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Public Health Preparedness: A Geographic Approach

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Public Health Preparedness: A Geographic Approach

Executive Summary

Safeguarding public health and providing protection against health-related threats are responsibilities that fall directly on the shoulders of public health preparedness professionals. These individuals, the agencies they work for, and their partners generate volumes of data in a variety of systems. Integrating these disparate data types into one comprehensive view so that it is accessible to all stakeholders is a challenge. Location is often the only data feature that's common among these different systems. Geographic information system (GIS) technology provides a framework to bring different types of location information together and combine them on a map. The map makes the data easier to understand and to plan a course of action.

Public health staff use GIS toolsets to visualize all types of information. Some tools connect different data types. Other tools expose data relationships and patterns that are impossible or difficult to see by using traditional tabular data methods. GIS produces intelligent maps that show where a disease outbreak is occurring and predict where it might occur next. By turning data into intelligence, GIS gives preparedness professionals the situational awareness they need to respond to an emergency efficiently and effectively.

Esri, the global market leader in GIS, offers the most powerful mapping and spatial analytics technology available. Esri provides a suite of tools and capabilities that help public health departments build, promote, and sustain healthy communities. Each day, health professionals face complex challenges ranging from disease outbreaks to natural disasters. Esri uniquely supports public health preparedness through its software, services, and expertise. Agencies around the world successfully deploy Esri® solutions for all types of emergencies, enabling them to use high-powered location analytics and visualizations to build a foundation of preparedness. These solutions will help your team make better decisions during a crisis.

Introduction

Today's toughest challenges have one thing in common: location. When disaster strikes, you need to locate health services, responders, and victims so that you can save lives, resources, and critical infrastructure. Increasingly, successful organizations around the world use location information and analysis for disaster preparedness, mitigation, response, and recovery operations. When data is connected to location, it becomes more valuable because you can see it in a geographic context. GIS manages "geodata" in a powerful record management system. GIS also processes and integrates data, generates maps, automates workflows, and shares outcomes in a platform that others can also use. GIS transforms organizational data into insight that helps managers differentiate their agency and add new value to services.

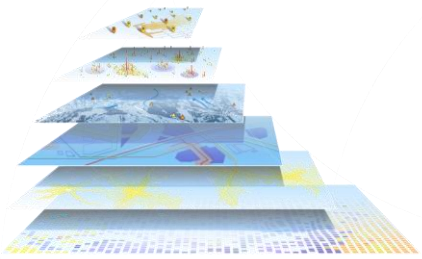

Figure 1. Integrate location-based data layers to see relationships.

The Value of a Location Strategy for Public Health Preparedness

To make the most of location information, your organization needs a location strategy. A location strategy comprises both a philosophy and a plan. Foremost, it's a commitment to proactively use location as a frame of reference for monitoring, measuring, and analyzing the health of a population. Use maps and spatial analysis to effectively place your people, resources, and capabilities where they are needed most.

Demographic statistics in a spreadsheet are cumbersome to use. But if location and time are included in the data, you can use GIS to map it so it is easy to integrate and understand. For instance, you can see the location and timeline of a flu epidemic and determine where best to place inoculation centers based on the need. A location strategy linked to your data brings that data to life, enabling administrators to visualize the impact of their plans.

Figure 1. Assess vulnerable populations

A demographic map helps you take preemptive action. Use it to identify at-risk and socially vulnerable populations and see where they live. Such knowledge allows you to plan and design a strategy that assists people with special needs or who lack access to transportation. You can more easily see the most effective evacuation routes. If GIS is included in a response strategy, responders will have the information they need to act quickly and make life-saving decisions.

Challenges in Delivering on the Mission

Public health preparedness planners have a challenging mission: to ensure safer, more resilient communities that are better prepared in the face of constant threats, whether from natural, accidental, or intentional origins. Insightful planning and mitigation activities deployed prior to a disaster improve response during the disaster and expedite the recovery process. Planning and coordinating emergency response and recovery strategies place a tremendous responsibility on agencies to make the best decisions under difficult circumstances. Modern technology delivers invaluable results when agencies combine the right tools with a clear disaster management strategy deployed ahead of, during, and after a crisis. This paper will explain how a location strategy can transform your public health preparedness plans. It will help you rapidly discover, visualize, and analyze critical information and share it across your organization and with partner agencies. A location strategy will make you more agile in the face of evolving threats.

Public health preparedness programs exist to maximize health security and minimize negative health consequences when emergencies arise. These programs' responsibilities encompass six key preparedness domains: community resilience, incident management, information management, countermeasures and mitigation, surge management, and biosurveillance. In each domain, agencies need timely and comprehensive situational awareness. Beyond that, the programs must coordinate with other entities, such as Health Care Coalitions (HCCs), and share information across departments, among agencies, and with the public.

GIS enables public health leaders to quantify risk. It is a platform for managing collaborative response efforts and optimizing resource allocation. GIS delivers intelligent situational awareness.

Applying the ArcGIS Platform to Public Health Preparedness Domains

Each domain is associated with several core public health preparedness capabilities. The ArcGIS® platform supports work in every domain, making workflows more efficient, more effective, and adaptable to the situation at hand.

Figure 3. The Centers for Disease Control and Prevention (CDC) has identified six key preparedness domains.

Information Management: Public health preparedness relies on a considerable amount of data that drives analysis, helps inform decision-makers, and supports emergency public information and warning systems. Creating, editing, and managing this data are foundational capabilities of the ArcGIS platform. Data comes from many sources (spreadsheets, web services, business systems, etc.) and can quickly overwhelm decision-makers. However, integrating data by geography uncovers patterns so that geoenabled tabular data tells a story that supports decision-making.

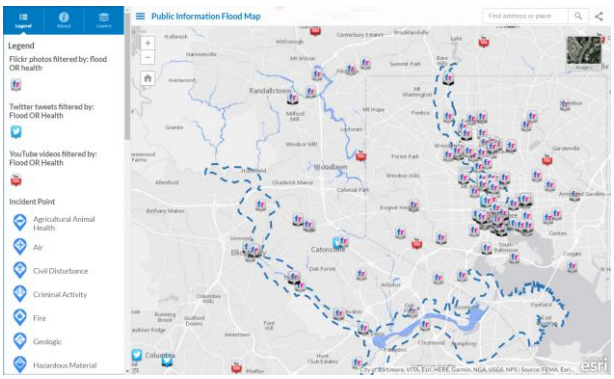

Figure 4. This public information flood map includes social media updates.

Once personnel capture data, they feed it into analytic models. Outputs are intelligent maps and applications, which provide insight into how a threat or emergency event is unfolding. GIS also creates scenarios that virtually show how a decision might impact an organization or a community. But data management is not just about consumption.

Use the GIS data management system to share relevant and authoritative data and information products with organizational partners. This ability to exchange information is vital for communication and critical for response.

ArcGIS drives a geographic approach to public health preparedness. This robust platform delivers sound data management and data sharing capabilities that reach across disciplines, jurisdictions, and HCCs. It opens the door for collaboration. Integrate ArcGIS with existing applications, such as incident management and disease surveillance systems, to build collaboration and cooperation between all stakeholders.

Incident Management: To create situational awareness, organizations typically manage and merge their disparate data within a common operating picture (COP). They then make situational data available through a web-based viewer. Unfortunately, these viewers are often cluttered with unnecessary datasets and tools, which make it difficult to understand the data. Moreover, regardless of individual users' roles in an organization, they all use the same COP. Everyone is seeing all the data rather than just the data they need.

Figure 5. Emergency Operations Center

ArcGIS improves the way content is delivered by allowing information to flow across the organization in a more purposeful and concise manner. The administrator tailors mission-specific situational awareness maps and applications to team members' roles. The administrator can also design apps for interacting with the situational data that accommodates different levels of user requirements, skills, and expertise. Each person accesses a user-friendly application; thus, customized web applications give responders the right tool for the right task during emergency operations.

Countermeasures and Mitigation: When incidents occur, crisis managers need to quickly gauge and locate public health and medical resources for their community. They must make real-time decisions that ensure their supply chain can deliver critical resources where and when they are needed. Crisis managers also make sure that pharmaceutical and nonpharmaceutical interventions are available at the right place and time. Moreover, they oversee responders' safety and health.

Figure 6. A situational awareness viewer shows infrastructure, severe weather conditions, and impacted populations.

Crisis managers use ArcGIS to quickly assess and accurately locate impacted populations, responders, equipment, volunteers, and supplies. They can also see if those locations are in the path of severe weather events and if their evacuation routes are at risk. ArcGIS real-time data maps help crisis managers take control of the situation, make decisions quickly, and protect lives.

Surge Management: Location is vital to command center operations. Staff need current information for managing activities. Intelligent maps show the most recent data about shelter capacity, alternate care locations, and facility evacuations. Citizens can access web applications to see where they can reconnect with their

families. Team members also use mobile web applications to coordinate volunteer activities.

An important part of preparedness is the backup plan should primary services be overwhelmed or incapacitated. The redundancy plan (commonly known as plan B) locates an alternate emergency operations command center. A surge in patient care needs may require another hospital, backup services, and additional personnel to step in. During a crisis, a real-time map shows the capacity of backup health facilities should they be needed.

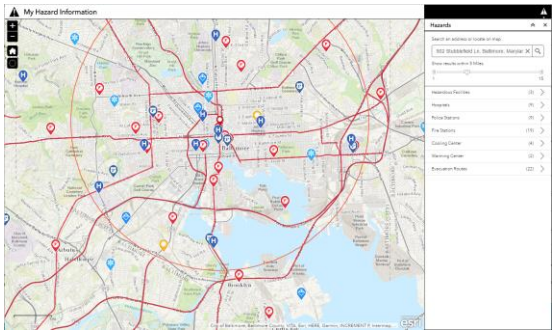

Figure 7. This map shows emergency shelter locations and color-coded icons that indicate bed availability.

Preparedness plan collaborators can test their ideas by using GIS to model various scenarios, such as unusually high patient populations. A resources map shows where critical resource gaps exist and where mitigation strategies must be developed. By having this information in a GIS in advance, crisis managers can quickly inform the public about alternate site locations, capacity, and directions in the event they're needed.

Figure 8. This analytics dashboard provides real-time situational awareness.

Biosurveillance: The path to resiliency is paved with awareness. A community needs to understand its vulnerabilities and risk. A jurisdictional vulnerability review helps preparedness managers identify critical infrastructure, such as health facilities and regional health care resources, and vulnerable populations, such as children, seniors, and individuals with special needs. Managers need to locate and understand where natural or biological hazards could impact the community, and determine the vulnerability of nearby people and assets. GIS helps preparedness planners select mitigation priorities, develop comprehensive response plans, and test the impact of different types of situations. While building a comprehensive awareness plan for the community, public health preparedness managers are also building a foundation for communities to be more resilient and recover from disasters faster.

Outreach and Communication

During a crisis, two-way communication with the public is critical. Agencies can post web maps and share their current plans, activities, and locations of health care facilities. These live web maps are subsets of larger operational datasets that the agency has approved for release. Interactive maps are intuitive so that citizens can easily access the information that matters to them. They can find shelter or health care locations as well as screening and disease intervention sites. They can see point-of-dispensing (POD) locations where they can get critical medicines.

Conversely, citizens can offer valuable insight that improves situational awareness. An agency can configure mapping applications that help citizens report information that the agency can add to its GIS database. With the capability to tap social media feeds such as Twitter, YouTube, and Flickr, GIS maps posts in real time, which provides additional context for and insight into the events that impact public health.

Esri has pulled together public health preparedness GIS tools and capabilities to help agencies kick-start their GIS-enabled preparedness program. The ArcGIS platform makes authoritative data easy to access and use across departments, agencies, and organizations. It allows teams to work together during the preparation, response, and recovery phases of any health-related event.

Vision for a Resilient Future

Disasters and epidemics are inevitable. For a community to be resilient in the aftermath of such events, it must prepare itself before adversity strikes. Administrators need to know where their city's weaknesses and strengths lie. They must develop an intelligent location-based plan that mitigates risk and helps the community quickly recover from disaster.

Use GIS to assess jurisdictional vulnerability such as deteriorating facilities and inadequate regional health care resources. Know where vulnerable populations—such as children, seniors, and individuals with special needs—live.

Public health officials also need to know the location and risk potential of natural or biological hazards and their proximity to vulnerable assets and neighborhoods. A risk map helps planners test the impact of different crisis situations, select mitigation priorities, and develop comprehensive response plans. Maps that integrate structural, population, and health services data vulnerability analysis and comprehensive preparedness plan data give public health preparedness professionals a solid foundation on which to build resilient communities.

In the past, responders used paper maps to try to make sense of a situation. These maps lacked continuity, contained questionable information, and showed what happened in the field no more recently than the previous day. With a common operating picture enabled through ArcGIS, crisis managers can now make timely decisions. All responders—whether in the emergency operations center or working in the field—use a common, updated map. Everyone has the latest incident reports and resource updates such as bed counts, available shelters, and asset locations. Managers have a real-time perspective that helps them effectively direct first responders and volunteers.

Agencies rely on one platform to house tabular and geographic data and feed dashboard updates. The same system models data and predicts the direction of emergent situations. A central platform reduces system sprawl and complexity while saving time and freeing up financial, technical, and operational resources to manage a crisis.

The Esri ArcGIS platform grows with your organization. It automatically scales to meet demands. Because it is a proven, robust system, you don't need to worry about system reliability and scalability during an event. The entire suite of ArcGIS apps is always available to ensure that you can quickly configure the right app to meet the needs of new or evolving workflows.

The ArcGIS Platform

Esri builds the world's leading mapping and analytics platform. It has designed ArcGIS to combine the science of geography with powerful computer, communication, and visualization technology to help you make more intelligent decisions. Use maps and spatial reasoning to explore data in new ways and gain a deeper understanding of any problem or situation. You can then share this insight and collaborate with others through web maps and apps.

Figure 9. The ArcGIS platform is for desktop, web-connected, and mobile users.

The ArcGIS platform connects responders to a common operational picture of shared information, including real-time data. The incident command center is better equipped to allocate resources and direct operations. Meanwhile, responders have the GIS tools they need in the field to report the status of events threatening health security. Using mobile GIS, they can document events on the ground and store the data for later analysis. With mobile devices and easy-to-use apps, staff have the intelligence support they need to complete tasks ranging from simple to complex—anytime and anywhere.

GIS Location Strategy for Public Health Preparedness

All epidemics, disasters, and health threats are connected to location. For this reason, public health agencies need to define and use a location strategy. Here are some essential directives for an effective strategy.

- **Collect and manage data.** Securely access, manage, and integrate data across your organization. ArcGIS lets you work with information stored in enterprise systems and databases; data collected on mobile devices in the field, such as post-incident surveys; and crowdsourced data from citizens reporting on health issues. Combine that data with content from Esri's massive collection of data and maps. By bringing all this information together, ArcGIS helps you take full advantage of your data so that you can make better decisions. For instance, use ArcGIS to gather photos and updates from your vector control team in the field, view them at headquarters in real time, and analyze vector-borne disease hot spots.

- **Perform spatial analysis.** Use location analytics to answer any question and inform any decision in which location is a factor. ArcGIS includes hundreds of spatial analysis tools that help you derive actionable insight from your data. For example, ArcGIS helps you allocate resources and personnel more efficiently during an exercise or a real outbreak, prepare for critical events and mitigate risks, and manage mass care during a medical surge. Cities around the world are using ArcGIS to plan smart initiatives for healthy communities.

Figure 10. Zika Risk Map

- **Use maps anywhere—** Maps let you spot spatial patterns in your data. This helps you see where and how to act, which is critical in the response and recovery phase of any incident or situation that impacts the health and well-being of the communities you serve. Because maps provide a common visual language for all kinds of data, they help you break down barriers to information sharing, communication, and collaboration. This will help you get critical information out to the public in the most efficient and effective manner. ArcGIS lets you create, use, and share data-driven maps anywhere, anytime, and on any device. During an event, having the ability to use maps in the field can make a significant difference in response times and asset management capabilities.

Figure 11. Access maps on any device.

- **Monitor real-time data—** Real-time information helps response teams direct action in a crisis. With ArcGIS, you can monitor streaming data from any type of sensor, device, or feed. It lets you continuously update maps and databases with real-time metrics and locations. Set filters to focus on the events and conditions that matter to you, and send alerts to personnel when certain thresholds are met. This level of visibility into live events helps you improve operational awareness and respond more quickly to dynamic situations.

- **Create 3D visualizations**—Visualize facilities and plans in 3D to effectively communicate concepts for health education, community outreach, preparedness planning, and training exercises. Virtually assess public health threats from every perspective, whether they are naturally occurring or resulting from human action. Transform your data into smart 3D models that help you analyze problems and convey information in ways that are only possible with a 3D perspective. ArcGIS support of 3D mapping and visualization allows you to view data in a geographic context.

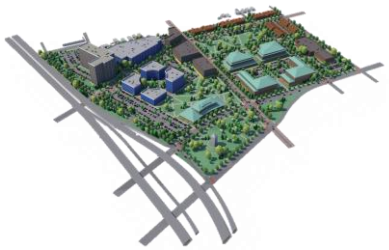

Figure 12. 3D facility visualization and planning

- **Process and analyze imagery**— Integrate imagery and remote-sensing data from satellites, aircraft, drones, full-motion video, and lidar with other types of geographic data. Identify patterns in your imagery and extract valuable information. By comparing before-and-after images of a location after a disaster, such as a flood, crisis managers can quickly assess the level of damage and assign health personnel to locations where they are needed most. ArcGIS provides a comprehensive set of tools that help you manage, process, analyze, and share imagery. In addition, having access to the world's largest collection of imagery ensures that you will have the context to understand any location.

- **Share and collaborate with others**— A collaborative platform allows health departments, hospitals, first responders, and volunteers to coordinate and leverage their expertise as they prepare for, respond to, and recover from any health-related incident. ArcGIS provides a centralized web portal that lets you publish data that others can find and access. This allows anyone you choose to access and use the same authoritative maps and data for their work. Communicate across teams and departments and with the public to develop collaborative solutions. During an emergency event, the ability to view current data is essential for first responders, health professionals, and the public to act quickly and decisively. For example, real-time maps that show road closures and treatment station locations direct people to the care they need.

ArcGIS supports flexible deployment options that meet your specific business requirements. One option is to access ArcGIS Online and take advantage of a cloud infrastructure managed by Esri. Or deploy ArcGIS in your own infrastructure and keep it secure in your local network. You can also choose to run it on other cloud platforms such as Amazon Web Services and Microsoft Azure. No matter how you

decide to implement ArcGIS, you will deliver critical capabilities and content to everyone in your organization.

By using GIS to process, interpret, and disseminate information, public health professionals can turn data into intelligence that saves lives.

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Esri inspires and enables people to positively impact their future through a deeper, geographic understanding of the changing world around them.

Governments, industry leaders, academics, and nongovernmental organizations trust us to connect them with the analytic knowledge they need to make the critical decisions that shape the planet. For more than 40 years, Esri has cultivated collaborative relationships with partners who share our commitment to solving earth's most pressing challenges with geographic expertise and rational resolve. Today, we believe that geography is at the heart of a more resilient and sustainable future. Creating responsible products and solutions drives our passion for improving quality of life everywhere.

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