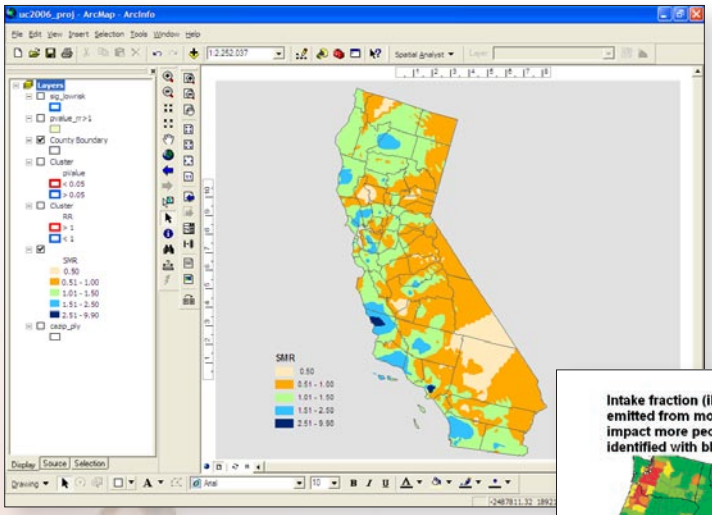
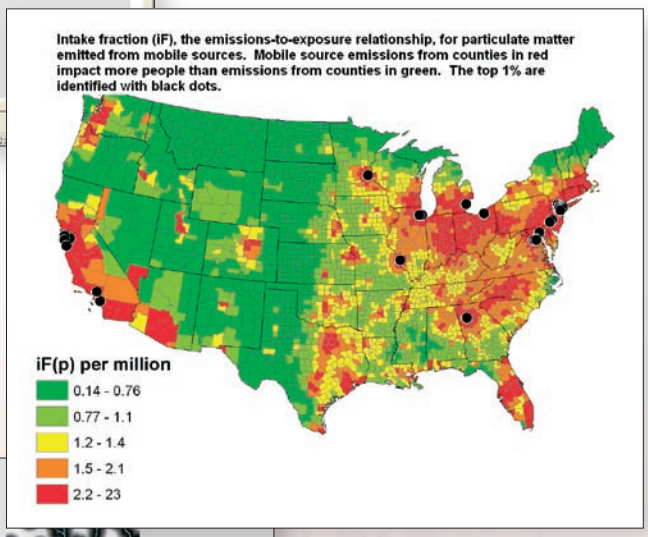
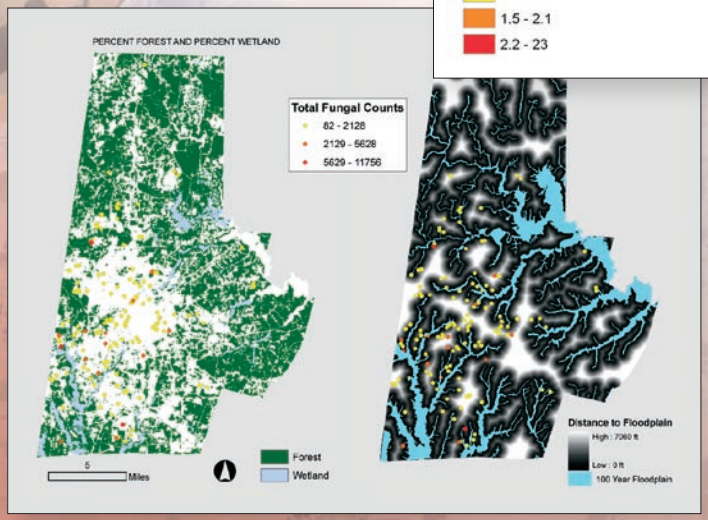
Approaches to GIS Programs In Health Education





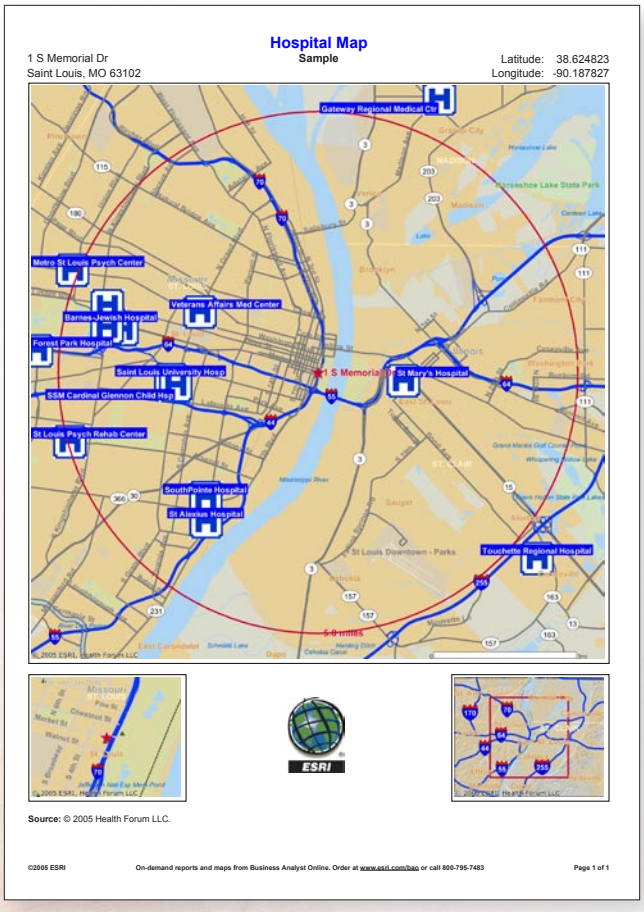


Approaches to GIS Programs in Health Education

Health and human services students need geographic information system (GIS) technological skills to analyze the geographic elements of health and human services science. GIS technology has progressed to a high level of sophistication and, therefore, is relevant to nearly every emphasis of the health major. The rapid evolution of GIS as an analytical tool has created specific applications for multiple health-related fields from environmental and global health to hospital management and marketing. Its acceptance as a strategic component of information technologies and incorporation into the central systems of many enterprises has been driven by both analytical capacity and competitive edge.

Although most colleges have GIS in geography or other disciplines on campus, few health-related schools offer their undergraduate and graduate students opportunities for emphasis in health geography technologies. In the face of industry demand for qualified health geospatial analysts, some universities are still debating the validity of GIS in an accredited curriculum while others are already trying to determine how to position this new field of study within their programs. A few schools offer health geographic programs or tracks that include GIS technologies. Each of these programs is born from unique environments that influence pedagogical approaches.

This brochure presents five cases that exemplify varied approaches to GIS academic programs in health-related schools and three cases where universities are applying geospatial technology in health research. While these may not represent all of the ways that GIS can be incorporated into health care programs, it is meant to highlight some ways that GIS is being used.



A map prepared using the Business Analyst Online℠ for Health application displays hospitals located within a defined area and gives public health administrators the ability to integrate demographic, hospital, and other data for planning purposes.

University of Canterbury and Ministry of Health, New Zealand

GeoHealth Laboratory

- *GIS in Department of Geography*
- *Collaboration with Ministry of Health*
- *Three laboratories and an eight-course progression*

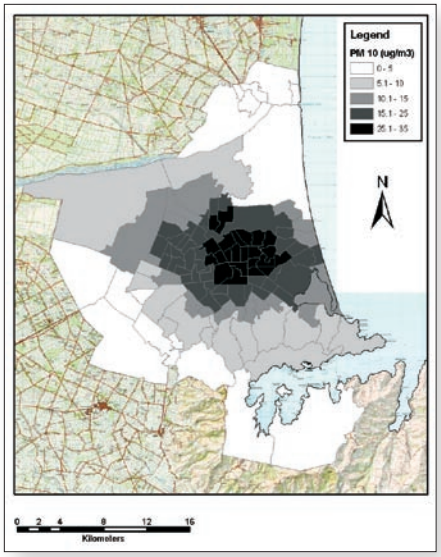
The GeoHealth Laboratory is a joint venture between the New Zealand Ministry of Health Public Health Intelligence (PHI) group and the Department of Geography's Health and Environment research group at the University of Canterbury (UC) in Christchurch. The collaboration vision is to build a strategic partnership around health geography, spatial epidemiology, and GIS and to increase research capacity and outputs in the health and GIS academic sectors. More than 13,000 undergraduate and 1,900 postgraduate students are enrolled at the University of Canterbury.

As a result of the driving forces of Paul White, PHI director, and Dr. Jamie Pearce, UC geography professor and GeoHealth Laboratory codirector, the laboratory was launched in 2004. With initial funding provided by the two parent institutions for three years, the collaboration seeks to advance the university's research agenda in the health sciences as well as the strategic aims of the Ministry of Health. The collaboration provides a resource that is unique in the Southern Hemisphere.

Staff members work on a range of research projects concerned with the social and environmental determinants of health and health care. Projects include neighborhoods and health, health inequalities, social dimensions of cancer, air pollution and health, environmental justice, and social gradients in health care utilization. In addition, the GeoHealth Laboratory, located in the Department of Geography, provides technical and financial resources for postgraduate students working in geohealth. Each year, the lab has three or four scholarships available to qualified students.

The university's Department of Geography established its first GIS course in the late 1980s thanks to a visionary group of academics who foresaw the benefits of computer technology in teaching, research, and administration. GIS course enrollment neared the 200 mark in 2006, and GIS and environmental remote sensing is one of four specialties that students can follow toward a geography degree.

The GIS group started out by winning a major university grant to computerize the Department of Geography building, build two computer labs, and purchase the requisite hardware and software. Initially starting with just two ArcInfo® licenses running on UNIX® workstations, the GIS program now has 10 ArcInfo and ArcEditor™ licenses and unlimited ArcGIS® ArcView® licenses running on Windows® PCs. Three computer laboratories are available for teaching undergraduate and postgraduate students and providing support for researchers in geohealth. ArcGIS ArcView is also installed in many Department of Geography staff machines and a growing number of computers in the Biological Sciences, Civil Engineering, Economics, Forestry, Geology, Math and Statistics, and Facilities Management departments.



Air pollutant concentrations in Christchurch, New Zealand

Eight courses follow an integrated teaching pathway and progression at different levels to accommodate a variety of interests and experiences. Courses run 12 or 13 weeks. The entry-level course introduces the fundamental GIS concepts, principles, and techniques of ArcView; geographic positioning systems; and remote sensing. Subsequent courses develop skills for acquisition and analysis of satellite data and its preparation for use in a GIS. Others introduce theory and methods of spatial analysis and quantitative GIScience and explore ArcGIS programming and GIS models. Graduate-level courses examine GIS technical concepts and applications in research, skills and concepts of environmental remote sensing, and applications in remote sensing.

Teaching objectives establish

- Fundamental appreciation of spatial analysis theory
- Hands-on software experience including the ESRI® ArcGIS Desktop suite
- Appreciation of society-wide impacts of GIScience
- Awareness of spatial data acquisition

Initial program challenges involved selling the concept of new courses to department heads and gaining access to limited resources. Once established, the GIS courses became increasingly popular with students from geography as well as other disciplines. A long-term issue has been the need to provide experienced teaching and support staff, a situation that is currently alleviated by providing visiting lecturers and hiring additional part-time teaching staff.

Harvard University, Massachusetts

Harvard School of Public Health

- *GIS research and teaching in School of Public Health*
- *GIS infrastructure and services in Center for Geographic Analysis*
- *Three main GIS public health research groups*

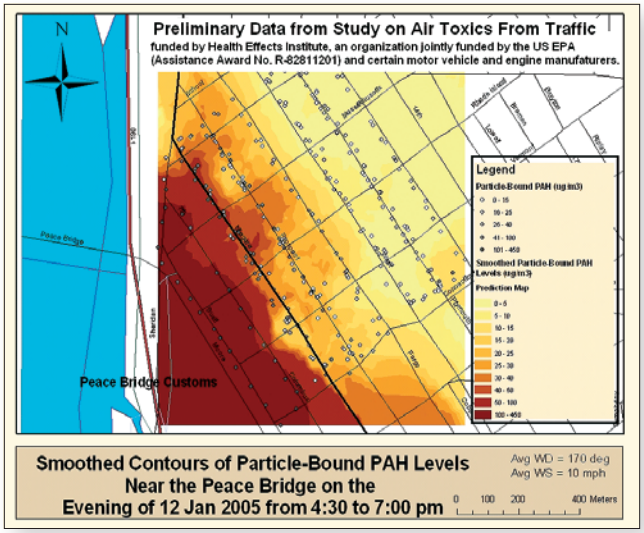
The Harvard School of Public Health (HSPH) was founded in 1922 with the mission of advancing the public's health through learning, discovery, and communication. Located in Boston, Massachusetts, near the Harvard Medical School and several affiliated hospitals, HSPH pioneered early HIV/AIDS research and has made important contributions to health findings related to air pollution, nutrition, coronary heart disease, and diabetes. With an endowment of more than $800 million, the school employs more than 380 faculty and 640 researchers and occasional instructors; enrollment averages around 960 students. HSPH degree programs award the master of science, master of public health, doctor of science, doctor of public health, and doctor of philosophy.

In addition to supporting computers that are dedicated to research and located throughout the campus, the HSPH Department of Information Technology operates the Instructional Computing Facility to serve the academic computing needs of faculty, fellows, and students. The facility provides 54 student Windows PC computers, with an additional three classrooms providing between 12 and 20 student computers each. Instructional facility hardware includes a Sun UNIX file server, Novell file server and PC local area network, two LaserJet printers, an optical scanner, three slide-maker machines, and five X terminals.

A site license agreement between Harvard and ESRI provides students, faculty, and staff with access to the latest GIS software from ESRI including ArcGIS and many ArcGIS extensions. For research purposes, students have access to 7.5 GB of GIS files from ESRI including imagery; the StreetMap™ USA dataset; and vector data for the United States, the world, Europe, Canada, and Mexico. Statistical software applications, such as SAS, Stata, Epi Info, EpiMap, and S-PLUS, are also available.

The Harvard Center for Geographic Analysis was founded in 2006. The center, a technology platform in the Institute for Quantitative Social Science, works across the university to strengthen geographic information system infrastructure and services. It also builds on the foundation already created by the Harvard Map Collection and Harvard Geospatial Library (HGL). HGL holds more than 5,000 layers of digital geospatial information in vector and raster format along with Federal Geographic Data Committee (FGDC)-compliant metadata. HGL now uses the ArcIMS® WMS connector to view open map services and display images managed by ArcSDE®.

Some students in public health programs have obtained the most detailed GIS training to supplement their public health curriculum through courses offered by the Harvard Graduate School of Design. Other introductory workshops have been sponsored by the Harvard Map Collection and HSPH. Beginning in spring 2007, a spatial statistics course will be offered jointly by the HSPH Biostatistics Department and the Harvard Faculty of Arts and Sciences Statistics Department.



Environmental health air pollutants mapping

While individual researchers throughout HSPH use GIS in a wide range of public health applications, three groups at the school have been particularly active in promoting the use of GIS and spatial analysis in public health research: the Exposure, Epidemiology, and Risk Program (EERP); the Environmental Statistics group; and the Public Health Disparities Geocoding Project.

EERP operates within the Department of Environmental Health, where more than 100 interdisciplinary researchers are actively engaged in studying environmental and occupational hazards. GIS has been a particularly valuable tool to researchers studying the health effects of air pollution. EERP researchers often work closely with the Environmental Statistics group within the Department of Biostatistics.

Environmental health researchers also receive GIS and biostatistics support through the Harvard National Institute of Environmental Health Sciences Center for Environmental Health. Environmental Statistics group members maintain a Web site that publicizes current HSPH research that involves GIS in public health (http://biosun1.harvard.edu/research/divisions/env_stat/GISinLMA/index.htm).

Researchers in the Department of Society, Human Development, and Health at HSPH have created a publication, *The Public Health Disparities Geocoding Project Monograph* (www.hsph.harvard.edu/thegeocodingproject), that provides an introduction to geocoding and using area-based socioeconomic measures with public health surveillance data.

Columbia University, New York

Mailman School of Public Health

- *GIS combines public health and urban planning*
- *First course design, instructor material, and real data*
- *Community collaboration projects for hands-on experience*

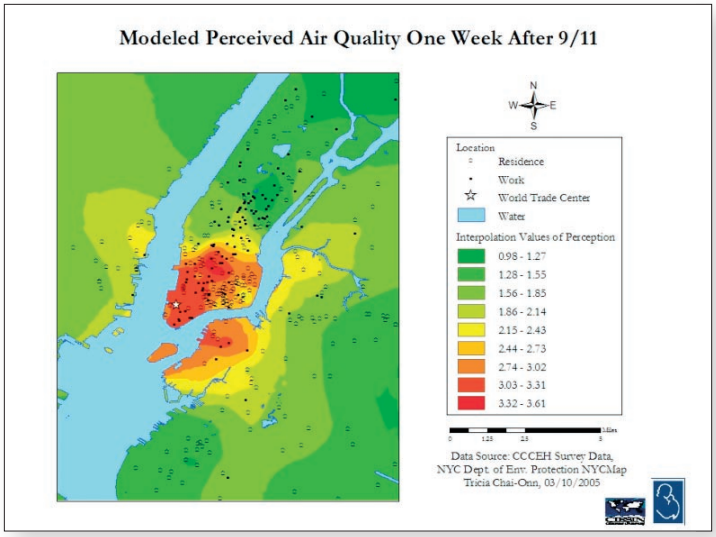
The Mailman School of Public Health (MSPH) of Columbia University in New York City, New York, is one of the first public health schools in the country and one of the largest. MSPH was the first institution to establish programs in sociomedical sciences and psychiatric epidemiology training and to offer a joint degree in business and public health. It has recently initiated a joint master's program in public health and urban planning and is beginning to incorporate GIS education into its curriculum offerings.

According to Dr. Brandt-Rauf, Columbia professor and chair of the Department of Environmental Health Sciences, professor of earth and environmental engineering, and professor of medicine, "GIS is a very important tool in environment health for visually mapping and seeing relationships between risk factors. Plotting data can help with prevention and mitigation efforts."

The introduction of GIS classes began when Mark Becker and Meredith Golden, senior research associates at the Center for International Earth Science Information Network (CIESIN), won the 2005–2006 Dean's Award for Excellence in the Curriculum, providing funds to develop and teach the first class in the spring of 2006. CIESIN, a unit of the Earth Institute at Columbia, had already been assisting researchers at the MSPH Columbia Center for Children's Environmental Health (CCCEH) and Columbia Superfund Basic Research Program in integrating spatial analysis and mapping into their projects. The demand for an introductory GIS had grown steadily because of these efforts.

Students registered for the GIS class represented a cross section of MSPH programs in sociomedical sciences, population and family health, epidemiology, environmental health sciences, biomedical informatics, general public health for physicians, and Harlem Hospital's continuing education. The course was designed to provide basic knowledge in GIS tools and techniques; population, environmental, and health databases; geospatial research protocols; and health policy and research applications. The format was a combination of lectures by instructors and guest speakers, hands-on lab exercises, class journal presentations, and a field trip to CIESIN laboratories.

Lectures followed readings from the required text, *GIS and Public Health,* by Ellen Cromley and Sara McClafferty. Hands-on GIS work was drawn from the ESRI Virtual Campus course *Learning ArcGIS 9.1* and from instructor exercises utilizing New York City (NYC)-specific data and health research planning scenarios. Guest speakers showed how GIS served as an essential tool to solve real-world problems in areas such as the GIS center at the NYC Department of Health and Mental Hygiene, United Nations Office for the Coordination of Humanitarian Affairs, and Columbia's International Research Institute for Climate and Society. Guest lecturers in many cases encouraged students to apply for internships.



Visualizing post-9/11 survey data

"GIS is a necessary tool for mapping patterns of health, morbidity, and mortality," said Dr. Robert Fullilove, a course guest speaker and codirector of the MSPH Urbanism and the Built Environment track. "Pictures are worth a thousand words and can tell a story more effectively to policy makers than the usual public health graphs. GIS is where our work is headed." Urbanism students are encouraged to take the GIS course as one of their electives.

Students were happy to have the opportunity to get some hands-on experience with GIS. Graduate student Patricia Peretz noted that she and her peers are gaining insight into using GIS for multidisciplinary research that addresses public health issues from several perspectives. "I have really enjoyed this course," said Peretz, "and I hope to utilize GIS in my professional work once I graduate this spring."

The course computer lab has 25 machines outfitted with ArcGIS software and its Spatial Analyst, 3D Analyst™, and Geostatistical Analyst extensions. Under the terms of Columbia's university site license program, ArcGIS is also installed in two library computer labs. Through ESRI's student trial license program, each class participant received a copy of ArcGIS with a number of extensions.

Evaluations from this first offering registered a strong interest in more advanced GIS and spatial analysis courses. Representatives from the NYC Department of Health and Mental Hygiene expressed an interest in building closer ties to MSPH through the development of collaborative GIS projects and training workshops. MSPH faculty will be working hard to develop a comprehensive geospatial analysis component as an essential and integrated part of the curriculum.

Loma Linda University School of Public Health, California

Health Geoinformatics Programs

- *GIS in School of Public Health*
- *GIS integrated into public health education, research, practice*
- *Bachelors and masters programs*

Founded in 1905 with a mission of bringing health, healing, and wholeness to humanity, Loma Linda University (LLU) supports a health care education program that provides personnel, training, and logistic support to health services around the world. Located in Southern California, the university enrolls approximately 3,400 U.S. and international students in health disciplines that include medicine, nursing, dentistry, pharmacy, allied health, graduate studies, science and technology, and public health. The LLU School of Public Health (LLUSPH) was established approximately 40 years ago. Accredited by the Council on Education for Public Health, LLUSPH operates the university's health geoinformatics education programs.

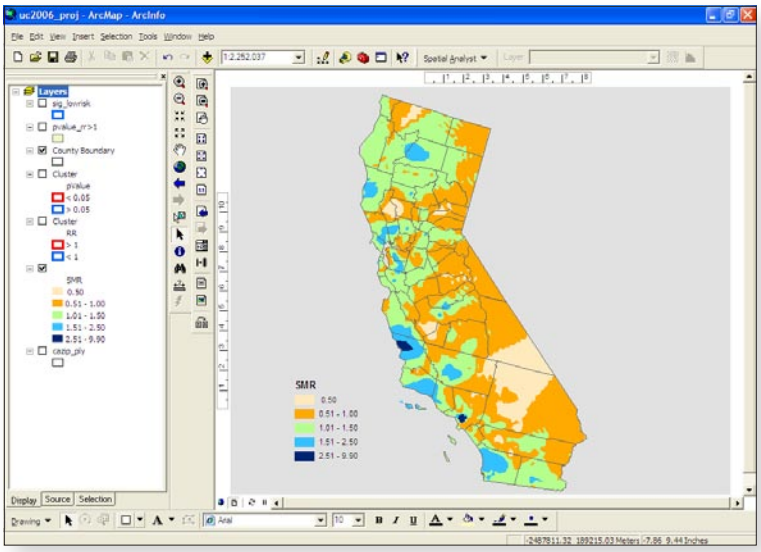
Health geoinformatics is an emerging discipline that uses innovative scientific and geospatial technology to investigate health issues. Geoinformatics practitioners collect, organize, share, and present information about where we live, who we are, and how we live with the ultimate goal of providing optimal solutions to public health. The LLU health geoinformatics programs prepare students to apply geospatial information science and technology to public health learning, research, and practice.

"The LLUSPH vision is to be the premier provider of health geoinformatics, training, and education for the public health workforce in the United States," said Dr. David Dyjack, LLU interim dean for the School of Public Health. "The school also supports efforts to enhance geoinformatics capacity in countries with developing economies and to advance the use of interoperable information systems in the many organizations that participate in public health."

In 1996, school faculty designed and taught the first graduate-level GIS course offered at a U.S. school of public health. Two years later, the university launched the country's first health geographics bachelor's degree. In late 2004, a graduate-level certificate in health geoinformatics was introduced. Three new tracks offer GIS degrees in global health and development, business administration, and environmental health.

To foster communication with other groups, LLU faculty members have participated in programs promoting the use of GIS in public health such as a Centers for Disease Control and Prevention (CDC)-sponsored satellite broadcast course on health geoinformatics. In addition, LLU belongs to Earth System Science Education in the 21st Century, a collaborative program through which faculty from 20 U.S. colleges and universities share learning resources.

Loma Linda University students work in the geoinformatics laboratory.



Map of standardized mortality rates in California renal transplant patients

Current study programs include

- Bachelor of science in public health degree program in Health Geographics and Biomedical Data Management
- Graduate certificate program in Health Geoinformatics
- Master of business administration in GIS track
- Master of public health degree in GIS for Global Health and Development track
- Master of public health degree in GIS for Environmental Health track

In the near future, LLU plans to establish a health geoinformatics education and training resource center. The center will support the use of spatial technology in health applications in interschool work, research, and service programs. It plans to develop and provide GIS educational methods and products that promote scientifically sound public health practices and ethical use, analysis, and dissemination of data. The center will also develop a continuing education program in health geoinformatics, establish a 10-week intensive Public Health GIS Institute program, participate in research promoting the use of geospatial technology, and support the global use of GIS and spatial analysis in health.

In addition to providing training and education, LLUSPH is involved in several funded research projects that use geospatial technology. An Environmental Protection Agency project studies the cardiovascular health effects of long-term exposure to ambient air pollutants in California. The African American Health Initiative project is a community-based participatory planning project that includes an inventory of all San Bernardino County, California, health service providers who offer African-Americans prevention and treatment programs for hypertension, heart disease, HIV/AIDS, and prostate and breast cancer. LLUSPH is also one of CDC's designated Centers for Public Health Preparedness (CPHP) and a regional academic center of excellence in environmental health with an emphasis on Native American workforce capacity building.

Program challenges center on funding and include limited external funding resources and few health GIS internship opportunities for students. Factors contributing to the success of the program include an availability of faculty with GIS expertise, support from program innovators within the School of Public Health, growing awareness of GIS potential in public health practice, continued growth of research and integrated use of GIS in health-related specialties, and support from LLU administration.

LOMA LINDA UNIVERSITY

University of Mississippi Medical Center, Jackson

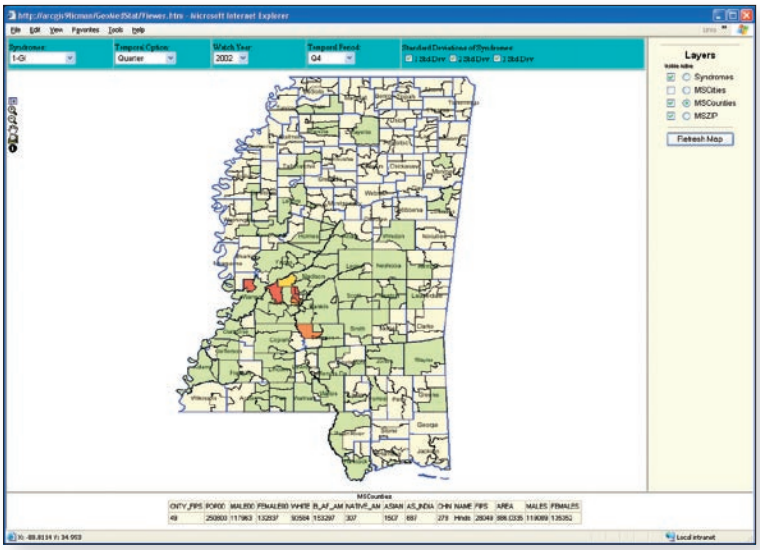
GIS Program

- *Statewide education ESRI software license agreement*
- *GIS and remote sensing*
- *Partnership with NASA to fund geospatial research*

The University of Mississippi Medical Center (UMMC) is the health science campus of the University of Mississippi. In 2000, UMMC was the nation's first public academic health center to establish its own GIS program.

Located in Jackson, the state's capital city, UMMC houses the Schools of Medicine, Nursing, Dentistry, Health-Related Professions, and Graduate Studies in the Health Sciences. It also includes the 722-bed University Hospitals and Clinics and the Rowland Medical Library.

"The impetus to begin applying GIS and remote sensing to health care research at the medical center was the collective result of a group of people thinking in innovative ways," said Dr. David Dzielak, UMMC associate vice chancellor for Strategic Research Alliances. "The primary element in successfully establishing a program was receiving really good administrative support from the institution."



Distribution of Mississippi hospital patients with gastrointestinal syndrome in 2002, mapped using GeoMedStat, a GIS-based surveillance system

After the Board of Trustees, State Institutions of Higher Learning of Mississippi, signed a statewide license agreement with ESRI, the associate vice chancellor for Health Affairs, School of Nursing dean, and other administrative leaders supported the idea of starting an academic program for GIS in health science applications. The GIS initiative began with a three-fold mission aligned with the UMMC mission for health professional education, patient care, and research.

In 2002, the GIS program acquired its own classroom and built the lab by using available equipment. Today, the program has 19 new student and research desktop stations with current state-of-the-art software. GeoMedStat, a software the medical center developed for GIS-based public health surveillance, is also installed.

The Divisions of Infectious Diseases and Clinical Immunology and Allergy in the Department of Medicine and the Department of Pathology, all in the School of Medicine, played critical roles in the technological advancement of the GIS and remote-sensing program. These groups fostered a partnership with the National Aeronautics and Space Administration (NASA) and related research projects, which helped spark funding and application ideas. Faculty are currently using GIS to develop applications that integrate emergency room data, study environmental variables for infectious diseases, and develop new ways of analyzing cancerous cells using hyperspectral images.

Synergistic forces, including staff, faculty, and administration, are behind the current pace of growth with the objective of being able to provide leadership in health GIS training and research. A priority for the program is obtaining external support and collaboration through strategic research alliances.

The academic component is available to all medical center graduate students, and students from any program can take directed-study courses. Dr. Fazlay Faruque, director of GIS and a professor of health systems, has more than 15 years of experience in GIS and remote sensing and is a certified instructor for ArcView and ArcGIS training courses. Visiting instructors with skills in their respective areas of specializations teach additional classes.

"The program philosophy is for students to learn GIS as a tool to enhance the learning process and apply this tool to research both in health care and in epidemiology," said Faruque. Courses have three components: background theory; hands-on training; and application on a real, but small, project. Most medical center students are enrolled in the clinical track, and the courses introduce students to the application of GIS in their respective areas.

Major challenges include textbooks, quality health-related data, and sustained funding. Faruque indicates that textbooks on health GIS focused on medical and clinical sciences are lacking. Currently, the ESRI training manual is used for the hands-on component, and handouts are provided for theory discussions.

"We also owe our success to the really dedicated individuals, such as Dr. Faruque and his team, who have worked so hard to put together the program and explain and demonstrate the vision of this new field," said Dzielak. "It is very much a cross-disciplinary project—similar to the way other modern research is moving forward—with a wide range of expertise within the team.

The program's five-year goal is to create a top geospatial research institute for health sciences. Commented Dzielak, "The future lies in being able to use GIS systems for more complex analytical challenges, such as for environmental health and mapping out disease surveillance in near real time. When you have an outbreak of symptoms such as a virus and you put them into a mapping format, the data and the situational awareness jump right out at you."

University of Mississippi Medical Center campus

New developments will include courses on GIS and remote sensing in epidemiology and health care as well as health GIS training for participants in the World Health Organization. Research will continue in the areas of epidemiology and health care.

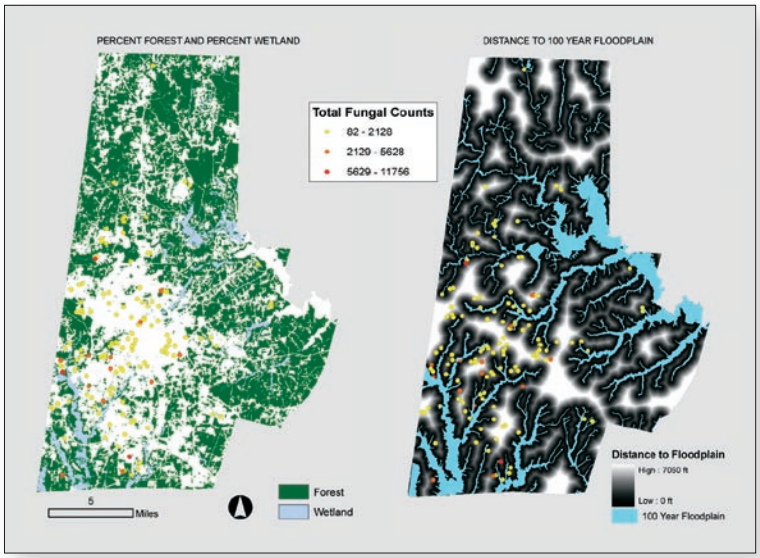
Duke University, North Carolina

The Children's Environmental Health Initiative

- *GIS for research*
- *State, local, and national partnerships*
- *Innovative methodologies and applications*

The Children's Environmental Health Initiative (CEHI) is a research, education, and outreach program committed to fostering environments where all children can prosper. Situated in the Nicholas School of the Environment and Earth Sciences at Duke University in Durham, North Carolina, CEHI maintains a staff of 18 full-time research associates and many graduate and undergraduate research assistants. Marie Lynn Miranda, Ph.D., serves as the director of CEHI as well as associate research professor at the Nicholas School. CEHI works to bridge the social and natural sciences in ways that provide policy makers and the public with a clearer sense of the trade-offs in children's environmental health program choices. GIS technology plays a prominent role in research design and results presentation.

The long-term vision for CEHI is to use spatial design of environmental health research to forge a completely new approach to addressing children's environmental health issues. To address children's health outcomes fully, CEHI views innovative methods for examining the simultaneous and combined influences of environmental, social, and genetic factors as imperative.



Display comparing patterns of fungal counts in homes with specific land type variables

Accounting for temporal, spatial, and other unique components of children's physical environments, combined with variances in host and psychosocial factors, can greatly enhance understanding of children's health. Thus, CEHI's research mission is to work collaboratively to develop sound and systematic methodologies for assessing and analyzing the causal interactions and pathways through which the environment, host, and psychosocial domains operate in a child's life.

Four approaches characterize all CEHI work. First, CEHI focuses on children, with a special emphasis on the developing fetus and very young children. Second, CEHI works to provide insight into how to shift children's environmental health programs from mitigation to preventive approaches. Third, CEHI pays particular attention to issues of environmental justice and health disparities, striving to identify populations at risk and prioritize them for preventive intervention and community outreach. Fourth, CEHI's technical area of interest is spatial analytics.

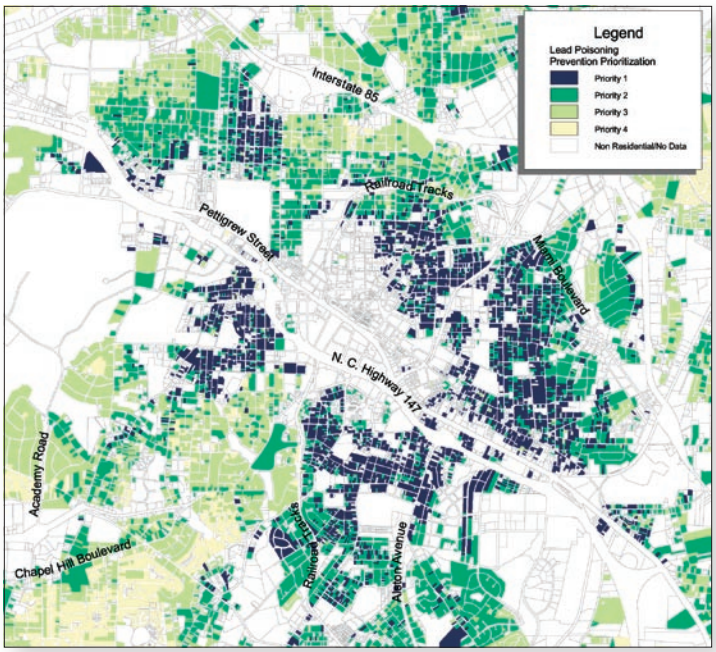
At least three things distinguish CEHI's spatial analytic work from other research. CEHI has developed methodologies for operating at very refined levels of geographic resolution that are particularly useful for identifying children at risk for environmental exposures. CEHI has also developed methods to link previously unrelated datasets such as census demographic, county tax assessor parcel, and childhood blood lead screening data. Finally, from the beginning of the research design of these models and databases to project end, CEHI strives to incorporate translational applications including methods for disseminating research results to the community at the local, regional, and national levels. In this way, CEHI ensures that public and private health providers, as well as community groups, are primed to implement policies based on research findings as soon as they become available.

All CEHI team members know how to use ArcGIS software. In addition, GIS analysts rely on ArcGIS software extensions, such as ArcGIS Spatial Analyst and Trimble GPS Analyst, to enhance their work. For fieldwork, CEHI uses Trimble GeoXH™ GPS devices. To control data access, all sensitive digital data at CEHI resides on a completely private (i.e., no access to the Internet), password-protected network.

Ongoing CEHI research projects range from studying the optimal spatial design for environmental health research to mapping for good health and disease prevention. Each project is funded by one or several outside organizations that include the National Institute of Environmental Health Sciences, U.S. Department of Housing and Urban Development, and U.S. Centers for Disease Control and Prevention.

With funding from CDC, CEHI developed a model of childhood lead exposure risk spatially resolved at the individual tax parcel level. The model combines county tax assessor, North Carolina blood lead screening, and U.S. census data to create a GIS-based interface for predicting lead exposure risk and communicating that risk to various audiences. The lead exposure risk model is a valuable tool to facilitate preventive intervention before lead poisoning occurs. CEHI is in the process of developing this model for the entire state of North Carolina as well as in some national replication sites.

CEHI maintains an expanding network of partnerships and collaborations with community organizations, researchers, and regulatory agencies on the local, state, and national levels. By working through these partnerships to address issues such as childhood lead poisoning, mercury exposure, indoor air quality, and the built environment, critical feedback from a variety of perspectives is channeled into CEHI's strategies for research design and implementation.



Map showing spatial pattern of lead exposure risk priority categories in Durham, North Carolina

Johns Hopkins University, Baltimore, Maryland

Bloomberg School of Public Health

- *GIS in Department of Molecular Microbiology*
- *Launches student research*
- *Malaria Research Initiative in Africa*

Located in Baltimore, Maryland, the Bloomberg School of Public Health was the first of its kind worldwide and is the largest school of public health in the world. In addition to educating a student body of approximately 2,000, school faculty is known for pioneering new research around the globe.

The school's Department of Molecular Microbiology and Immunology (MMI) integrates many disciplines concerned with the study of the transmission of infectious diseases of public health importance. Research takes place in the laboratory, in the clinic, and in the field. The department's Geographic Information System/Remote Sensing (GIS/RS) Lab was established in 1991 with the goal of developing and supporting analytical approaches for identifying environmental risk factors that affect human diseases.

Federal government support of individual investigator projects provides most of the lab's funding, although it has also received substantial support as part of the Malaria Research Initiative, which is funded by a private donor. The majority of the work in the lab is done with ESRI and ERDAS® products on PC-based computers.

Most students are graduate students or postdoctoral fellows associated with the School of Public Health. Students receive training through a two-term set of courses, Spatial Analysis and GIS, offered through the biostatistics department, and through special studies courses.

"Many students who have taken the formal coursework have used their course projects as the starting place for their official research projects that are later published in the peer-reviewed literature," said Gregory Glass, Ph.D., supervisor of the GIS/RS Lab and MMI professor.

Quickbird satellite image of a site in Zambia used to study population and malaria distribution, land cover patterns, and more, with ArcGIS

Environmental Surveillance Core Facility for Malaria Research Initiative

Johns Hopkins Malaria Research Institute

The GIS lab provides support for ecological and environmental data associated with the school's initiative for malaria research in sub-Saharan Africa. To provide spatially explicit environmental data for researchers, the group relies on current advances in information technologies, remote sensing, and GIS to generate and manage the data.

Core personnel use a spatial scale, or GIS mapping, to provide a common factor for integrating the different environmental correlates of malaria risk. This approach complements and expands the use of traditional field and laboratory studies. Malaria field researchers at the school's Malaria Institute in Macha, Zambia, link their study data to the core's environmental GIS database. The data layers are linked to one another in a common format and scale so researchers can easily query the relationship between measured outcomes, such as the distribution or abundance of a malaria-carrying mosquito species, and numerous environmental features such as land cover, meteorological conditions, soil types, and sociological data.

In addition to specific studies, the core maintains a Web-based service to provide daily updates on the environmental conditions monitored in sub-Saharan Africa. Data provided by organizations such as National Aeronautics and Space Administration, National Oceanic and Atmospheric Administration, and the World Health Organization is available for climatological modeling of disease vector (mosquito) population dynamics. Data and maps are available for land cover type, land surface temperatures, calibrated radiance, vegetation, air temperature, and precipitation, among others. For example, satellite sensor estimates of land surface temperature have been merged with ground station instrumentation to obtain approximate +1°C accuracy in recorded temperature.

University of California, San Diego

Center for Research on Biological Systems, Calit2, San Diego Supercomputer Center, and the BIRN Project

- *GIS for research*
- *Collaborative use of data from many sources*
- *Designing GIS research tools*

The University of California, San Diego (UCSD), is a large research university with several graduate schools and institutes ranked at the top of their fields in the nation. The UCSD Department of Neurosciences and the Center for Research on Biological Systems' (CRBS) National Center for Microscopy and Imaging Research (NCMIR) hold top national and international rankings. The San Diego Supercomputer Center and the California Institute for Telecommunications and Information Technology (Calit2) are world leaders in information technologies supporting large-scale scientific and engineering projects and home to several of America's fastest and most powerful supercomputers, data resources, networking, and visualization efforts. In the absence of a geography department on campus, GIS projects have clustered at these research centers.

The Biomedical Informatics Research Network (BIRN), also a CRBS project, is a collaborative effort in which scientists from these and other institutions use GIS technology to support biomedical research and clinical information management. BIRN is harnessing the power of knowledge sharing to enable new capabilities in large-scale studies of human disorders. Launched in 2001 as an initiative of the U.S. National Institutes of Health's National Center for Research Resources, BIRN is prototyping the collaborative use of data from disparate sources to support biomedical research. The coordinating hub is located at CRBS and oversees the networking, distributed storage, and software development needs of various "test bed" neuroimaging projects. More than 30 universities and hospitals and 39 research groups participate in one or more of these projects.

Key BIRN Project Features

- Provide an infrastructure for collaborative medical research based on a large-scale grid model.
- Develop tools for analysis, visualization, and interpretation of biomedical data including analysis of spatial relationships.
- Design and deploy tools for the storage, management, and querying of complex neuroimaging data.

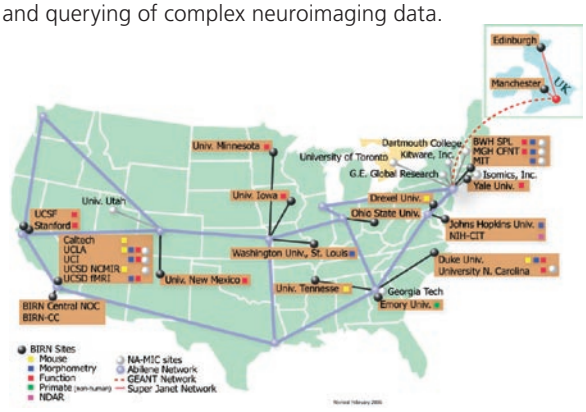
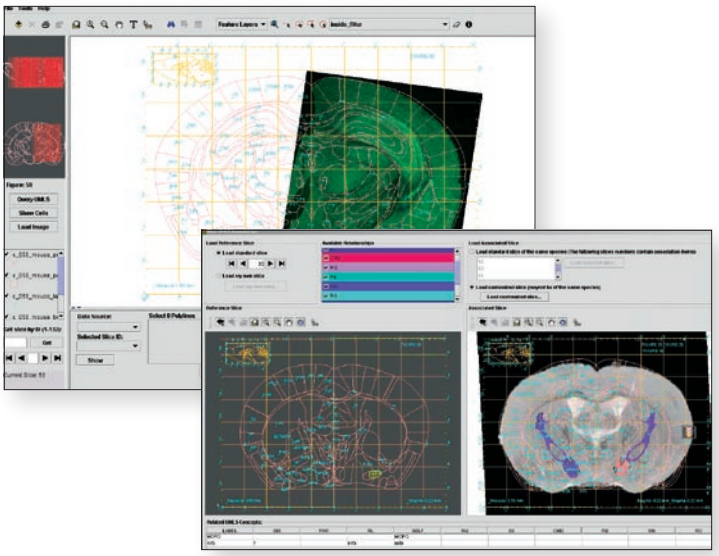


Diagram of participants in the Biomedical Informatics Research Network



Images of mapped brain cross-sections are made available through a collaborative spatial database.

Using GIS to Map Brain Diseases

Biomedical studies of brain diseases usually center on brain imagery collected from many different researchers using different instruments and techniques. Participants in BIRN's Multi-Scale Mouse Models of Disease Test Bed use ESRI GIS technology to permit open access to diverse, distributed data and make comparisons using a common mapping system. In other words, they use GIS technology to spatially integrate distributed multiscale data.

Their efforts resulted in the Spatial Markup and Rendering Tools (SMaRT) atlas, a spatial database for registration and querying of brain data. BIRN developed the SMaRT atlas using ESRI's MapObjects®—Java™ Edition. BIRN uses ArcInfo tools to align and analyze biological images and brain segmentations retrieved from partner university servers including ArcIMS servers. Instead of standard geographic nomenclature, the SMaRT atlas uses the scientific community's standard coordinate system for regions in the brain. One geographic feature layer is the anatomical delineations of the brain and their associated medical labels. Researchers can easily query, integrate, and retrieve images or biological data referenced to the standardized coordinate system.

UCSD

Getting Started with GIS in Health Education

- *Administrative support is key*
- *Funding and teaching approaches vary*
- *Teaching resources are expanding*

What can you do to add GIS to the offerings of your health education institution? These schools cite the perception by administration, faculty, and students that GIS is a viable discipline for health science as a primary element for implementing and sustaining a successful GIS program. Geographic information technology is increasingly successful in bringing new applications to health science, and many faculty researchers include geospatial components in their health research programs. However, most colleges are just beginning to implement GIS into the health curricula. Several models are in place for schools that plan to incorporate GIS curricula in their health education programs.

Attitudes about the placement of GIS within the academic institution are still being formulated, but more often than not, ownership lies outside the health education department. Regardless of the department or departments that run the GIS program, facilitators who actively offer technology accessibility to a wide scope of disciplines have a broader opportunity for applications and benefit. Health-related schools lacking GIS resources have been proactive in seeking them through interdepartmental cooperation, grant writing, and the development of strategic research alliances.

Research alliances help establish funding for acquiring technology and some student scholarships. The research programs also provide an opportunity for students to work with real data, learn sophisticated GIS techniques and modeling, and apply GIS technology solutions to real health and human services issues.

Pedagogical approaches differ between schools. Some focus more on developing GIS technological skills; others focus more on analysis within the body of health science. Both approaches blend technology and science, but the balance of emphasis varies, as does the use of class materials and project types. On one hand, formulaic approaches that use tried and proven data and projects geared for success allow students to learn a wide range of applications. On the other hand, real-world projects and research offer a comprehensive view of how GIS seats itself within the organization and introduce the student to project management experience.

Some instructors were frustrated by a lack of health-specific textual resources for classroom support and research projects. Faculties enrich course material by bringing in guest speakers and developing collaborative projects with local health departments, but there is a need for case studies, shared data for research projects, and local health community relationships. Some schools broaden students' experiences and networks by hosting workshops and conferences.

ESRI Press offers a new health-specific teaching resource, *GIS Tutorial for Health,* by Kristen S. Kurland and Wilpen L. Gorr. Other relevant ESRI Press publications include *GIS for Health Organizations* by Laura Lang; *Cartographies of Disease: Maps, Mapping, and Medicine* by Tom Koch; *GIS Tutorial: Workbook for ArcView 9* by Kristen S. Kurland and Wilpen L. Gorr; and *Designing Geodatabases: Case Studies in GIS Data Modeling* by Dr. David K. Arctur and Michael Zeiler.

Success in all the schools in this study was a result of strong administrative support. Proponents of GIS for health education face the task of both formulating and changing the positions of administrators, faculty, and students about the advantages GIS brings to health sciences. Attitudinal change frequently comes by creating awareness.

The tactics employed by the schools in this study for improving teacher education and learning resources include establishing their own education and training resource centers, sharing learning resources with other higher education institutions, sponsoring collaborative workshops and satellite broadcast courses, and developing relationships with the health community and GIS industry.

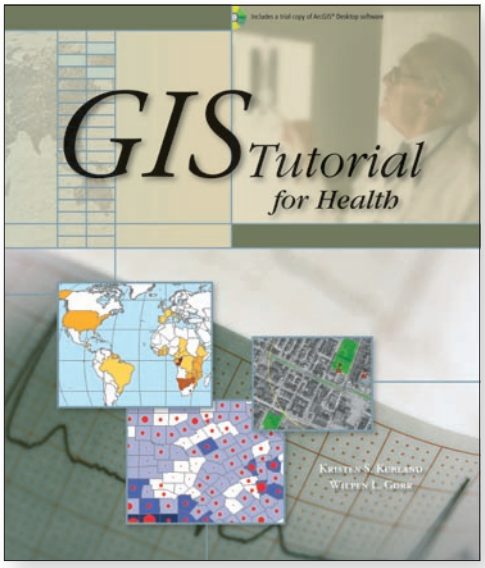
Additional resources for learning more about GIS in health and education and course listings are available at

www.esri.com/health

www.esri.com/university

www.esri.com/industries/health/resources/training.html

For more information, contact Peggy Harper, ESRI health and human services industry solutions team, at pharper@esri.com.



GIS Tutorial for Health, *an ESRI Press textbook designed to help students use GIS to solve problems and gain hands-on experience with health-related data*

Institutions Offering Health-Related GIS Courses

Many higher education institutions offer health-related GIS courses and programs worldwide. The following is a selected, but not exhaustive, list of courses and programs offered in Canada, New Zealand, the United Kingdom, and the United States.

Canada

McMaster University
School of Geography and Earth Sciences
Hamilton, Ontario, Canada
Course Title: *Applications Course*

University of British Columbia
Department of Geography
Vancouver, British Columbia, Canada
Course Title: *Applied GIS in Conservation Biology, Health Geography, and Crime Analysis*

New Zealand

University of Canterbury
GeoHealth Laboratory
Waitaha, Christchurch, New Zealand
Course Titles: *Geography, Health and Welfare* and *Geospatial Information Technology for Health Scientists*

United Kingdom

University of Bristol
Department of Social Medicine
Bristol, United Kingdom
Course Title: *Geographical Information Systems*

University of Leeds
School of Geography
Leeds, United Kingdom
Program: Master's in Geographical Information Systems

University of London
London School of Hygiene and Tropical Medicine
London, United Kingdom
Course Title: *Two-Day Introduction to Geographical Information Systems and the Software ArcView*

United States

Carnegie Mellon University
H. John Heinz III School of Public Policy and Management
Pittsburgh, Pennsylvania
Course Title: *Health Geographical Information Systems*

Columbia Univeristy
Mailman School of Public Health, Environmental Health Sciences
New York City, New York
Course Title: *Environmental Health Science GIS*

East Tennessee State University
Public Health Department
Johnson City, Tennessee
Web site: www.etsu.edu

Emory University
Rollins School of Public Health, Department of Biostatistics
Atlanta, Georgia
Course Title: *Geographic Information Systems for Public Health*
Program: Master's in Public Health Informatics

Florida A&M University
Institute of Public Health
Tallahassee, Florida
Course Title: *Demographic Analysis Using GIS*

George Mason University
Office of Continuing Professional Education
Fairfax, Virginia
Course Title: *Public Health Administration and Analysis*

Harvard University
School of Public Health
Boston, Massachusetts
Course Titles: *GIS and Health Planning: Facilitating Use of Geographical Data in Public Health* and *Spatial Statistics for Health Research*

Johns Hopkins University
Bloomberg School of Public Health
Baltimore, Maryland
Course Title: *Epidemiologic Applications of GIS*

Loma Linda University
School of Public Health
Loma Linda, California
Programs: Bachelor's in Health Geographics, Health Geoinformatics Certificate Program, and Health Geoinformatics Summer Institute

New York University
Robert F. Wagner Graduate School for Public Service
New York City, New York
Course Title: *GIS in Health Care*

State University of New York (SUNY)—Albany
School of Public Health
Albany, New York
Course Title: *Geographic Information Systems (GIS) and Public Health*

Tulane University
School of Public Health and Tropical Medicine
New Orleans, Louisiana
Course Titles: *Introduction to Public Health GIS* and *Introduction to ArcGIS I*

University of California, Berkeley
School of Public Health
Berkeley, California
Course Title: *GIS and Remote Sensing in Public Health*

University of Illinois, Chicago
School of Public Health
Chicago, Illinois
Course Title: *Geographic Information System Application in Public Health*

University of Illinois, Urbana-Champaign
College of Veterinary Medicine
Urbana, Illinois
Course Titles: *Workshop in GIS* and *Spatial Analysis for Public Health and Spatial Epidemiology*

University of Mississippi Medical Center
Jackson, Mississippi
Course Titles: *Introduction to Geographic Information Systems (GIS)* and *Environmental Health*

University of North Carolina at Chapel Hill
University Libraries
Chapel Hill, North Carolina
Course Title: *GIS and Health Geography*

University of Pittsburgh
Department of Behavioral & Community Health Sciences
Pittsburgh, Pennsylvania
Course Title: *Information Management in Public and Nonprofit Organizations*

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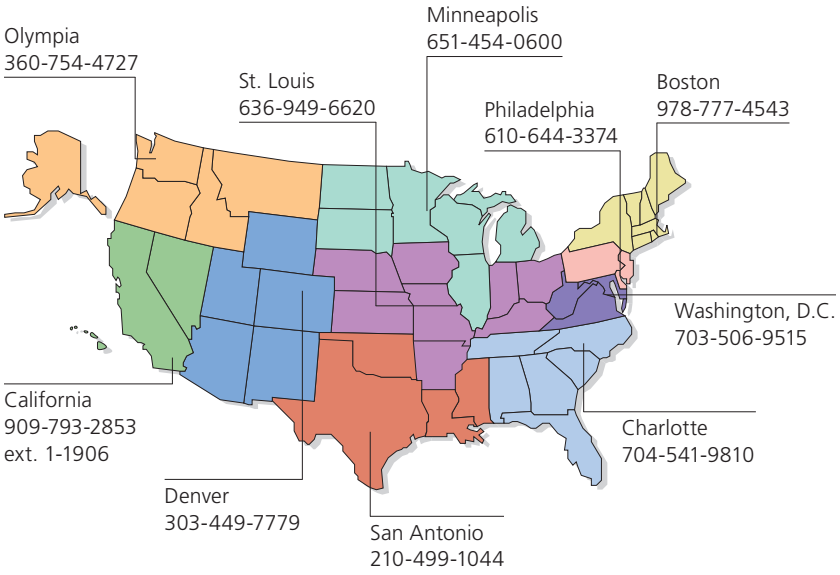

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