

# GEOMEDICINE CAN GEOGRAPHIC INFORMATION MAKE ME HEALTHY?



By Bill Davenhall, Esri



## **What Is Geomedicine?**

This e-book sets forth the notion that the emerging field of geomedicine will produce a new type of medical intelligence that will leverage national spatial data infrastructures to benefit personal human health. Linking one's own personal health status to specific geographic factors can provide another set of powerful information tools that medical professionals can use to improve the quality of the care they deliver. Geomedicine, in the future, will mean that we will experience an increase in the number of patients who benefit from a more precise clinical understanding of the links between their health and where they live, work, and play. At the present time, very little of health-relevant geographic information is available to a clinician at the time of a medical diagnostic encounter, and it is certainly not a typical part of a comprehensive medical record. Leveraged by a geographic information system (GIS), information on a patient's potential environmental exposures can be delivered into the hands of clinicians while the patient is in the examination room. Using modern information technology in this way can go a long way to help both physicians and the patients they serve.

## **About the Author**

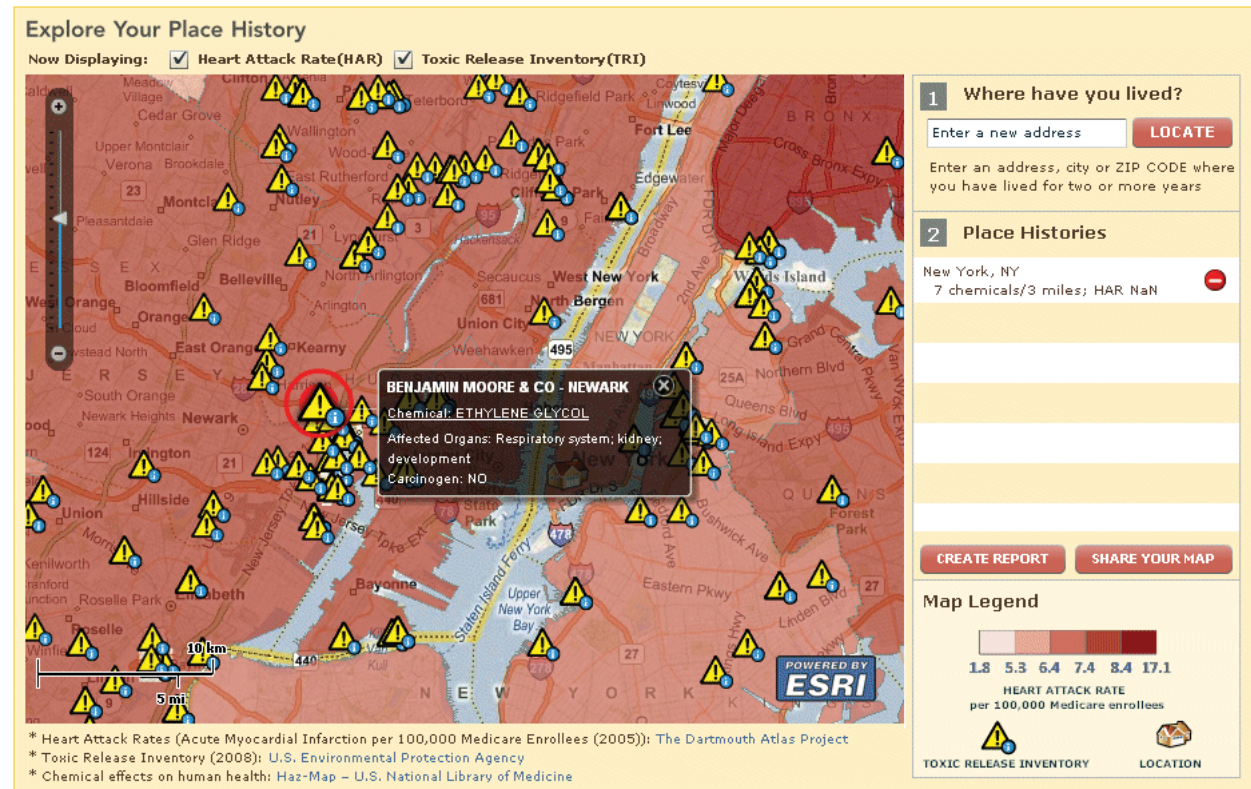
Bill Davenhall has worked in the health and human services field since the early 1970s; since then, he has directed many different initiatives that involve the progressive use of information systems within health care and human service delivery organizations. Davenhall is a frequent speaker and writer and is well known as one of the leading advocates for the use of GIS to help solve the challenges in health and human services. He earned a master's degree focused on medical behavioral science research from the University of Kentucky (USA). Davenhall is the global manager of Esri's Health and Human Services Solutions Group at its headquarters in Redlands, California. Founded in 1969 and presently the world's leading GIS software vendor, Esri serves more than 300,000 clients. The health and human services solutions sector is a community of more than 5,000 licensed users worldwide, housed within over 114 national health ministries and thousands of community-focused health departments, community hospitals, managed health care programs, and health-related businesses. Esri develops and supports its software through 90 international distributors and more than 3,000 associates worldwide.

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# The Missing Link in Our Personal Health History

In 2001 I was hit by a train. Not a real train—but it might as well have been! My train was a heart attack. When it happened I thought to myself, "why me," "why now," "why here?" I thought I was in good health. I had followed the advice of many doctors, but still the train hit me. As I worked through my crisis, I started thinking about the many factors that could have contributed to my heart attack and wondered *why had I not had better warning?*

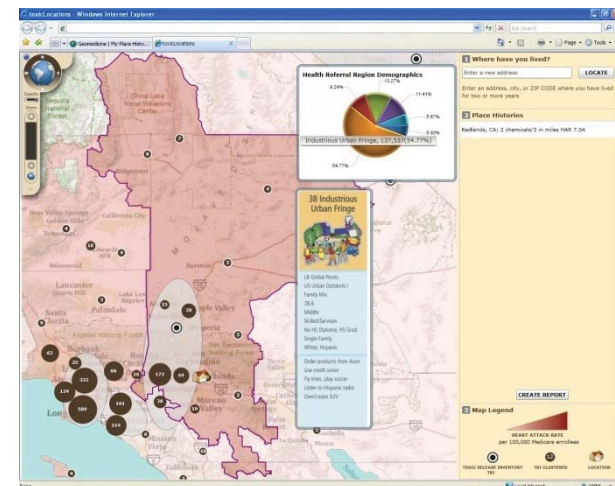


Using Esri's *Explore Your Place History* mapping application at [www.esri.com/geomedicine](http://www.esri.com/geomedicine), you can view heart attack rates, the U.S. EPA's Toxic Release Inventory, and more, for areas where you've lived and worked.

Having worked in and around healthcare for many years, I had learned a great deal about how to avoid a heart attack. You know, the usual things: avoid risks, live a healthy lifestyle, control my weight, choose better food and drink, don't smoke, reduce stress . . . all excellent advice to a reasonable person.

Like many of you, however, I had provided a lot of personal information to all my healthcare providers over many years, such as family history, medication history, surgical history, disease history, allergy history, social history and of course my lifestyle inventory. I now wondered why none of that information had actually helped avoid the roaring train bearing down on me.

I soon began to discover that there were many different reasons why I may have been hit by that train. In addition to all the usual suspects, high blood pressure, high cholesterol, stress, genetics, I discovered that many environmental conditions and exposures could greatly increase my risk for a heart attack. Things like air quality and exposures to pollutants—some that I did not even know existed in the communities where I lived. As I began to research the places (aka geographies) where I had lived—both as a child and an adult—I began to discover disturbing information on what I (and my doctors) could have already known about the quality of my various environments and what the impact might be on my future health.



*Heart attack rates, EPA Toxic Release Inventory, and other information can show links between your health and where you have lived. (Copyright Esri and the Trustees of Dartmouth College)*

My search was not easy, even on the Internet. Large volumes of health information spread across many governmental and health related Web sites of varying quality. While I cannot prove that any one of my specific environments caused my heart attack, there was plenty of evidence that some of the contaminants I had been exposed to in places where I had lived were well known precursors to circulatory and respiratory disease—and yes, heart attacks. It was at this moment that I realized that a physician looking at my health history, in the absence of any specific information about my unique environmental exposures (geographically), would be less likely to warn me, let alone guide me away from the oncoming train wreck. The problem, as I have come to see it, is that none of my physicians had a useful or easy way of translating all that rich environmental health research into something that would benefit me directly. Why was it so difficult for me and my doctors to connect the dots?

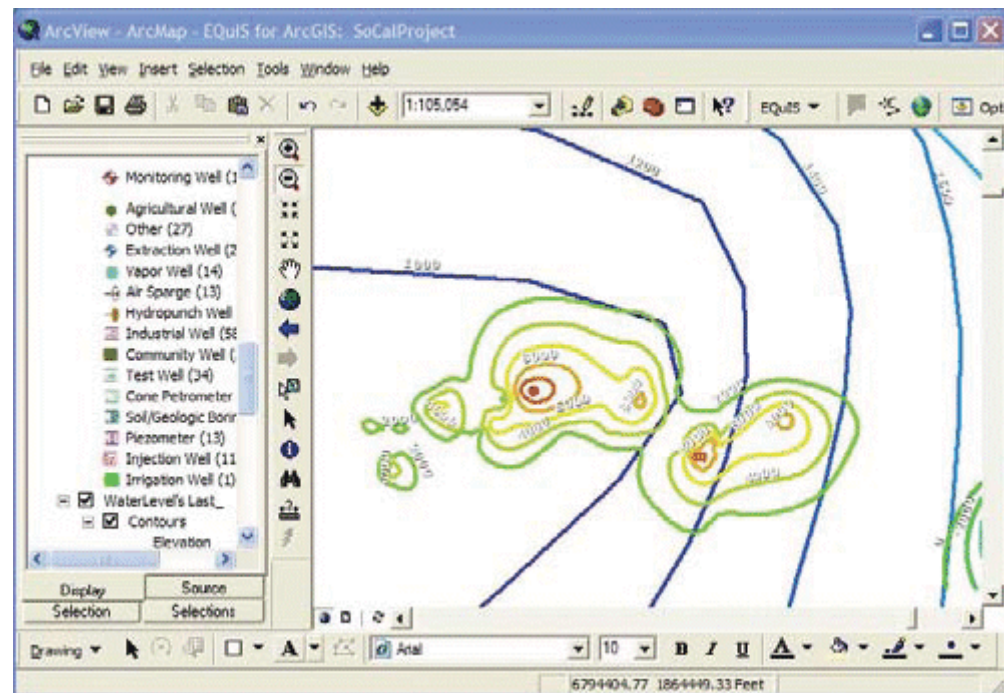
Every place I have ever lived and will live is part of my medical history. The impact of breathing bad air in many of the places I have lived will surely follow me wherever I go, and therefore, my medical record should be automatically informed about new research findings of relevant health risks.

Unfortunately, today my medical record, and probably yours as well, is already a vast collection of clinical facts, observations, test results and diagnostic conclusions but remains silent about the accumulation of environmental health impacts and risks. As a patient as well as a good health-seeking consumer, I need to be better served by the great wealth of environmental health research that is available. I also need to do what I can to increase the capacities of physicians to consume and use this information in smarter ways.

I invite you to think about the places you've lived, or where you live today, and learn more about the impacts of your environments on your own health. Think about how you might approach your own health discovery process as I have done. There is much to learn about geomedicine and understanding how it can become a valuable tool in clinical practice. I hope this discussion of geomedicine is the beginning of your personal journey to discover ways to stay healthier longer.

## Geography—The Missing Vital Sign in Your Physician's Office

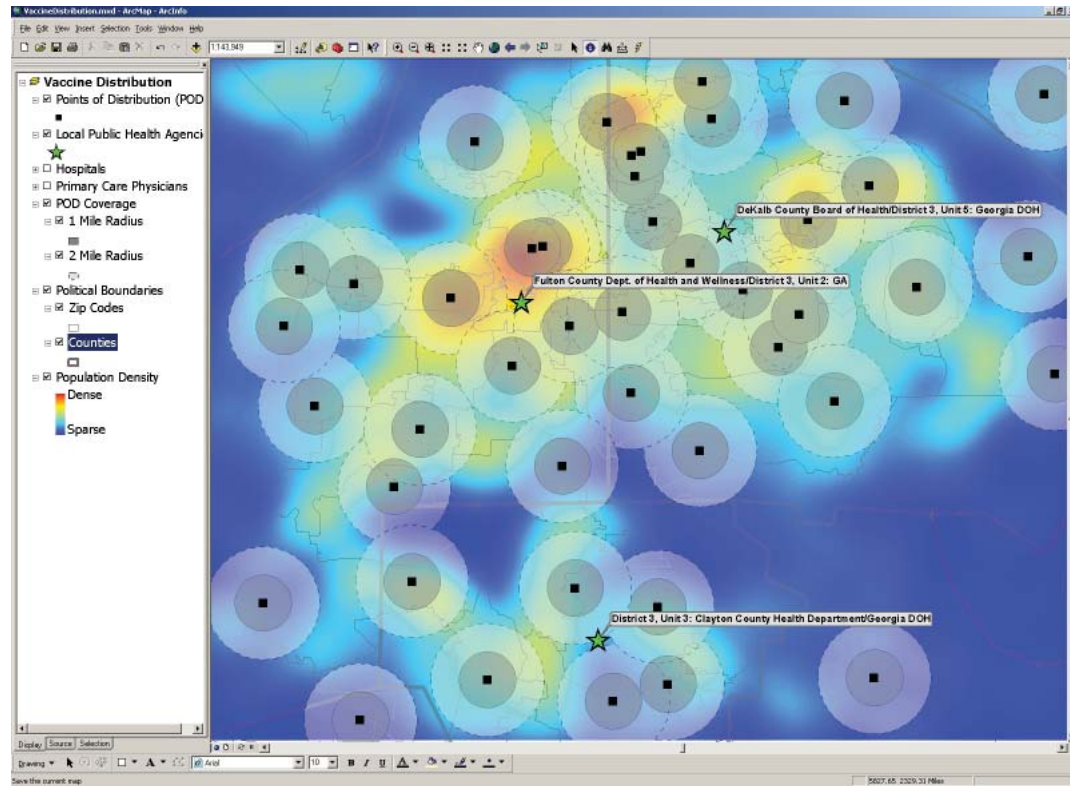
What do Hippocrates and Ethan Berke have in common? Well, for starters they are both physicians. Despite 2,400 years' difference in their ages—Hippocrates of course lived in about 400 BC, and Ethan Berke lives in the present—they both understand the direct connection between the "places" in your life and their respective impact on your personal health. They both concluded that your health depends on the air you breathe, the water you drink, and the environment in which you live. In fact, Berke believes that place (geographically) matters in your own personal health and so do many of his colleagues in family medicine.



*Assessing levels of perchlorate contamination in the water supply. Perchlorate is a chemical associated with thyroid disease and cancer.*

Berke suggests that place is another useful "vital sign" to any primary care physician—someone who is concerned about the whole patient. This belief that our "places" are actually another "vital sign" is not so hard to grasp when he suggests in the *Journal of the American Board of Family Medicine* that "recommendations made in the clinical setting pertaining to healthy lifestyles—more activity, better diets, avoidance of potential toxins or pollutants—cannot occur in a vacuum. If our patients are in a home or a work environment that does not give them the opportunity to heed our recommendation, their chance of success will be diminished." Strong words but good advice!

Here is where I am on the same page with Hippocrates and Dr. Berke: where a person lives (and has lived) must be considered as part of the context in which clinical decision-making occurs. I would add that increasing the transparency and utility of the information upon which physicians make recommendations and patients are encouraged to comply could change the way we all go about "partnering" with our personal physicians. So the next time you say "there is no place like home," think about its environmental context. The relationship we all have with our home, regardless of its amenities, is unique and potentially harmful to our health because of where that home is located geographically (and perhaps what products were used in its manufacture).



*This map helps in understanding population density in relation to vaccine distribution centers.*

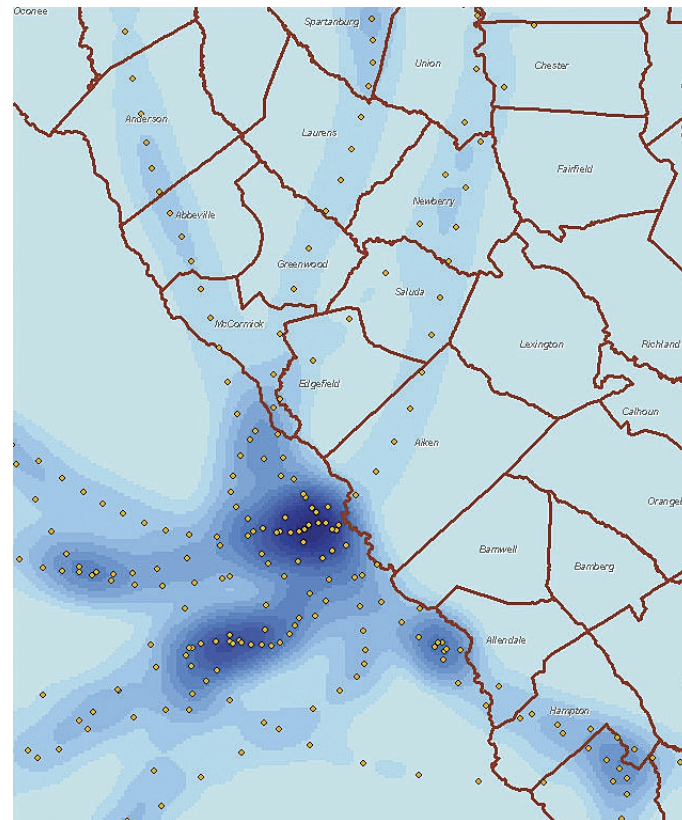
You don't have to look very far to find the evidence on this subject—just keep reading! While we typically get introduced to our first "home" shortly after birth without a choice, our personal and local environment either allows us to get a good start on life or diminishes it from the start in many different ways. So our chances of success in achieving life-long health and wellness are very connected to the places we spend those early years. Of course, adults can control many aspects of their "local" environments. We can choose not to smoke or cook over open indoor flames and to use indoor sanitation, etc. But children never get that choice.

A child has to trust someone else (like parents and governments) to protect our air, water, soil, and in some cases, our exposures to things that can harm us. This is a very big adult responsibility! You probably have your own story about geomedicine—unusual health symptoms that can't be explained, cancers that run in certain families, neighborhoods, or communities, or the onset of chronic conditions that don't appear to have a genetic or lifestyle link. Suddenly people start to pay attention to what's around them, searching for anything that might help discover a cause or offer relief or a cure.

Much like the mountain stream has a headwater, so does our personal health. Many will say that genetics is our health headwaters, but as the stream meanders across many different geographical landscapes, so does our health, accumulating unseen exposures and facing uncertain and not very apparent risks. The application of geomedicine, then, is about translating what we know about illness and disease and what we understand about the role that our various environments play in making us sick (or well) into practical information that allows each of us—physician or consumer—to make better choices about where we live and better decisions about how we engage with our environments.

## Harnessing the Power of Geography to Improve Personal Health and Safety

There is abundant evidence that the use of geographic information has had a dramatic impact on the work of health professionals. Medical epidemiologists, the first line "disease detectives," have extensively used GIS in their fight against diseases that have clear relationships between person, place, and time. GIS has also played an important role in protecting communities from otherwise overlooked risks and toxic exposures.



*A trajectory density map of the Aiken area in the state of South Carolina shows high ozone days.*

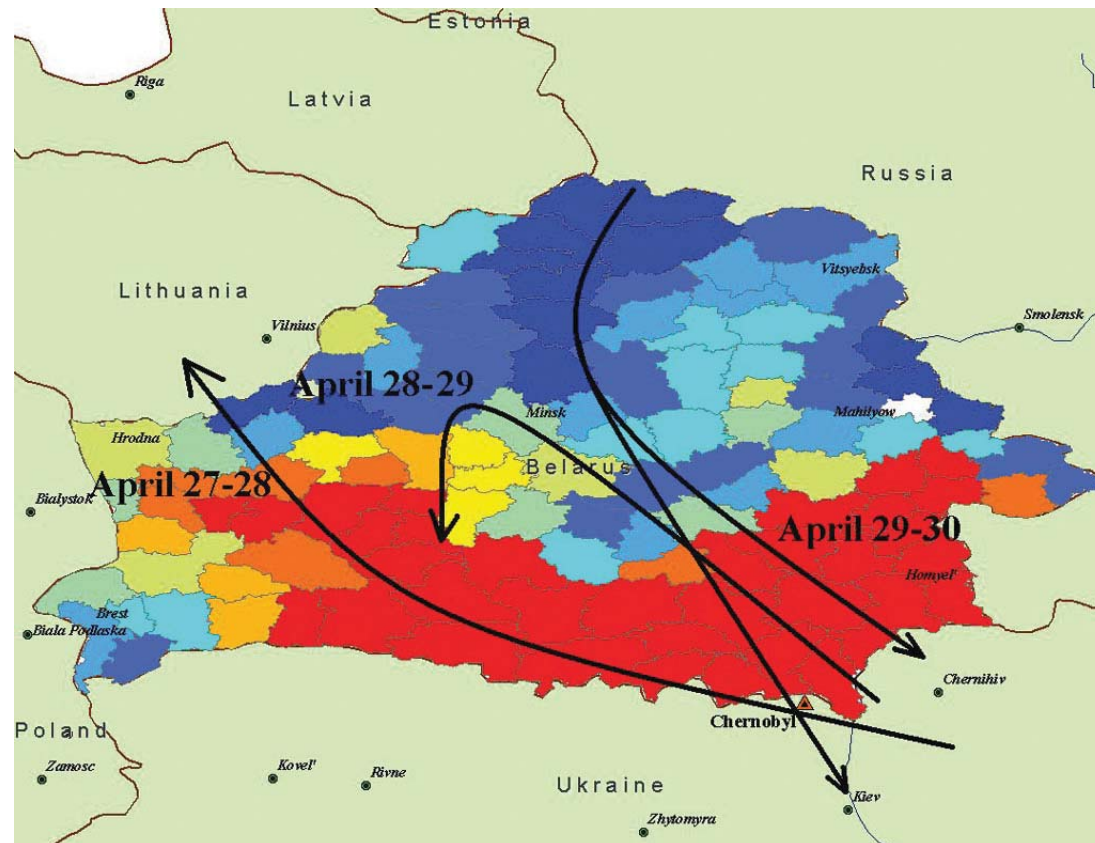
Geomedicine applies the power of GIS technology to personal health. As this concept continues to be adopted by more health care professionals, physicians will increasingly use geomedicine to help diagnose, treat, and even prevent illness, and in some cases even make recommendations to patients on where they might live, work, and play and where achieving the highest level of health status that they are capable of maintaining can occur—geographically.

Healthcare accreditation and oversight bodies have also expressed interest in redefining the geographic scope of patient safety, encouraging healthcare providers to consider the value of integrating internally generated healthcare information with externally available population health information. Principal drivers for such a redefinition of quality care and patient safety include the impacts of unintentional toxic exposures, compromised environmental conditions, unexpected situational dangers, untoward outcomes, medical misadventures (during or after clinical care), and the lack of timely logistical information for distributing health professionals and dispensing medical supplies.

The persistent and unmistakable convergence of two powerful forces—personal human health factors and environmental conditions—continues to drive geomedicine forward. Using GIS to deliver geomedical intelligence to healthcare practitioners could profoundly alter the way healthcare providers view patient safety and quality of (life) care.

## Does the Environment Really Matter to Your Health?

The geomedicine idea has recently been receiving a lot of attention—at TEDMED 2009, Microsoft's Health Tech Today, the *Huffington Post*, and elsewhere. This exposure has led to many interesting and thought-provoking comments about geomedicine and the larger question of the importance of environment to health. I'd like to take a few minutes to address some of the comments and concerns here.



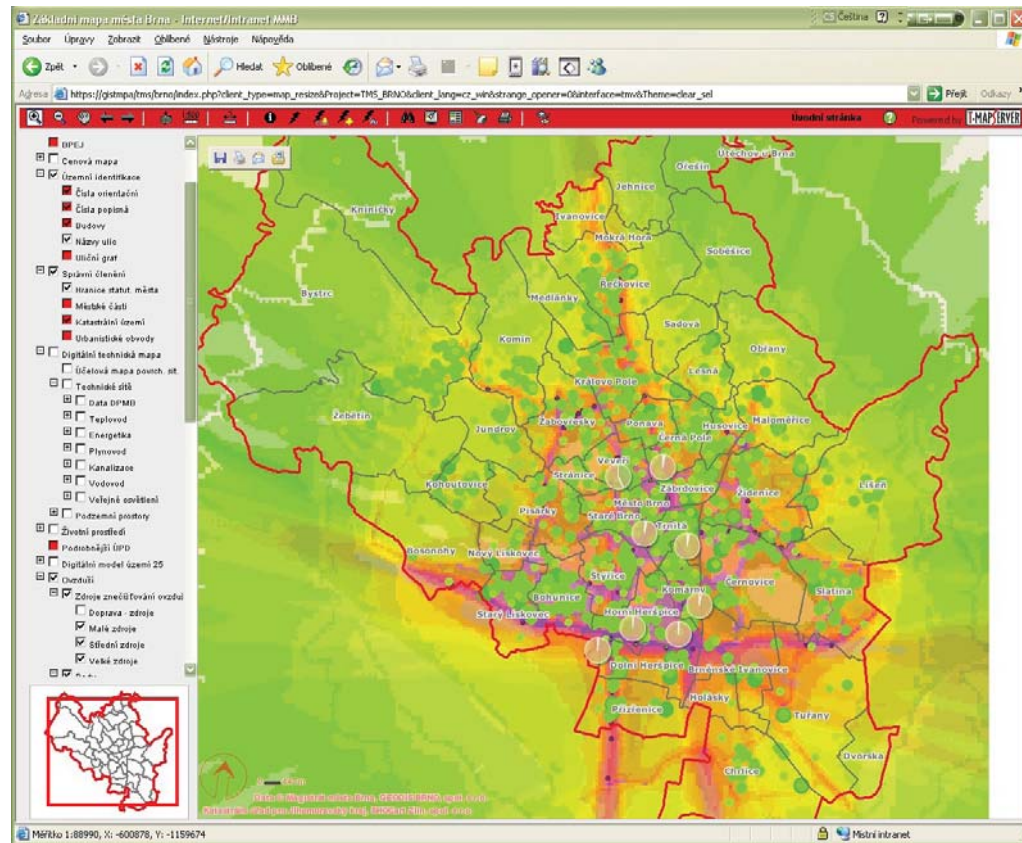
*This analysis examined the probability of thyroid cancer rates in children in Belarus as a result of the Chernobyl nuclear reactor explosion.*

Some felt the evidence of relationships between our environment and human health was marginal, at best, while others stressed its importance. One reader mentioned the vastness of the "evidence" in the scientific literature about the harmful effects of environmental contamination on human health while others took issue with the notion that our environments are as important as lifestyles or genetics. Several comments warned that knowing more about the potential hazards of environmental impacts on health would only promote more lawsuits.

One comment in particular that caused me to flinch was a suggestion that people with limited economic opportunities and less access to medical care tend to live in less healthy places. This, if it is really true, would have huge societal implications. Which comes first—bad health or unhealthy communities? Do you think that the "poor" are naturally drawn to "less" healthy places?

A physician commented that my personal story over-reached the environmental impacts on my health, suggesting however that the idea of creating a place history had merit. Some people wished for solid evidence (correlations and causation) in what I had to say. Even the comments that were critical of the strength of environmental evidence were supportive of the idea that society should get busy cleaning up known compromised environments! Much to my surprise, there were many comments that reflected people's concern over government's role in "watching" society too closely—and the potential abuse of this type of information or its analysis by health insurance companies and governments to deny coverage or otherwise limit our economic opportunities.

It was also suggested that, if your physician thinks your symptoms reflect an environmental cause, then he/she would certainly ask you more about your personal geographic "place" history. Many comments agreed on the value of creating a personal place history, and many others shared stories where they believed overlooked environmental factors could potentially explain a personal health event or condition. One physician said that this idea is "an incredibly common sense approach [that] could help to unveil risk factors from your past and potential health issues to look out for."



Analysis of air pollution by the Brno City Municipality. (Courtesy ARCDATA Praha, s.r.o.)

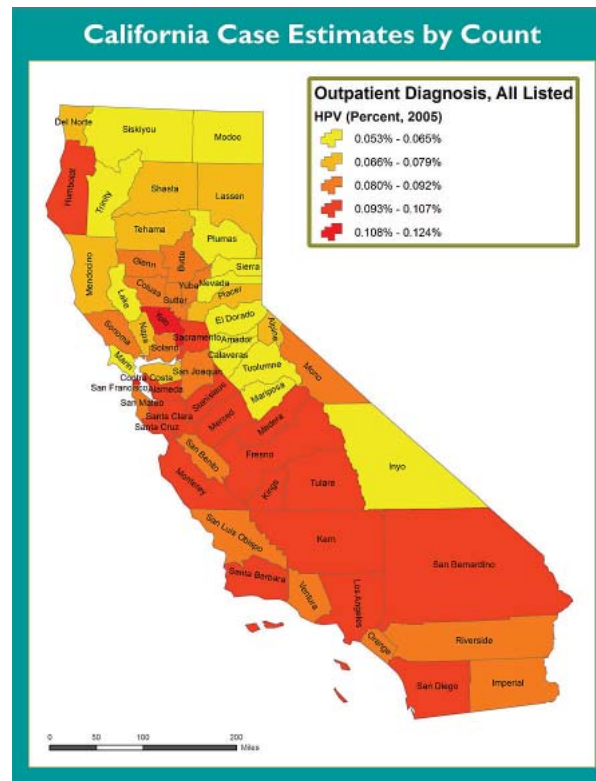
That doctor suggested that patients should tell their doctor if they think they have been exposed to a toxic substance. While I certainly agree with that advice, it is often what we don't know and see in and around our environments that is the most harmful to our health! In general, comments reflected a growing awareness of the potential impact of environmental factors, and most felt it was "smart" to try to use all the available information when it comes to understanding what makes them sick.

The recent news stories of the identification of a long-term pediatric cancer cluster in Florida by the US CDC and of the contaminated well water and soil from the long term disposal of hexavalent chromium in a rural Pennsylvania community by the US EPA have people worried. One thing that both of these events have in common is the need to discover the many people that lived near this contamination long before it was identified as a potential threat—thus the compelling need for an accurate personal place history linked to our electronic medical record.

In my opinion, those who are building electronic health records—supposedly for the benefit of patients and health seeking consumers—need to make sure we have a reliable way to link our personal place history to the sophisticated electronic health records they are building now.

## Cancer Maps: The Power of Geomedicine at Work

Inspired by a bill introduced into the New York State Legislature several years ago, the NY State Health Department has liberated some powerful data about cancer incidences and mapped it at the ZIP Code level. If you don't live in the state of New York but still want to see the incidence of cancers in the county where you live (there are 3,141 counties in the United States), you can visit the National Cancer Institute's Web site, where every state is represented.



*Map of California human papilloma virus (HPV) cases by outpatient diagnosis in each county. HPV infection is responsible for 99.7 percent of all cases of cervical cancer.*

While presenting cancer data at this small geographical level is still very "new," the technology behind it is not. In fact, I would expect that as more people learn about this site, there will be a demand for more information-sharing—such as adding cancer incidence rates, using more current population data to calculate rates and interactive graphs and charts to enhance the visitor's overall experience.

Mapping our health geographically is a great opportunity for a health department to begin educating the public in ways that make sense to the public and not just the needs of health professionals. The site, as you would expect, has several important disclaimers and caveats that site visitors are encouraged to read. Nevertheless, knowing more about where cancers actually occur is simply intriguing. This site engages us and feeds our self-discovery. I wonder why it's taken governments so long to realize the public's interest in looking at this type of data.

The linking of geography to personal health using interactive mapping technology at this more useful scale (such as ZIP Codes and census tracts in the United States) fuels incredible curiosity about the possible harmful exposures around the places we live and work. It also provides a public window for seeing potential environmental contamination in our communities. So, will we all become "citizen-epidemiologists"? Well, perhaps. This could be similar to so many other areas of our society where we have witnessed a "de-professionalization" of a complex field. Maybe it's health's turn?

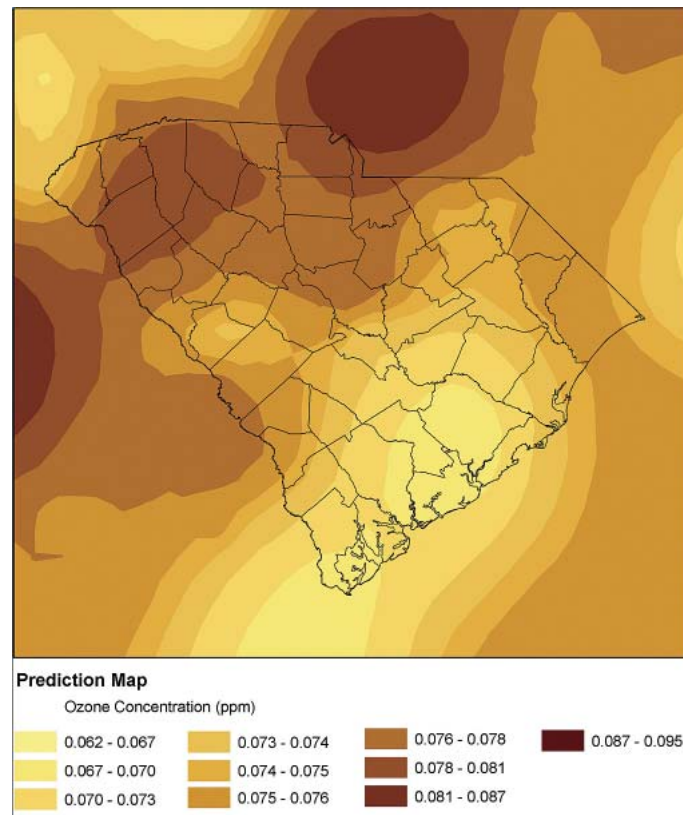
Thanks to the Internet and the development of software applications that demystify complex processes and data—coupled with the public's interest in their own personal health—public health agencies across the world will experience increasing numbers of curious and tech savvy health-seeking consumers demanding much more health relevant data delivered creatively over the Internet. If you are like me, you will wonder why every state does not make cancer data easily available.

There will be many people who will take issue with the validity of exposing small area cancer data to the average citizen and showing at the same time the exact locations

of harmful chemicals regulated by governments. I happen to believe that the more information I have about the geographical incidence of cancer, the more informed I am as a health seeking consumer. What about you?

## Environmental Health Watch: Are There Toxins in *Your* Home?

Did you grow up in a house that was built before 1978? This story is about how one State's progressive Community Affairs Department is linking geographical information to potential environmental health risk information to help protect young children. If you're pregnant or have children or grandchildren younger than six who will spend any significant time in a house built before 1978, then read on!



*This map shows predicted ozone concentration in the state of South Carolina.*

Before my 6th birthday, I had already lived in several houses that were built long before 1977, when the US EPA ban on lead in paint took effect. This means that I am probably among millions of people who were most likely exposed to unhealthy levels of lead in my blood. Most of the lead in my blood probably came from simple things most children do—licking or chewing the painted surfaces on tables, walls, staircase railings, doors, window casings and painted toys, or from a combination of breathing lead dust generated by sanded or chipped paint containing lead.

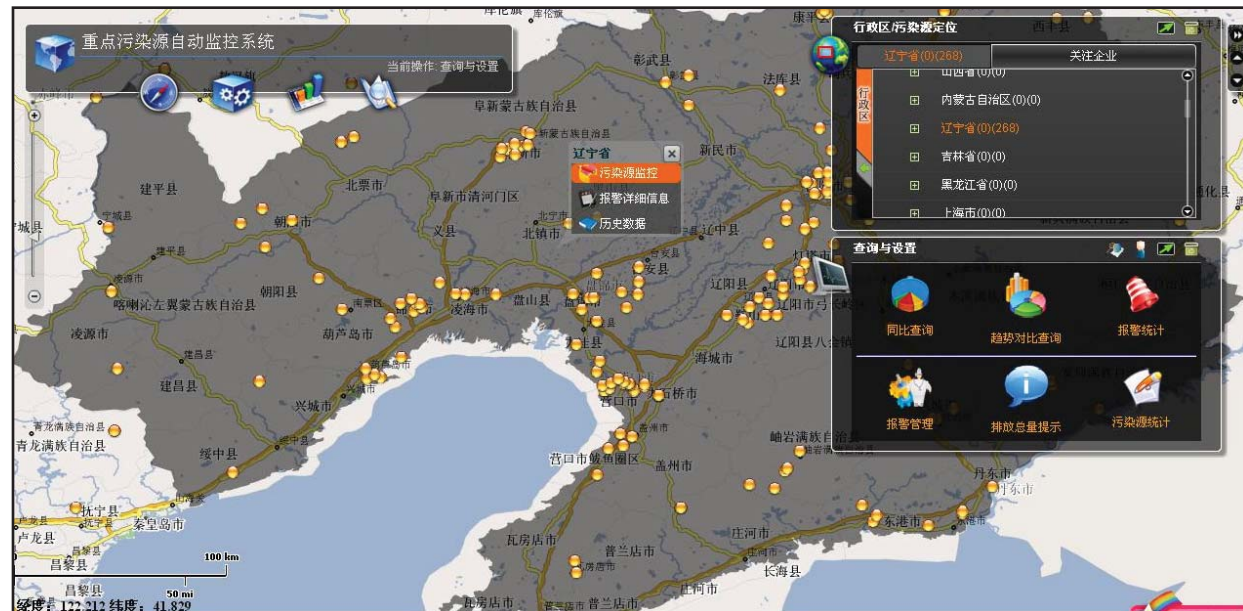
I am certain that I am not alone in having ingested more than a fair share of lead into my body during my first six years of life. Well, 32 years later, public health departments across the world are still on an aggressive mission to rid us of this toxic material, particularly from the bodies (and blood) of young children. There are many other ways that lead could get into the blood of a child (i.e., lead water pipes, cosmetics made with lead, certain imported candies containing lead, cooking utensils made with lead, lead painted toys, and lead dust from making handcrafts). Public health experts go as far as to warn that pregnant women should not remain in a house built before 1978 that is undergoing remodeling (where old paint is being sanded and dust is not contained).

At last count, more than a quarter of a million children aged one to five years in the US alone have unacceptable blood lead levels that are leading to learning disabilities, behavioral problems and, at very high levels, seizures, coma and even death. The State of New Jersey Department of Community Affairs allows you to check a dwelling address online to see if lead contamination has been detected or is in the process of being cleaned up. In some cases they tell you if it's a "lead free" dwelling.

Web sites such as this, I strongly believe, are the beginning of the response to the public's demand for environmental health transparency. Such Web sites usher in a whole new dose of public empowerment. This site validates the notion that geomedicine's chief contribution will become helping people "connect the dots" and take health knowledge to the next level by linking the "what" to the "where" and "when"—and at the household level, since this is where most, if not all, of the clinical knowledge and environmental health impacts become relevant to each of us.

# Shaping Global Health

The use of GIS is rapidly spreading across the world as one of the most important technologies that helps nations address their most serious health goals including reducing disparity in the medical services available, improving access to services, and preventing the spread of disease. Striving for ubiquitous health could mean health everywhere, anytime. I acknowledge that health is on a continuum—one does not arrive at good health accidentally. Personal health begins before birth and continues throughout a person's life. Access to health and human services has become one of the major determinants of the degree of health attained. Multiply one person's health by billions, and this brings us to global health.



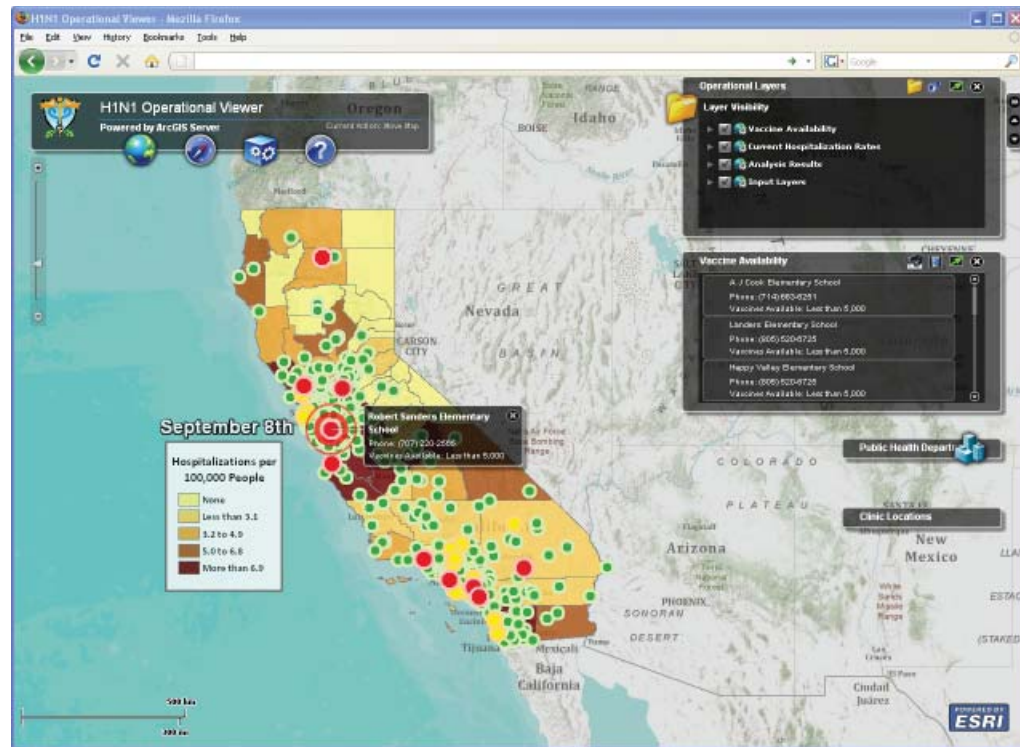
Ministry of Environmental Protection of the People's Republic of China uses GIS to reveal manufacturing sites.

The strength of modern GIS technology extends well beyond geographically relevant data analysis and powerful data visualization. It excels as a medium that helps inform, organize, and deliver health and human services. GIS supports every Web-based service locator, every directions-finding Web site, and every consumer-facing information and referral service sponsored by health organizations.

As nations strive to protect their citizens from the threat of infectious diseases, such as legionella, dengue fever, West Nile virus, tuberculosis, or avian influenza, GIS has become an important technology for adding intelligence to existing disease surveillance systems at the local, regional, and national levels. GIS technology's ability to author, publish, and share critical information about the spatial dynamics of disease makes it, without exception, the technology of choice for accelerating the detection and identification of disease clusters. GIS technology's capacity to reach beyond geopolitical boundaries makes it highly desirable in public health emergencies and responses.

As every person is different, so is every community and nation. However, the varied ways that information technology is used seem fundamentally parallel. The way GIS is used by health and human service organizations and the professionals who lead these organizations is more similar than dissimilar; therefore, one of the greatest promises of GIS is its ability to speak a common language. In my opinion, developing a common language about health and human services helps nations move forward.

The adoption of any information technology is ultimately a function of its ability to produce results such as creating evidence, identifying inequities, better informing decision makers, and aiding more responsive actions and interventions to protect human health.



*This H1N1 operational viewer lets health officials and the general public track influenza cases.*

Today, more than 90 national health ministries located across every continent use some type of GIS technology. In developing nations where modern information technology is resource challenged, GIS technology is being deployed in the form of specialty epidemiological software distributed at low or no cost to health professionals through organizations such as the World Health Organization, Pan-American Health Organization, and the U.S. Centers for Disease Control and Prevention.

As GIS technology continues to enjoy wider adoption in health and human service organizations across all types of government and private health care organizations, knowledge about our communities—especially how our local environments impact our personal health—will command greater attention by community leaders everywhere.

The ability to respond to emergencies and prepare citizens for disasters such as pandemics cannot be overlooked or under-resourced in regard to information systems.

Global health begins at home. The obligation of nations to help citizens have a safe, healthy passage through life is neither a small nor simple matter. Dedication by health professionals in building effective systems and practices must be supported by evidence and results. It also takes knowledgeable people and progressive technologies to promote confidence in the information that is communicated.

In my opinion, delivering on the goal of global health requires unrelenting devotion to leveraging today's knowledge and technologies to mitigate the problems we face today. GIS will certainly play a large role in moving communities and their nations forward, and when we move forward, everyone everywhere has a better chance to attain the optimal health that is so needed in the world.

## Geomedicine's Promise

A key element in the growing acceptance of geomedicine will be exploiting the body of research produced by the health science community. Also critical will be the ability to build and organize relevant medical content that links "place" to health conditions, risks, and outcomes. For example, research examining the impact of ambient air quality on cardiovascular and respiratory disease is under way in many nations of the world, and research is confirming that a patient's health is related to proximity to high-volume roadways, an idea being examined using GIS. There is a substantial body of scientific literature that describes the impact of geographic location on health problems such as cancer, diabetes, hypertension, and osteoporosis, and the importance of place is increasingly becoming better understood.



A key element of the acceptance of geomedicine by physicians will be the usefulness and accessibility of this body of research. Also critical is the ability of medical libraries and health research organizations to make their data holdings accessible over the Internet.

Integrating a patient's place history into existing electronic medical and personal health records is one of the principal roles of today's geographical "expert" system. Just as the collection of family medical history helps clinicians look for certain predispositions to diseases, geographic place will provide the context within which the clinician can assess environmental factors and make judgments about diagnosis, treatment and prognosis. Much like the capabilities of lab systems to make clinicians aware of "panic values," GIS can provide the same "early warnings" to suggest to clinicians environmental factors to be explored. Geomedicine has the potential to transform the way physicians "see" patients and the potential to provide a more holistic view of the many hidden factors that often defeat achieving successful long-term health outcomes.

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This e-book sets forth the notion that the emerging field of geomedicine will produce a new type of medical intelligence that will leverage national spatial data infrastructures to benefit personal human health. Linking one's own personal health status to specific geographical factors can become another set of powerful informational tools that medical professionals can use to improve the quality of the care they deliver. Geomedicine, in the future, will mean that we will experience an absolute increase in the number of patients who benefit from a more precise clinical understanding of the links between where they live, work, and play. At the present time, very little of geographically health relevant information is available to a clinician at the time of a medical diagnostic encounter and certainly not a typically part of a comprehensive medical record. Leveraged by a geographic information system, information on patients potential environmental exposures can be delivered into the hands of clinician's while the patient is in the examination room. Using modern information technology in this way can go a long way to help both the physician and the patients they serve.



## About the Author

Bill Davenhall has worked in the health and human service field since the early seventies, during which time he has directed many different initiatives that involve the progressive use of information systems within healthcare and human service delivery organizations. Davenhall is a frequent speaker and writer and is well known as one of the leading advocates for the use of GIS to help solve the challenges in health and human services. He earned a master's degree focused on medical behavioral science research from the University of Kentucky (USA). Davenhall is the global manager of Esri's Health and Human Service Solutions Group at its headquarters in Redlands, California. Founded in 1969 and presently the world's leading GIS software vendor, Esri serves more than 300,000 clients. The health and human services solutions sector is a community of more than 5,000 licensed users worldwide, housed within over 114 national health ministries and thousands of community focused health departments, community hospitals, managed healthcare programs, and health related businesses. Esri develops and supports its software through 90 international distributors and more than 3,000 associates worldwide.



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