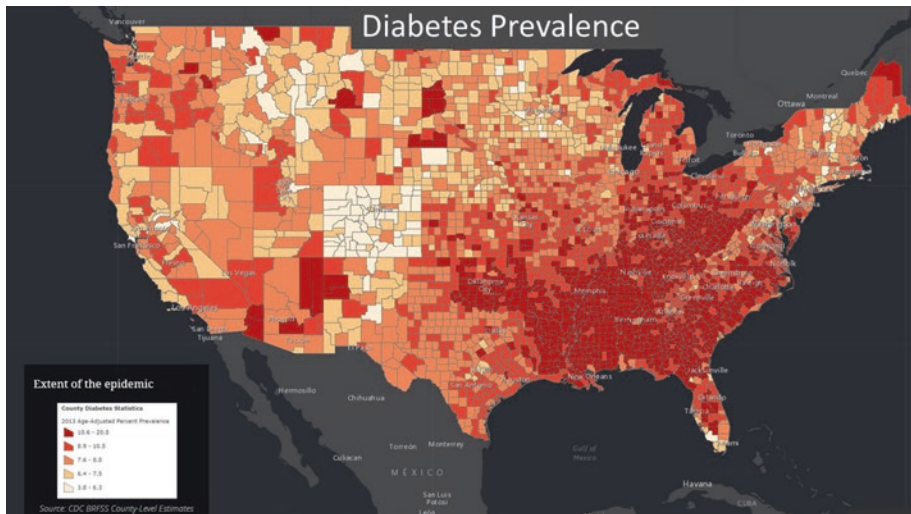


Fig. 15.1 Prevalence of diagnosed diabetes by county in the US, 2013. (Data were accessed from the Centers for Disease Control and Prevention's calculations of prevalence at the county level using both census information and survey responses from the Behavioural Risk Factor Surveillance Survey (BRFSS) [10])

Where are things changing? Understanding spatio-temporal patterns in data has significant policy implications (see Chap. 20). We can use such data in looking forward in time to see if certain patterns are predicting a future problem that may require a larger up-front resource allocation to avoid downstream consequences. On the other hand, examining the historical spatio-temporal variation in a dataset may tell a story about the success or failure of an intervention. I recall a powerful example of this during my tenure at the California Department of Public Health. A colleague created a set of comparative maps showing teen birth rates, by state, across the US in 2000 and in 2010. Calculating the difference between the two maps she produced a third map showing the rate of change for each state. Then governor, Arnold Schwarzenegger, was said to have been quite pleased to share the map highlighting California's significant decrease in the rate of teen births over the decade.

As in traditional statistics, there are some basic spatial statistics that help us to dig just a little deeper into the *What is where?* question. While we observe minima, maxima, means, and standard deviations in traditional datasets, we focus on measuring size, shapes, and spatial distributions and directions in a geographic dataset. For example, we might observe racial segregation/de-segregation over time, the increase in urban sprawl, the spread of infectious disease, or the path of a storm through populated areas. Understanding how things are moving through space and time helps policymakers to anticipate impacts and prepare response activities.

The most effective GIS systems begin with *What is where?* Foundational data needs have been carefully anticipated, collected, and kept updated so that they are ready when either a common or critical use arises. Foundational dataset examples for health include facilities and capital assets, partner locations, demographic data with population characteristics and potential vulnerabilities, and thematic information relevant to the organization's mission. The Ministry of Health and Sports in Myanmar shared its story about how geo-enabling foundational data in its health information system helped it to address Universal Health Coverage in obstetric care as well as respond to unexpected emergencies, like the Chauk earthquake of August 24, 2016 [11]. A GIS system, fuelled with relevant foundational datasets, moves an organization one step closer to creating well-designed information products that help people make better decisions.

4 Why Is It There?

Understanding *What is where?* grounds a decision-maker in the geographic distribution of a theme or concept of interest. That has great power since geographic visualization makes data more compelling, more readable, and engages the viewer at a deeper level. A natural consequence of that engagement is that viewers will begin to recognize patterns in their data and ask questions about them. Are they real? What's causing them? How do those causes or triggers vary over space and time? Ultimately, we need to employ analytics to address questions of why.

Geographic or spatial analysis is different from traditional analytic methods. The difference originates from a basic principle articulated by Waldo Tobler which states: 'Everything is related to everything else, but near things are more related than distant things' [12]. The weather offers a useful example of this idea. The temperature in adjacent towns is likely to be more similar than the weather in distant towns. This idea of relatedness, also known as spatial autocorrelation, is the first law of geography. It is exactly what makes geography worth studying. As a measure, spatial autocorrelation tells us the level of importance of geographic characteristics in affecting a given object, person, or population. Spatial autocorrelation helps us to understand pockets of disparity, varying access to care and clusters of cancer to name a few.

Given the value of spatial autocorrelation in health geographics, it is important to properly account for it in any geographic analysis. At the highest level, we must recognize the implications of relatedness in statistical procedures. A primary consideration is the impact of relatedness on the statistical power of a study. This is key since we require adequate statistical power to ensure that study data can support, with high probability, the appropriate rejection of the null hypothesis when a specific alternative hypothesis is true. In traditional statistics, ensuring power is usually straightforward. Studies are strategically designed so that observations are independent before undergoing testing. However, geographic observations, by their nature, and by Tobler's first law of geography, are related. This means that each observation is not independent and in fact, contributes to power less. More data are always needed to achieve adequate statistical power in a geographic study. This may be inconsequential when the study uses datasets with a plethora of observations, like hourly pollution monitoring from multiple sensors over an area. But the impact could be devastating when studying a rare health condition in a rural area. A second important component of spatial analysis that differs from traditional methods is the actual testing of the level of spatial autocorrelation. There are several

potential measures from Geary's C and Moran's I to the Mantel Test. No matter the test, the idea is to determine the intensity of spatial relatedness in a dataset. High levels of relatedness are called clustering, like when we find evidence of cancer cases proximate to a toxic waste site. Low levels of relatedness can be seen in completely uniform datasets, like arranging pharmacies at the Northeast corner of every block in an area. Accounting for statistical power and the intensity of spatial relatedness lays the groundwork for asking *Why is it there?*

Specific analytic methods for asking why can take many forms. I recommend that policymakers begin with the question needing resolution before deciding on a method of analysis. I know this sounds obvious, but too often, we see examples of data driving the analytic method or the analyst performing their work with the same set of tools with which they are most comfortable. This is so common that we might even call it human nature. However, to achieve the desired impact in making policy decisions, we must always begin with the question and let that drive data collection and analytic methods. In the paragraphs that follow, I will share examples that highlight how different geographic methods are applied to get at key answers.

Sometimes we want answers about how people and places are related. Diving into this analysis provides specifics about what may be nearby or coincident, what is closest, what is visible from a given location, what overlapping relationships exist in space and time, and how many of a thing exist within an area. Practical examples of this kind of analysis include correlations of increased lung or liver cancers in residents living near a sewage plant [13], gravity or choice models looking at the role of geography on patient access to treatment locations [14], and the number of disabled people living within a flood zone. Getting clear on the relationships between people and places provides needed insight for mitigation strategies when health concerns arise.

A second area for which decision-makers need answers is for finding the best location or the best way of getting somewhere. Finding a location or site selection is a common type of geographic analysis. Generally, a decision-maker has a set of criteria in mind befitting an ideal location. For example, a health system manager may decide to open a multi-specialty clinic and will look for a location that is currently under-served, well-populated, in need of specialty services, distant from major competitors, and low on neighbourhood crime. Each criterion in this example can be defined within a range and weighted in importance to determine a final list of compliant sites. The analysis of paths or calculating the best way to get somewhere can range from very simple to very complex. We should not underestimate the value of getting a person from point A to point B. Perhaps that value is easier to grasp when we

consider the consequence of not getting from point A to point B effectively. A 2005 study of 100 US hospitals found that operating room charges averaged \$62/minute (range was \$22 to \$133/minute), so unused operating room time can add up quickly [15]. If simple outdoor and indoor navigation (finding places in hospitals is never easy) could get a patient to the surgery centre on time, then the hospital operating room ceases to lose money and can potentially function at capacity. This is good for both the hospital and the patients waiting to schedule a procedure. Path determination can become more complex as more factors come into play, such as routing to shelters during a hurricane. We must then account for real-time storm information, road closures, traffic patterns, and shelter types (regular vs. special needs). Stronger analytic methods in this instance will significantly improve decision support for the end-user.

Detecting and quantifying patterns comprises the most common of the spatial analytic methods. Techniques in this category include hot spot analysis, cluster and outlier analysis, time trends and feature grouping to name a few. It's critical for decision-making to know if a visualized pattern in the data is real. Analytically, we do this by testing for statistical significance, assessing the biologic plausibility, and observing the effect size. When we confirm significant clusters we can allocate resources to places with the highest need. Dr. Atul Gawande provided a great example in his 2011 article, *The Hot Spotters*, in which he related a story of hospital readmissions in Camden, New Jersey [16]. Hospital readmissions are an expensive problem that also reflects unfavourably on quality of care. Dr. Gawande highlighted how hot spot analysis, performed on a hospital's most expensive patients (those frequently readmitted to the hospital within 30 days of discharge), found that a large number of those patients lived in two of Camden's low-income housing complexes. Further analysis determined that the people in those buildings had difficulty accessing primary care services that would have helped them to manage their chronic diseases and avoid repeated hospitalizations. In the end, placing small primary care offices in the two buildings in question both improved the continuity and quality of care while also cutting hospital readmissions costs by nearly 50 per cent. Knowing the hot spots, determining the underlying causes, and smart resource allocation dramatically improved results.

The final analytic category helping us to understand *Why is it there?* is about making predictions. Many researchers are comfortable with observational studies that make use of historical information to bring new understanding to our collective intelligence. However, decision-makers frequently want to know what's coming next so they can prepare for it. The need for prediction spans all aspects of health. Health systems have a need to do capacity planning

which involves predicting population needs in the geographies they serve. Public health officials need to predict the spread of infectious diseases, whether locally contained, like a food-borne illness, or global like Zika virus, dengue fever, or malaria (Fig. 15.2). Social services departments can use their GIS to predict the areas at highest risk for homelessness (see Sect. 6—*Putting it all together: embedding GIS in a homelessness workflow*). Using geography to make predictions offers the potential to get ahead of health issues—a game changer for any decision-maker.

Although I focused in this section on spatial analysis and its inherent differences compared to traditional statistical analysis, it is important to note that some things remain the same. As we endeavour to understand why things happen, we must always exercise caution in how we present information. We've all heard that statistics can lie. Well, the same is true for maps. It is incumbent upon the GIS analyst to ensure that they use proper cartographic and visualization methods to show results that fairly and correctly answer the question. At the same time, map readers should also develop a fundamental understanding of geographic data presentation. When these things are

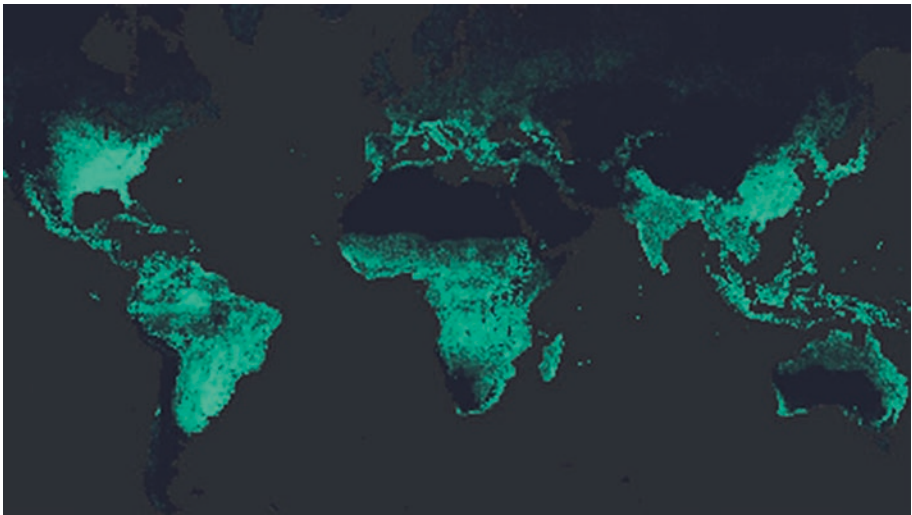


Fig. 15.2 Global map predicting possible locations for *Aedes albopictus* mosquitoes, one of the potential vectors for Zika virus, 2011. (Brighter green areas have the highest probability of being suitable habitats for these vectors based on modelling temperature, precipitation, elevation, and land cover. Data sources were publicly available from WorldClim 2009 (temperature, precipitation, elevation) and ESA 2010 and UCLouvain Team (land cover). The 2011 data on human population density from Oak Ridge National Laboratory's LandScan Database is available to researchers upon request. Additional details on the data sources can be found at [17])

properly achieved, answering *Why is it there?* provides the critical link between raw data and decision-making. For additional information about spatial analysis and specific tests and methods, I recommend the following journals: *Spatial Statistics*, *Spatial and Spatio-temporal Epidemiology* [18], *International Journal of Health Geographics* [19], and *Health and Place* [20] (see also Chap. 20). Readers may be interested in this website which provides several spatial statistics resources such as videos, slideshows, documentation, and hands-on tutorials [21].

5 Why Do I Care?

We might say that we answer the first two questions *What is where?* and *Why is it there?* to get to this last question *Why do I care?*. This is the part of the workflow where all the action takes place, where policy decisions are made, where resources are allocated, and where interventions are targeted and tailored for greatest impact.

We care because, as leaders, it is our responsibility to render the best possible decisions to improve health. Those decisions must be driven by timely and accurate data, sound analytic techniques, and the unique insight offered by geography to address some of the greatest health challenges of our day. The social determinants of health, the opioid crisis, tobacco use, and universal health coverage all serve as compelling use cases for a geographically based approach. And as such, GIS can have a profound effect on the way an organization functions and the confidence with which it makes decisions. Health decisions are often critical. For example, the World Health Organization's polio eradication programme used GIS tools to address the polio outbreak in Syria and Iraq in late 2013 and early 2014. Real-time data collection helped them to identify gaps of unvaccinated children and intervene to prevent the spread of this disabling and sometimes fatal disease [22].

Not only is a GIS an indispensable tool for evidence-based decisions, but it also promotes policy initiatives in transparency and engagement. The Northern Kentucky Health Department provides a great example. In an interactive story map, the department explains how it has educated the population about the severity of local opioid abuse usage and its sequelae, shared the resources available to the community, and showed how the department and other local organizations are responding to tackle the crisis. Over 15,000 people have engaged with the story map to date [23].

6 Putting It All Together: Embedding GIS in a Homelessness Workflow

To fully grasp the power of a geographic approach, it can be helpful to bring multiple GIS capabilities together to address an entire workflow. Homelessness is a health and social concern in many places around the world. In fact, in some cases, homelessness is syndemic with other health concerns which only increases the urgency for strategies to address it. For example, homelessness and opioid abuse may synergistically exacerbate one another in a community. A spatial perspective, using GIS, can shed new light on this issue and offer evidence-based approaches for interventions. In what follows, I describe how we can apply GIS to every step of the workflow aimed at mitigating homelessness.

We may want to start by identifying where people experiencing homelessness are located in our communities. In some places, this is a requirement—a regular count of sheltered or unsheltered homeless individuals. Mobile GIS tools can be deployed on tablets or smartphones to conduct surveys that gather important information on the homeless like location, basic demographic data, and duration of homelessness. Understanding where homeless people are supports targeted allocation of resources. Fortunately, given the state of the technology, some kinds of interventions and resource allocations can be initiated in real time. For example, a jurisdiction may set a goal to ensure that children under the age of 18 years do not spend another night on the street once they are known. A real-time GIS makes this possible. The moment a location-enabled homeless survey is submitted from the field with demographic information indicating a person under the age of 18 years, an alert could be triggered to immediately deploy resources to the child's location.

Analysis or asking why people in certain areas are experiencing homelessness is needed to identify risk factors. Taking an evidence-based approach, we may bring in data on unemployment rates, poverty rates, lack of health insurance, and lack of affordable housing. Other datasets may be relevant depending on the specific geography. Whatever our identified risk factors are, we can combine them through map overlay or by creating an index of risk that will not only explain why we are seeing homeless people (per our mobile GIS count) in certain areas, but will also help us to predict high-risk areas for prevention strategies.

The next steps in our workflow are about taking action. The first action is deceptively simple—connecting people with the health promoting resources they need. Most health organizations have endless lists of resources for the populations they serve, but it's a challenge to identify and select the right resource for a person given their location. That becomes especially difficult if

the population is transient. GIS can help by integrating all relevant programmes, community partners, and services in a location-aware app. Previous research indicates that, in the US, among homeless youth alone, more than 60 per cent own a cellular phone and many consider it as important to their survival as food [24]. Making resource information accessible through a mobile app, helping users find and navigate to the nearest resource given their current location empowers and connects people. And by the way, the policymaker can examine the same set of integrated and mapped resources to expose potential gaps in the network and take steps to fill them.

A second action that GIS supports in this homelessness workflow use case is in the long-term planning of affordable housing units for areas deemed to be high risk for homelessness. This represents a site selection scenario much like the multi-specialty clinic example discussed in the *Why is it there?* section. In this case, the difference is in the criteria needed to find the best places. It is likely that in addition to planning for affordable housing in areas proximate to high-risk areas, city planners would also want to consider areas near employment opportunities with access to public transportation, health care, and social services that can provide a safety net and prevent future families from the tragedy of homelessness.

Perhaps one of the most overlooked applications of GIS is operational efficiency. While there are multiple potential ways to streamline our work, one that relates to this scenario is the real-time monitoring of field workers. In the case of surveying homeless people, scads of volunteers are usually recruited. It can be a logistical nightmare to ensure everyone's safety, avoid duplicate coverage of areas, and coordinate activities. A modern GIS can assist by tracking devices, defining territories, communicating assignments, and observing activity levels to name a few. Keeping field workers safe and productive is a top priority in any organization.

Our workflow thus far has included gathering and analysing data, conducting interventions, and ensuring operational efficiency. The last two pieces of the homelessness workflow include stakeholder communication and evaluation of impact. It has already been suggested that maps are engaging. That trait is very useful in delivering public information, whether it's to simply share information about the extent of homelessness and the actions being taken or to proactively reach out and offer education to at risk communities. When it comes to assessing impact, spatial and temporal analytics can reveal before and after effects by place, compare results to goals or national averages, and provide evidence of future adjustments. A modern GIS is more than a map, it is a value-based approach to an entire workflow that offers a range of benefits and insights not available elsewhere.

7 Making It Happen

At this point, I hope that you share my conviction that GIS offers powerful value with a rich infrastructure and sophisticated analytic capabilities integrated in a platform that supports numerous tools and apps to get work done. The question remaining now is how to realize this value in your organization.

The first consideration for most organizations will be the price tag associated with purchasing software. There are many choices available to fit the needs of any health unit. The range of costs, however, is broad (from open source to vendor-based solutions), making choices more complicated. For that reason, multiple factors will enter in to a buying decision. What features and functions are essential to address the organizational need? How many people will use the system initially and what are their training needs? Will the system scale and expand as the business needs grow? Are developers required to write applications and ensure interoperability or is the system configurable and ready to go? Will this be a desktop solution or an enterprise solution? Does the organization want to manage the infrastructure (i.e. servers) or work in a cloud-based environment? Are prospective users of the system dealing with protected health information? How quickly can the system be implemented and used to create value? What kind of support needs are anticipated as the organization adjusts its workflows to leverage geography? Each of these questions will reframe the idea of *cost* in a way that helps you make the best choice for your unique situation. I'll explore these in more detail in the paragraphs that follow.

The fact of the matter is—it's not just about the software. Before the first tool is downloaded, I would suggest that the astute organization would begin with developing a location strategy. This means that people within the organization have taken the time to assess whether the geographic perspective will add value to their mission and they envision the specific value-based outcomes they plan to achieve. In fact, the expected value of the system should be greater than the cost of purchasing and implementing the system.

Once the location strategy has begun and initial outcomes are defined, then an organization should consider the other resources they'll need. The biggest investment in resources is generally in the human capital required to run the system, collect and organize data, run analytics, and evaluate progress. Investments should be made in proper training as well as change management to ensure that organization's success in implementing its new GIS programme. A 2011 study from IDC (International Data Corporation), a global advisory firm in information technology, found that a 6.25 per cent project budget dedicated to training led to an 80 per cent success rate for the project as com-

pared to a 4.75 per cent training investment resulting in only a 50 per cent chance of success [25]. It's also worth remembering that training is not always the same for every user. Depending on the role of the GIS user, they may need relatively simple skill development, like when using mobile survey tools, whereas the GIS analyst, performing statistical procedures on data, will need longer and deeper training.

Finally, you should determine the technology needs and deployment methods. Whatever GIS technology they use, purchasers should look for extensibility, scalability, and whichever features and functions are required for planned activities. Nowadays, interoperability is critical to technological efficiency, and should be a requirement imposed on any GIS software vendor before signing on the dotted line. Organizations should not have to write programmes to connect one technology to another.

There are several deployment options for a GIS platform system. A simple yet powerful approach is to use an online GIS, engaging in a software as a service (SaaS) model. In this model, the organization does not need to host the infrastructure to support an enterprise system, but can extract all of the value through the cloud. Some health-related organizations, however, may be unable to use or opposed to cloud-based models. One reason may be the need to pay for annual licencing of the services. This should be balanced against the costs of internal infrastructure over time. In most instances, however, the opposition to a cloud-based system is related to concerns about unintentional breaches of protected health information. Those organizations may prefer an enterprise deployment, on premises, and within firewalls. Between these two options is a hybrid approach that leverages the advantages of each method. An organization should consider which approach offers it the flexibility and security needed for its proposed usage.

Any organization that chooses to take advantage of the benefits of GIS for advancing its health agenda should also take the time to develop and systematize governance procedures. This effort will help to align staff on the policies surrounding the use of geographic data and keep the system humming.

8 Conclusion

Whether your goal is to improve access to your health services, stem the spread of infectious diseases, or systematically turn the tide on longstanding health problems, a GIS can positively change and improve how you do your work. Everything happens somewhere—don't let that ubiquitous data element go to waste!

Key Messages

- The importance of place and health has been recognized for more than 2,400 years.
- Understanding where things are in space offers insights for decision-making.
- Spatial analytics differ from traditional statistics in important ways.
- GIS for health policy promotes better decision-making, resource allocation, transparency, and constituent engagement.
- Deploying a GIS system is about much more than software.

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