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GIS, Pollution Prevention, and Public Health

Local health officials are continually searching for new and improved tools that will help to assess local hazards and identify opportunities to protect community health through prevention strategies. Geographic information systems (GIS) are powerful tools that enhance a health department's ability to protect the community. Using examples of preventing pollution and reducing risk of exposure to communities, this guide answers basic interest and start-up questions, addresses benefits and limitations, and illustrates the value of GIS for local health departments.

This guide is one of three parts of NACCHO's pollution prevention activities in 1998. Other activities include:

- the development of a companion document entitled *GIS Pollution Prevention Case Studies* that provides three examples from local health departments of the potential uses of geographic information systems resulting in integration of pollution prevention practices into local health programs; and
- the development of an introductory GIS session at the 1998 NACCHO Annual Conference.

What are GIS?

GIS are computer-based tools used to present multiple types of data on a map from a database in which each record has geographic reference (i.e., latitude and longitude). Maps are not only created to display data, but also to emphasize their spatial patterns and relationships and associated health, demographic, environmental, and geographic characteristics. In addition to displaying data pictorially, GIS applications have functions that standard databases do not, such as creating routing by time and distance, tracking the spread of an event, and identifying residents of an affected area. GIS also provide many functions that the public can use every day utilizing only database features (e.g., users can simply enter an address or zip code and be told any number of features about that area). GIS provides increased access to information and the opportunity to analyze complex data, solve problems, and present data in a graphical format that decision makers and the public can easily see and understand.

INSIDE

What is Pollution Prevention?

Pollution Prevention is defined in the Pollution Prevention Act of 1990 as any practice which 1) reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream, or otherwise released into the environment (including fugitive emissions) prior to recycling, treatment, or disposal; and 2) reduces the hazards to public health and the environment associated with the release of such substances, pollutants, or contaminants. Pollution prevention practices encourage increased revenue to industry though reduction in liability and hazardous material handling costs, decreased risk to workers and the public, increased worker productivity, better product and company image, and cost cutting through quality management of the manufacturing process.

Pollution Prevention and Public Health

Pollution prevention brings environmental protection together with disease prevention. When we prevent environmental problems from occurring, we protect human health in a variety of ways. For example, by reducing or eliminating the use of hazardous substances from industrial processes, we can prevent those substances from entering the air, water, soil, and food chain. And, by finding alternative and substitute products for hazardous materials used in industrial processes and by consumers, we reduce the overall harmful effects to both humans and the environment.

GIS, Pollution Prevention, and Public Health

Some examples of how GIS might be used to further pollution prevention goals and activities include: using GIS to overlay environmental, health, and demographic data to identify communities and individuals at disproportionate risk of environmental exposures; targeting communities for education about pollution in their community and opportunities for prevention; providing technical assistance or resources to businesses by conducting environmental audits and finding less toxic alternatives for inputs in their production processes; and convincing local elected officials to restrict growth or zoning in certain geographic areas if that growth is not sustainable and would increase pollution or create other public health hazards. GIS is also an excellent tool for describing groundwater sources, potential contamination, and potentially affected populations.

GIS is an excellent tool to characterize pollution sources and other health information, which in many cases is not known or easily understood. GIS can be used to locate pollution sources impacting the community, such as sanitary sewer outfalls, landfills, underground storage tanks, urban runoff from impervious surfaces, agriculture, and chemical storage facilities. Pollution prevention planning in the targeted areas can then help to address such environmental and public health risks.

In addition to being an important pollution prevention tool, GIS has many other applications for local health departments. Among these are: identifying children at risk for lead poisoning, finding the quickest route for nurses and outreach workers making home visits, targeting children for immunizations, and defining eligibility for medical screening (e.g., when a plant has released a toxic plume). It can also be used in conjunction with NACCHO's Assessment Protocols for Excellence in Public Health, linking together health information from a variety of different databases to recognize where public health interventions would be cost-effective and require action.

GIS can assist with projects at all stages, including advancements in surveillance, assessment, allocation of resources, increased access to information, exposure information, spatial and relational data analysis, and presentation of data.

Issues GIS can address

GIS can address current and future data requirements and analysis. Looking toward the 21st century, each community should have the capability to link together health information from a variety of different databases (e.g., those of state and local public health agencies, the U.S. Environmental Protection Agency Toxic Release Inventory (TRI), hospitals, and managed care plans) and to recognize data patterns where public health interventions would be cost-effective and require action. GIS is likely one of the major keys to successful development of this capability.

GIS makes it easy to comprehend large volumes of data and explore spatial relationships, patterns, trends, and outliers that otherwise might go unnoticed. GIS also makes it easy to "zoom in" from a map showing the spatial pattern of information from a large area to a more detailed view of a small area of interest.

In addition, GIS can be used as a revenue generator. Many local health departments must track all waste sites and other hazards and provide this information to those investigating land purchases or areas for development. Geocoding this information (assigning latitude and longitude or street addresses for use in a GIS), and charging a fee for service will reduce valuable staff time spent on paper chases, provide accurate and professional maps for customers, and possibly lead to other services for the community. Revenue can potentially fund part or all of a GIS position(s) and provide resources to the public in a timely and cost-efficient manner.

GIS also strategically increases planning and analysis capabilities and reduces information redundancy, decreasing the amount of time it takes to assemble data that was previously retrieved manually

Generating Revenue from GIS at the Albuquerque Environmental Health Department, NM

Creation of the Site Environmental Audit (SEA) Information System was motivated by increased demand for record search services — especially data for environmental site audits — during a period of severe financial cuts at the City of Albuquerque. To address a greater demand for services with limited funding and personnel resources, the Albuquerque Environmental Health Department, initiated a state-of-the-art application utilizing the city's existing geographic information system to provide quick and accurate data from state and federal databases for sites in question. The SEA provides consultants with a set of custom maps and a series of reports for the sites that are annotated on the maps. The following maps are included:

- **A one-mile map that provides data on Superfund sites and hazardous waste handlers, including NPL, CERCLIS, RCRA, SARA Title III, and landfills or illegal dumps sites.**
- **A half-mile map that indicates any leaking underground storage tanks.**
- **A quarter-mile map that includes RCRA generators as well as registered underground storage tanks that are not leaking. The base layer (information) for this map is land use, so that the client can easily recognize whether the site is within a predominantly residential or commercial neighborhood.**
- **A natural features and infrastructure map contains information on the 100-year floodplain, approximate depth to groundwater, arroyos, city wells, and sanitary sewer lines.**

The SEA processes an average of 230 requests for service per year and has generated an average of $37,500 per fiscal year.

For more information on Albuquerque Environmental Health Department's revenue generating program, contact Gloria Cruz, GIS Program Coordinator, at (505) 768-2603 or e-mail at gcruz@cabq.gov.

and analyze and publish it from days to hours or minutes.

Limitations of GIS

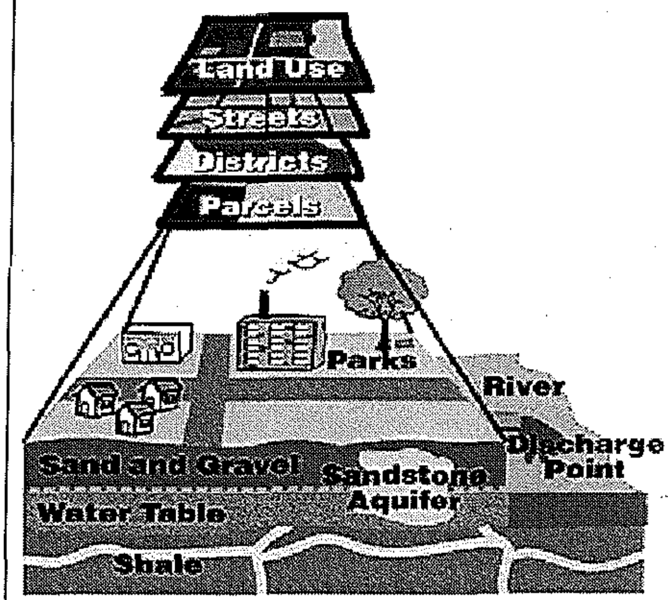
This fact sheet is intended only as a starting point. Local health officials should carefully think about their needs and investigate available options before making an investment in GIS. GIS is a significant investment in time as well as money and requires trained personnel to operate the system. Training cannot be limited to only the technical specialist who maintains the system, but must also be provided to those who use it to help them perform their everyday work. One must realize that developing and operating a GIS system is time intensive and the quality of the results will take time, depending on type of software used, available data, and results sought.

Some local health officials may find non-GIS mapping solutions (See EpiInfo and EpiMap under GIS Software) to be more than adequate for their needs. In addition, new and improved products are available each year—some at a lower cost. Although GIS is an innovative and useful tool, there is still much to learn about how to appropriately use it in public health practice. While maps illustrate problem areas, they also can lead people to identify hotspots that are not real. Collaboration with an epidemiologist is recommended to avoid misuse of GIS and incorrect conclusions.

Because GIS can provide pinpoint accuracy of data on a map, confidentiality is another important issue that must be addressed when using private information or developing information that may impact members of the community (however, given a population of sufficient size, data may be displayed in less detail to conceal identities—such as by providing information by block or larger area).

How it Works: System Design

A GIS consists of five key components: hardware, software, data, people, and methods. Hardware is the computer terminal and its parts, such as the microprocessor, monitor, hard drive, etc. (see computer requirements under Addendum). There is no single computer software program that is "the GIS" software program. Rather, a computer software program is classified as GIS when it is able to perform GIS functions. These include: zooming from a large area to a small area and vice versa; changing projections; searching and retrieving data; measuring distances, areas, and events within a boundary area; drawing buffer zones (e.g., rings around points); and linking information such as tables, charts, and photos to points on maps. Maps are made up of data with geographically referenced identifiers organized in different data layers, also called themes or coverages (see Data under Addendum for more information). Each layer consists of similar geographic features, such as property zones, household income, hazardous waste handling sites, emergency evacuation zones around hazardous waste handlers, etc. Maps are created by overlaying data layers.



One of the most important parts of a GIS are the trained people who operate the system. People who use GIS include technical specialists who maintain systems, people who develop methods to solve problems, and everyday users who use it to complete their work. The final component of a GIS is the methodology, or practices, rules, or procedures applied to utilize the GIS functions and analyze data. Methodology will vary according to field, training, and organizational standards.

Types of Applications

Software applications range from simple to complex and cost from $300 to $18,000. Similar to advancements in word processing and database software in the last ten years, GIS software has also come into its own, allowing for different levels of expertise to be developed and applied. Some of the most current GIS software will allow you to use it as it is or customize it to meet your needs. Software ranges from very simple with little expertise needed that may also offer few options for customizing data and maps, to user friendly desktop GIS that can be customized and manipulated, to the programmer's GIS software which can be customized to analyze and present data in any format needed.

However, if all you want to do is view census data, you can view it for free through the Census Bureau's Web site at http://www.census.gov, or through the Bureau's prototype viewer called Census Mapper. The U.S. Environmental Protection Agency also offers free maps of its Toxic Release Inventory and other data on the Internet at http://www.epa.gov. In addition, Arc Explorer software is offered for free for viewing map (shape) files (see resources for more information). Examples of software applications are given in NACCHO's *GIS Pollution Prevention Case Studies*.

Time

Perhaps more important than GIS software is the ability to have dedicated time to work on the GIS program. GIS work, like many specialties, requires formal instruction and extensive on-the-job self-training and orientation to software and available data sets. The GIS specialist's work is comprised mainly of responsibilities in acquisition, development, and maintenance of databases; conducting geographic analysis; documenting and presenting results in visual and written formats; providing needed project planning and system quality assurance; and working with all areas of the health department, especially the areas of epidemiology and assessment.

> ***"Without a dedicated, trained staff, GIS can end up being like that expensive piece of exercise equipment stored in your basement or garage."***
>
> —Daniel L. Partidge, RS, BS, Environmental Health Supervisor, Reno County Health Department, KS

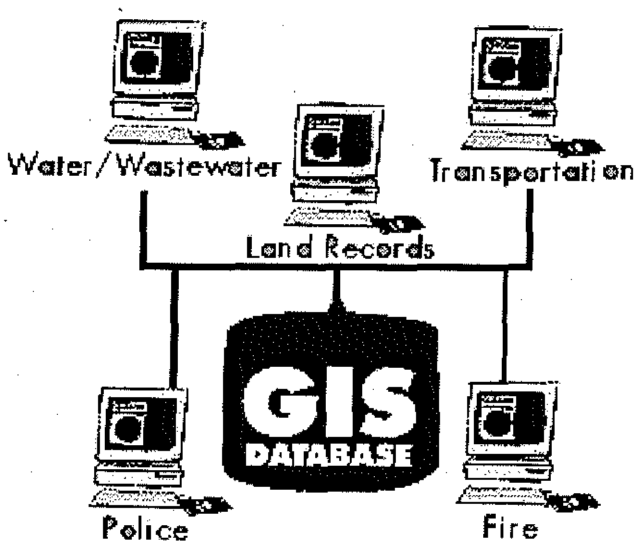
Costs

To get your program off the ground and reduce costs, consider interns or work-study agreements with nearby university graduate programs to staff a small start-up project. Funding with which you can incorporate costs for staff time or hardware costs may be available from federal and state agencies such as the U.S. Environmental Protection Agency, U.S. Department of Housing and Urban Development, the Centers for Disease Control, and your state departments of health and the environment. Current hot topics areas include environmental justice and source water protection. While an initial GIS software investment can range from about $300 to $18,000, depending on what you want to do (e.g., put maps on the Internet), additional purchases may be needed to add on software components or update to newer versions.

Sharing Resources Among Agencies: Opportunities for Communication and Cooperation

The full potential benefits of technology and data can only be realized through intergovernmental and private sector cooperation, coordination, and partnerships. GIS technology has taken such large leaps forward in the last few years in the area of data accessibility and management, that it is now a resource for integrating local government data. By working with other agencies, you can enhance GIS capacity and reduce time and money needed to develop your GIS resources. In addition, other local agencies, such as public safety, planning, public works, tax assessment, etc., may already be using GIS to increase the efficiency and effectiveness of their programs.

Many local governments have already created agencies, offices or agreements to coordinate agency/agency or county/city-wide GIS development and data integration. Don't be left out.



Advantages of working with other agencies:

- Sharing information can lead to better service delivery for cooperating agencies. For example, working with the transportation agency you may find that in order for high-risk community members to take the bus to local clinics, they must change buses three times or walk a long distance. Improved cooperation can lead to better bus routes and cost effective sitings of future clinics.

- Many factors may influence which GIS software package might be best for a specific LHD. Of particular importance is: what GIS equipment is being used by other units of your state and local government? Some state and local governments have started to standardize GIS equipment to help reduce cost and to facilitate exchange of GIS information between local government agencies.

- Integrating existing data between local agencies will result in major benefits such as increased capacity to support GIS technology and services, reduced field work and research time, improved customer service, increased productivity, more professional and detailed presentation of graphics, and increased cross-agency cooperation and support.

Define Your Needs

For many local health departments, a good approach to GIS might be: 1) Start to gradually learn more about GIS by subscription to informational newsletters such as the National Center for Health Statistics's *Public Health GIS News and Information* (newsletter available via e-mail), and introductory readings or courses (see resources); 2) Don't be the last local health department to use GIS; 3) Start small; get hands on experience with what GIS can do; demonstrate a success; and then consider making a more substantial investment; and 4) Take some time to explore, learn, and talk to other local health department and local government GIS users in your community before making an investment. GIS also is increasingly used in business decision making (e.g., to determine

Central GIS Management for Local Government, Good for all Involved

In 1984, the City of San Diego and County of San Diego jointly initiated the Regional Urban Information System (RUIS) project in response to the increasing complexity of delivering efficient and effective municipal services to the residents of this large and growing region. The mission of the RUIS project was to develop a highly integrated geographic information system (GIS) designed to meet the needs of all city and county activities that create or use geographic information. RUIS' goals were: to improve productivity; reduce costs; provide access to accurate, timely information for decision making; and, to improve service to citizens.

Through the RUIS program, a highly integrated GIS was created including data, software, hardware, and administrative components necessary to operate a successful GIS for the city and county. Much of the data are maintained by various county and city departments, including the county Environmental Health Department, and are made available to all participating departments through a distributed network. The RUIS project helped improve decision making and efficiency in local government by providing more timely information and eliminating redundant activities and by re-engineering and automating manual processes. RUIS is considered one of the most successful multi-participant geographic information system ever attempted and was presented the Exemplary System in Government Award by the Urban and Regional Information Systems Association in 1995.

In 1997 a Joint Powers Agreement (JPA) between the city and county formalized their partnership in GIS by creating the SanGIS JPA. SanGIS is carrying on the work already set in motion by RUIS by ensuring that geogrphic data is maintained and accessible. Its mission is to establish, maintain, and promote the use of a regional geographic data warehouse for the San Diego area and to assist in the development of shared geographic data and automated systems which use that data. For more information, call the SanGIS Executive Director at (619) 702-0400, or search its Web site at http://www.ruis.org.

customer location and buying habits, and locate sites for stores). Consequently, your regional economic development office or chamber of commerce also may be an excellent source of information about GIS.

Available Resources

The following resources are compiled only as a starting point for further research and is by no means complete. Therefore, it should not be your only reference. Any listing of information and/or materials, software, and/or data should not be construed as an endorsement or recommendation by NACCHO. Prices listed are the normal commercial price at time of publication. However, special discounts or additional costs may apply.

GIS Software

Software listed performs some or all functions of a GIS program. Listing format: software application name, type, cost, website, phone (Ph.).

- Atlas GIS
  Desktop software
  $795
  http://www.esri.com
  Ph. (800) 447-9778
- Arc Explorer
  Viewing software
  Free
  http://www.esri.com
  Ph. (800) 447-9778
- ArcInfo
  Programming Software
  $18,000
  http://www.esri.com
  Ph. (800) 447-9778

- Arc View GIS
  Desktop Software
  $1,200
  http://www.esri.com
  Ph. (800) 447-9778
- Business Analyst (includes ArcView)
  Desktop software
  $11,000
  http://www.esri.com
  Ph. (800) 447-9778
- HUD Community 2020
  Desktop software
  $249
  http://www.hud.gov/commut
  Ph. (800) 998-9999
- Landview
  Desktop Software
  Free (http://www.rtk.net/landview/)
  http://www.epa.gov/swerosps/bf/html-doc/lvfctcpo.htm
  Ph. (800) 424-9386
- Map Info Professional
  Desktop software
  $1000
  http://www.mapinfo.com
  Ph. (800) 327-8627
- Maptitude
  Desktop Software
  $395
  http://www.maptitude.com
  Ph. (617) 527-4700
- Epi-info and Epimap
  Non-GIS software with some mapping functions
  Free on the Internet
  http://cdc.gov/epo/epi/epiinfo.htm
  Ph. (404) 639-0840

E-mail Lists and Electronic Newsletters

- Subscribe to *Public Health GIS News and Information*: a free e-mail newsletter from the National Center for Health Statistics. To subscribe, send email to: cmc2@cdc.gov.
- Subscribe to the free Community 2020 listserve, called ppgis-scope. To sign-up see: http://www.projectscope.org
- Subscribe to the free magazine, *Business Geographics*, through web site: http://www.geoplace.com/bg

Internet Resources

- Environmental Systems Research Institute maintains an extensive list of resources on GIS: http://www.esri.com
- Geoplace Warehouse sells books on general and specific topics: https://secure.aip.com/gisbooks/index.html
- GIS Master Bibliography Project provides a comprehensive bibliography of GIS related research and literature: http://paradise.sbs.ohio-state.edu/resources/
- HDM's Virtual GIS Bookstore provides GIS links and offers numerous GIS titles: http://www.hdm.com/gisbooks.htm
- *Improving Public Health Through Geographical Information Systems...*, Web Version 1.0, December, 1997: http://www.uiowa.edu/~geog/health
- National Pollution Prevention Roundtable: http://www.p2.org/
- National Association of County and City Health Officials: http://www.naccho/org
- Pollution Prevention Information Clearinghouse: http://www.epa.gov/opptintr/library/libppic.htm
- U.S. Census Bureau provides information on census data: http://www.census.gov/
- U.S. Geological Survey maintains a comprehensive list of links and resources: http://www.usgs.gov/network/science/earth/gis.html

GIS Resources and References

- Clarke KC, McLafferty SL, and Templaski BJ. 1996. "On Epidemiology and Geographic Information Systems: A Review and Discussion of Future Directions." *Emerging Infectious Diseases* 2 (no 2): 85-92.

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📖 Gordon A, and Womersely J. 1997. "The Use Of Mapping In Public Health And Planning Health Services." *Journal of Public Health Medicine* 19 (No 2): 139-147.

📖 Lavin MR. 1996. *Understanding The Census: A Guide For Marketers, Planners, Grant Writers and Other Data Users.* Kenmore, New York: Epoch Books, Inc.

📖 Popovich ML, and Tatham B. 1997. "Use of Immunization Data and Automated Mapping Techniques to Target Public Health Outreach Programs." *American Journal of Preventive Medicine* 13 (Suppl 1): 102-7.

📖 Public Technology, Inc. 1997. *.gis://the next management tool.* Explores why local governments should implement GIS and how they can plan, fund, launch, and maintain successful systems. See http://pti.nw.dc.us/PubsnNews.htm, or call (301) 490-2188 for more information

💻 Rushton G, and Armstrong MP. 1998. *Improving Public Health Through Geographic Information Systems: An Instructional Guide to Major Concepts and Their Implementation, Version 2.0.* CD-ROM, Cost $20 per copy, orders of 10 or more $10 per copy. For more information, http://www.uiowa.edu/~geog/health; e-mail: gerard-rushton@uiowa.edu; or fax: (319) 335-2725.

📖 U.S. Department of Housing and Urban Development. 1997. *Mapping Your Community: Using Geographic Information to Strengthen Community Initiatives..* Free guide (#HUD-1092-CPD) by the, Office of Community Planning and Development, call (800) 998-9999.

NACCHO Pollution Prevention Publications:

📖 *Drinking Water, Pollution Prevention, and Public Health: A Matrix for Disease Prevention and Environmental Protection.* 1997. Provides public health officials with an understanding of how to integrate pollution prevention into everyday activities, and to define other roles health departments can play to reduce risks through pollution prevention. The Guide is an excellent educational tool for health departments and community residents. Available online at: http://www.naccho.org/projects/p2.html.

📖 *Pollution Prevention and Public Health: A Unified Approach to Disease Prevention and Environmental Protection.* 1996. Illustrates the critical link between pollution prevention, drinking water and public health, and promotes steps local health officials can take to reduce health risks by helping to safeguard the nation's water supply. Available online at: http://www.naccho.org/projects/p2.html.

📖 *Preventing Pollution in our Cities and Counties: A Compendium of Case Studies.* 1995. This report describes how local governments are employing innovative, low cost pollution prevention strategies. available to both members and non-members for $7.50.

To order, send a check or purchase order (or number) to NACCHO, 1100 17th Street, NW, Washington, D.C. 20036, or Fax to: (202) 783-1583, Attention: Anissa Bradby; e-mail: ABradby@naccho.org. Phone orders to (202) 783-5550, ext. 237.

Addendum

Data

Data that has a geographic reference is referred to as *geocoded* data. To *geocode* data is to give it a geographic reference. Any value that can be attributed to a referenced point or area (for example, property lines, zoning boundaries, household income, exposures, roads, sewer systems, auto body shops, wells, septic systems, hazardous material handlers, and hospitals) can be mapped using GIS. Data can also be displayed at different magnification levels, ranging from a parcel of land, to city blocks, to multiple counties, states or larger.

GIS data is stored in databases (ie., Microsoft Access, Excel, dbase etc.) that are not unique to the GIS software. Each record must have a geographic reference (latitude and longitude or a street address—if working with software that allows this function) to be utilized by the GIS software and placed on a map.

Availability of geo-coded public health data needs careful consideration. The largest component of "cost" in a GIS system can often be the data, or getting "clean" data in a form that can be used in a GIS. Most software comes with a limited amount of data and maps, such as census information and maps of county boundaries in the U.S.

Data is available from federal, state and local government, and commercial sources. Much of the start-up data used in local government applications is from federal government sources. This includes U.S. Environmental Protection Agency Toxic Release Inventory data, and TIGER (census data) files from the Census Bureau.

Commercial sources of data consists of value-added products and vendors that will convert or customize data to meet your project needs. Value-added data products consist of data available from the government that are customized and/or packaged with other data for specific uses or requirements. While the U.S. government and commercial industry has a wealth of information available to you, your first stop on your data search should be state and local agencies that may have data and maps already customized for your locality *(see Sharing Resources Among Agencies)*.

Eventually, you will want to have capacity to prepare and analyze data from your local health department and other community sources (e.g., you may need to convert your data to dBase files and then geo-code your own data). In addition, some data sources have flaws (even TIGER files may not be perfect). It's best if a local health department can collect and digitize their own information whenever possible to assure quality control—the quality of one's output is only as good as the data used.

Choosing data is not as simple as purchasing it off the internet rack. It may be helpful if all data is in the same scale (e.g., 1:24,000 meters, kilometers, miles, etc), but the map projection system must be the same (e.g., Universal Trans Mercator). In terms of scale, if you would like to do a very detailed study of an area, it is best to use a smaller scale map. If the focus changes to a larger scale, then there is no problem. However, if a person starts off with a larger scale map and wants to look at the area in greater detail (smaller scale) then there will be a lot of extra work to do.

Collecting and Plotting Data

Data can be purchased or collected in the field and attributed to boundary areas on a map that are already made and usually included in software purchases, such as counties, zip codes, census tracts, and by street address if the GIS system you are using supports this function. Local data can also be acquired through surveys and field research. Data from surveys can be attributed to street addresses, blocks, zip codes, or other areas. Data can also be acquired in the field by using the global positioning system.

Global positioning system (GPS) receivers are used in the field to collect real-time data points that can be easily recorded in a database for development and customization of local maps. GPS is a satellite-based navigation system developed by the U.S. Department of Defense (DOD) that allows land, sea, and airborne GPS users to determine their three dimensional position, velocity, and time 24 hours a day, in all weather conditions, anywhere in the world. The system depends on 24 satellites in orbit around the earth. GPS receivers collect signals from satellites in view and display the user's position, velocity, and time as needed. GPS provides two levels of service—Standard Positioning Service (SPS) for the general public and an encoded

Precise Positioning Service (PPS) for the DOD. SPS signal accuracy is intentionally degraded by the DOD for the purpose of "national security" through a process called Selective Availability (SA). SA limits the accuracy of signals from satellites by 100 meters horizontal and 156 meters vertical. The basic GPS unit is handheld and costs $100 to $400 or more. However, more sophisticated systems have evolved around the SA limits to provide users with more accurate data. These are differential GPS receivers and surveying systems. Differential GPS receivers are accurate to within three to ten meters if the service is available in your area. Surveying systems using two or more units working in tandem provide accuracy of more than 1 cm for the better models, and range in price from $7,000 to $30,000 or more. The military is preparing to do away with SA in the next ten years.

The Nuts and Bolts: Hardware Requirements

It suffices to say that like most software requirements, system complexity correlates with system capacity. Initial computer investment depends on the computer equipment that you already have available and what you want to do. For small "beginner" projects and learning about GIS, the computer equipment that you already have may be more than sufficient. However, as projects start to grow and become more sophisticated, a relatively high-speed computer and capability to store large amounts of data are advantageous.

The following are suggested minimum and recommended computer requirements for free-standing independent units; however, hardware requirements vary with each software package, and hardware technology is continually improving, making today's technology less expensive tomorrow.

Suggested Minimum Requirements

- Industry standard personal computer with at least a 486 MHz or higher Intel-based microprocessor
- Hard disk with at least 144 MB or greater capacity
- 16MB of Ram
- 3.5" floppy disk or CD ROM drive
- capacity for additional disk or storage space
- 17 MB of virtual memory
- Video graphics adapter (VGA) or better resolution monitor
- Operating system of MS-Dos 5.0 or higher, Microsoft Windows 3.1, Windows for Workgroups 3.11, Windows NT 3.51, or Windows 95

Mouse

Printer

Recommended Requirements

- 300 MHz or faster (for dealing with large amounts of information) Pentium Processor II with MMX Technology
- Hard Disk with at least 4 GB EIDE hard drive
- 64 MB Ram memory
- 12x EIDE CD ROM drive
- Back-up capability (e.g, Iomega ZIP 100 MB IDE internal drive, LAN system back-up, tape drive back-up, or CD ROM writer)
- Video Board with 8 MB RAM
- 17 inch viewable or higher graphic quality color monitor
- 56kbs Modem or ability to connect to

Internet

Options:
    Color printer
    Digitizer

NACCHO Information

The National Association of County and City Health Officials (NACCHO) is the national voice of local health officials and is dedicated to improving and protecting the public's health by increasing the capacity of local health departments (LHDs) to fulfill the core functions of public health: assessment, policy development, and assurance. NACCHO serves all of the 2,932 LHDs nationwide; this includes county, city, and district health departments. NACCHO's work focuses on providing education, training and technical assistance aimed at ensuring the public's health. GIS is one tool that is used in fulfilling this role. In addition, NACCHO serves as a communication vehicle among local, state, and federal public health and environmental health agencies, allowing NACCHO to promote pollution prevention and share successes.

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