Harm Reduction Using GIS

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Introduction

There is a large amount of analysis using Geographic Information Systems (GIS) in environmental fields such as natural resource management or wildlife preservation. I am a statistician with a background in psychology and sociology, and I work primarily with government (or similar) data concerning a variety of political, social, and economic factors about people and communities. As animals and extremely impactful members of nature, people too interact with the spatial aspects of where they live, and I will propose ways to model this interaction with the infrastructure and environment.

Specifically, in this proposal I address the use of GIS in harm reduction organizations. This heavily involves dealing with people who use drugs, and patterns of use vary across states and even cities. Since I have been working with an organization here in Tucson, my proposal will be most useful in Pima County and similar locations. This is not an argument of the merits of such a style of drug treatment, but rather how the technologies available through GIS would serve the goals of such an organization. Any discussion of the theory behind its use is purely so the reader can understand some reasoning better. Because much of the data I work with in this organization is confidential, I propose a generalizable database model, and refer to the harm reduction group as "an organization" or similar.

While still controversial in some areas, in the last 20-30 years harm reduction has increased in popularity as a method of community-wide drug treatment, even becoming

the basis of Canada's Drug Strategy (Single, 1995). There are many interpretations on what the phrase "harm reduction" entails, but at its core it is a method of reducing risk in a community by encouraging practical rather than idealistic goals such as zero-tolerance abstinence. This involves providing clean equipment, access to care, resources for overdose, and education on the potential risks of drugs. Centers for distributions of these materials are becoming more common, and my proposal will be for these organizations' benefit in distributing materials effectively.

Problem Statement

Because there is mixed support for this kind of approach to drug treatment, the funding and available resources are not often in surplus. Also, many of the people that would benefit the most from this care are not easily accessible and do not reach out because of the heavy stigma around the topic and looming threat of the criminal justice system. Therefore, an efficient system for the distribution of supplies is crucial. These organizations need to know

1. The locations of overdoses, so they can predict the places most likely to need help
2. Areas where drugs are commonly used, both for education and for providing clean resources
3. The areas in which different drugs are popular, which need different responses
4. The locations of volunteers and employees
5. General population characteristics to set up community outreach and testing stations

All of these things change with relative frequency, so in response I propose a way to organize information, provide access for various parties, and provide methods of analyzing

that information to reduce the most risk among the community while ensuring people's safety.

The goal of this organization is not to stop the use of drugs, but rather to help people reduce risk if they choose to use drugs, and to support them in their goals. Therefore, the desired locations to put in the database are not the locations where drugs are sold but rather where drugs are commonly used, which is not always the same (Freisthler 2005).

Application of the Technology

Problems like these arise frequently in any application—the need to draw conclusions from spatial information. Especially when dealing with humans and community interactions, it is extremely important to have the capability to update the information to reflect their quickly changing status. With GIS technology, we can create many different layers of information and easily update it without the need for detailed computational knowledge. One does not even need to know anything about GIS to use web apps created from geodatabases, making its use in small organizations such as these harm reduction groups so helpful because it negates the need for technical training in order to use its features.

From the list of five needs in the previous problem statement, there are clear GIS applications to address them. In a program such as ArcGIS, spatial data can be stored as different layers to serve different purposes, and then exported to web applications for employees or volunteers to use in outreach to collect data. With this data, analytical models can be created to predict locations of high need. Any changes in drug use patterns or volunteer density are noted in this software, and this information can be accessed instantaneously.

Database Analytical Requirements

To hold information, this database would require at least one geodatabase to hold feature classes and datasets created by the organization, and for analysis purposes it would likely be helpful to include information about population density, urban infrastructure, and homelessness locations from the local government (in this case Pima County). Much of this is publicly available information.

To make predictions, the database needs to have capabilities to create probabilistic models. This can either be the ability to implement a logistic regression for classification, or any parametric or non-parametric model to predict outcome values. In ArcGIS, you can implement parametric models by using the *Raster Calculator* tool. This software also has the capability to implement IDW or cubic-spline models (spatial analyst tools) if non-parametric models are desired for a tighter output.

Tables can be used to store information that is not necessary or is redundant to be in the feature classes. For volunteer outreach, a raster of high-density drug use places can be created and classified using the *Con* tool, and each volunteer's distance to these areas can be calculated to minimize the burden and required distance for them.

Other landscape information tools (such as climate, slope, and UV intensity) will also be useful. Part of risk reduction includes making sure that harmful weather conditions, which affect unhoused and poor people significantly more (McKernan, et al. 2008), and being able to map out these will help the organization respond quickly.

For functional use, the ability to query people based on their past affiliation with the organization is necessary. Also, to update data, employees and volunteers likely need

access to an online web application. This would simplify the process and ensure that no one accidentally or purposefully changes significant data in a harmful way.

Lastly, there is useful demographic information available through most local governments, but this database would be beneficial because much of the work that these organizations do involves private information that people might not be willing to give a government agency. Whether because of fear of the authority or past harmful experiences, many of the people these organizations serve would prefer a private database not accessible by authorities.

Database Visualization Requirements

Visualization is an extremely important aspect of any geographic product, usually in the form of maps or graphs. In this example, most of the visuals are for the organizer, but outward-facing maps are important for outreach and information dispersion. In each section below I describe a visualization product, its creation, access, and purpose.

Mapping urgent need

For mostly the organizers, this is perhaps the most important product necessary for the goals of this proposal. “Need” involves many factors, including spatial, temporal, and severity information. A raster can be created using various input parameters, as in a regression, to take into account the following:

1. The geographic grouping of points such as overdose locations
2. The change over time and recency of overdose events
3. The health impact and type of event (drug type, etc.)

4. Distance and accessibility to care
5. Amount of help previously offered at these locations

These factors combined can create a map of current need areas so that the organizers can send out supplies to the most necessary locations. This raster can be created using Raster Calculator with parameters and weights either manually set or calculated using a regression model. This map can be housed in ArcGIS itself, because the information is private, and the information in this map is not publicly available. The person who needs this map would likely also need to use ArcGIS for other tasks and knows how to use it.

Mapping locations of drug areas

Knowing simply the locations of need does not tell the organizer which type of aid to send. Combining some of the information in the previous map into a new map which classifies cells into common problems, such as overdose from certain drug types or virus transmission from sharing needles. This can be viewed as a classification problem that can be solved by logistic regression or decision trees, depending on the type of statistical analysis the organizer desires to use for the specific issue. This would provide not only areas of need but also the type of issue that occurs in those places, so that the organization can respond with an appropriate set of resources.

Mapping volunteer activity

An organization of this nature is only as effective as the people who are helping facilitate, and knowing their locations can make sure any offered labor is not wasted. Having a basemap of the city with points where the volunteers say they are from or live near would help set up events that do not require long travel, which is difficult for a lot of people.

Additionally, if there are many volunteers from a certain region, setting up recruiting stations near there might have more success than picking a random park.

Mapping urban infrastructure

This is an example of an extremely helpful outward-facing product, as information about transportation, healthcare (including mental health), community spaces, and other resources is an extremely effective way to reduce risk in the community (Chan, et al. 2014). This information can be found using publicly available maps, and using ArcGIS online, the organization can create a web application with filters so people can access the sort of information they need. This can include updates on free services (transportation), information about unemployment and housing, and options for health care.

Finding community

These products together allow for the effective distribution of resources as well as providing people with information about people and help near them that they can access themselves. This reduces the potential for harm by both providing clean equipment for drug use as well as providing a sense of community for people who view the products (Chan, et al. 2014).

Data Archive and Integration Requirements

Like described before, some aspects of this database design are meant to be accessed internally, and some externally through web applications. Because most of this data is not entirely for public viewing, large effort into hosting capabilities probably is not necessary. However, documentation of the data structure, outgoing maps, online elements, and details

on how to update information is crucial, and backups of the data are recommended (with version control). Data dictionaries will be created to hold this information.

A difficult part of implementation will likely be in incorporating the data from local governments, as this type of data is prone to be missing or full of errors. Most of this information can be hosted in its own maps and geodatabases, however, limiting the need to ensure compatibility between internal and external data sources. To make sure that the internally created data is consistent, restraints such as datatype restrictions and coded value/range domains will be created for some of the variables, so volunteer input does not negatively affect the analyses.

Maps, geodatabases, and web apps will all be stored as part of this database design.

Database Specification

I describe the data structure split into internal, external, and output categories based on the origin of the information and its use. The ArcGIS data structure is provided for each.

Internal

Overdose sites is a point feature class that contains much of the information used in the analysis and map creation. Data will be acquired from volunteers providing aid or self-reporting that people learn about from community outreach.

Overdose ID*	Integer
Date	Date
Severity Scale	Integer range domain 1-10
Drug Used	Coded value domain (with other listed)
Drug Name if Other	Short text, optional
Using alone?	Y/N coded value domain

Have access to clean materials?	Y/N coded value domain
Receive naloxone/other medical care?	Y/N coded value domain

Volunteer locations is also a point feature class. There is a lot of information that could go in this table, but I do not include it here as it is not relevant to this geographic analysis. It is basically a roster with spatial data.

Volunteer ID*	Integer
Start Date	Date
Trainings completed	Y/N coded value domain
Hours volunteered	Integer
Any other necessary volunteer information, which is unnecessary here	

Resource distributions is a point feature class as well, which includes time, resources, and amounts given at certain points in the community. This is used to model cites of frequent need as well as tracking for organizational purposes.

Distribution ID*	Integer
Date	Date
Resource given	Coded value domain
Amount	Integer
Units	Short text, optional

External

Hospitals/care centers can be either a point feature class or a polygon, depending on how the facilities are to be represented. For the purposes of analysis, only a single distance is required, so I recommend a point feature class unless public data is already given as a polygon.

Center ID*	Integer
Care offered	Coded value domain
Insurance Information	Short text

Transportation is a line feature class, which can be represented as routes. This would allow people to find the places they can go with certain bus, tram, or other routes of public transportation.

Distribution ID*	Integer
Cost	Integer
Run time	Short text
Interval (minutes)	Integer

Output (Maps)

The output maps described above contain all the necessary detail, but repeated here are their data structures for the sake of completeness:

Need map	Raster with calculated need metric as values
Drug map	Raster with drug classification as values
Volunteer Map	City basemap with volunteer points visualized
Infrastructure Map	City basemap with transportation routes and care centers visualized

Online resources

Using ArcGIS online, the previously described infrastructure map is made publicly available. Also, web apps are created so that volunteers can report incidents and the data be sent back to the original datasets. These can be edited and used by people who do not have any training with GIS.

Conclusion

Community care is an extremely difficult logistical task, especially with limited funding, public availability, and worker hours. However, with technology such as GIS, the limited resources a harm reduction organization do have can be efficiently distributed in order to care for the most amount of people. The instantaneous updating of web apps along with the ability to spatially model need data will greatly increase the effectiveness of the desired risk reduction, education, and community building.

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