October 2014

Essays on Geography and GIS

Volume 7

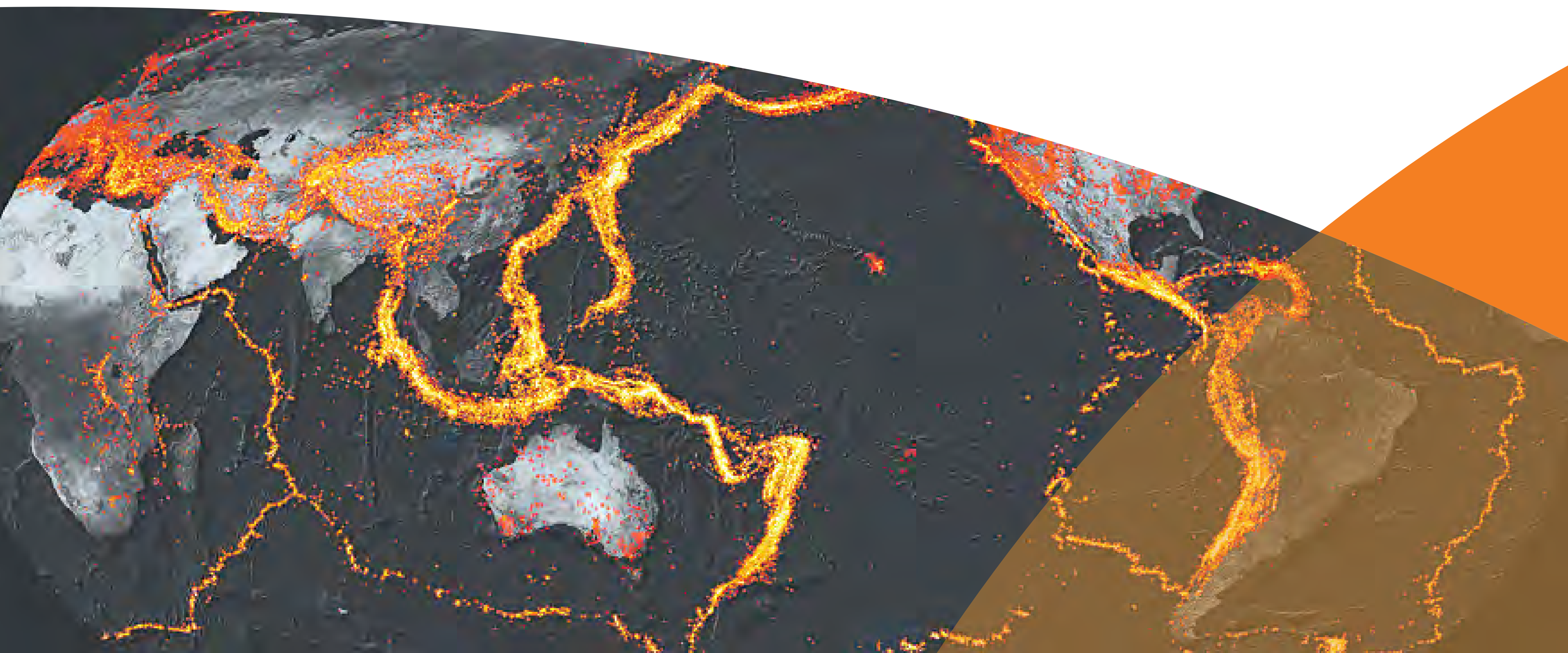
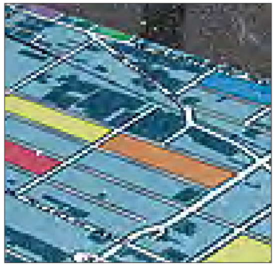


Table of Contents

The Relevance of Cartography

By University Professor Dr. Georg Gartner, President, International Cartographic Association



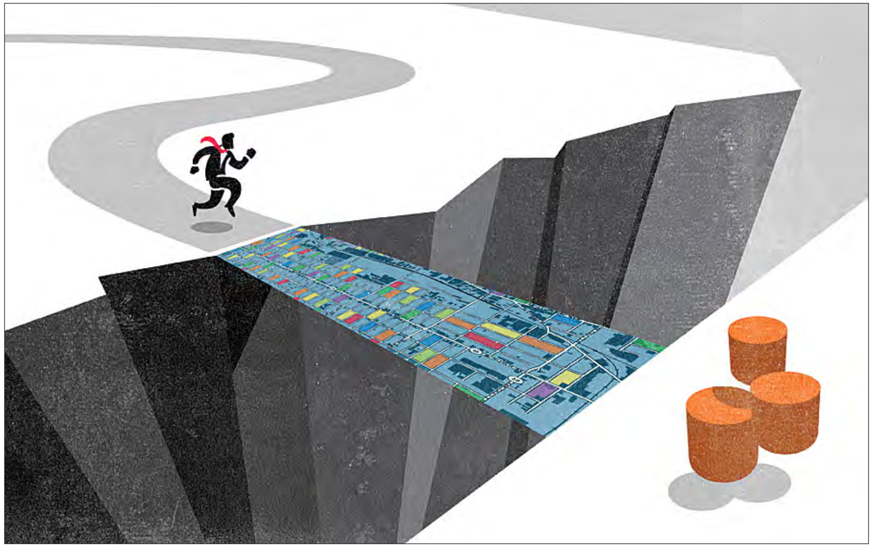
In the geospatial domains, we can witness that more spatial data than ever is produced currently. Numerous sensors of all kinds are available, measuring values; storing them in databases, which are linked to other databases being embedded in whole spatial data infrastructures; following standards and accepted rules. We can witness also that we are not short of ever more new modern technologies for all parts of the spatial data handling processes, including data acquisition (e.g., unmanned aerial vehicles currently), data modeling (e.g., service-oriented architectures, cloud computing), and data visualization and dissemination (e.g., location-based services, augmented reality). So **where are we now** with all those brave, new developments?

Obviously, **we are not short of data** in many ways. Clearly, we can state that it is rather the opposite. The problem is often not that we don't have enough data but rather too much. We need to make more and more efforts to deal with all that data in an efficient sense, mining the relevant information and linking and selecting the appropriate information for a particular scenario. This phenomenon is being described as "big data." Often, application developments start there. Because we have access to data, we make something with it. We link it, we analyze it, we produce applications out of it. I call this a data-driven approach.

We are also **not short of technologies**. It is rather the opposite; while just being able to fully employ the potential of a particular data acquisition, modeling, or dissemination technology, new technologies come in and need to be considered. New technologies become available more and more quickly and need to be evaluated, addressed, and applied. Often, application development starts there. Because we have a new technology available, we make something with it. I call this a technology-driven approach.

However, the particular need, demand, question, or problem of a human user is often taken into account only when the data-driven or technology-driven application, product, or system has been built. Often, this causes problems or leads to products, systems, and applications that are not accepted, not efficient, or simply not usable. By starting from the question What are the demands, questions, problems, or needs of human users in respect to location? we could eventually apply data and technology in a sense that they serve such **user-centered approaches** rather than determine the use.

But how can we better unleash the big potential of geoinformation in such truly interdisciplinary approaches? How can we make sure that spatial data is really applicable for governments, for decision makers, for planners, for citizens through applications, products, and systems, which are not forcing them to adapt to the system but are easy to use and efficiently support the human user?



Maps can be seen as the perfect interface between a human user and big data.

In this respect, maps and cartography play a key role. Maps are most efficient in enabling human users to understand complex situations. Maps can be understood as tools to order information by their spatial context. **Maps can be seen as the perfect interface** between a human user and all that big data and thus enable human users to answer location-related questions, to support spatial behavior, to enable spatial problem solving, or simply to be able to become aware of space.

Today, maps can be created and used by any individual stocked with just modest computing skills from virtually any location on earth and for almost any purpose. In this new mapmaking paradigm, users are often present at the location of interest and produce maps that address needs that arise instantaneously. Cartographic data may be digitally and wirelessly delivered in finalized form to the device in the hands of the user or the requested visualization derived from downloaded data in situ. Rapid advances in technologies have enabled this **revolution in mapmaking** by the millions. One such prominent advance includes the possibility to derive maps very quickly immediately after the data has been acquired by accessing and disseminating maps through the Internet. Real-time data handling and visualization are other significant developments, as well as location-based services, mobile cartography, and augmented reality.

While the above advances have enabled significant progress on the design and implementation of new ways of map production over the past decade, many **cartographic principles remain unchanged**, the most important one being that maps are an abstraction of reality. Visualization of selected information means that some features present in reality are depicted more prominently than others, while many features might not even be depicted at all. Abstracting reality makes a map powerful, as it helps to understand and interpret very complex situations very efficiently.

Abstraction is essential. Disaster management can be used as an example to illustrate the importance and power of abstract cartographic depictions. In the recovery phase, quick production of imagery of the affected area is required using depictions that allow the emergency teams to understand the situation on the ground from a glance at the maps. Important ongoing developments supporting the rescue work in the recovery phase are map derivation technologies, crowdsourcing and neocartography techniques and location-based services. The role of cartography in the protection phase of the disaster management cycle has always been crucial. In this phase, risk maps are produced, which enable governors, decision makers, experts, and the general public alike to understand the kind and levels of risk present in the near and distant surroundings. Modern cartography enables the general public to participate in the modeling and visualizing of the risks neighborhoods may suffer from on a voluntary basis. Modern cartography also helps to quickly disseminate crucial information.

In this sense, cartography is most relevant. **Without maps, we would be "spatially blind."** Knowledge about spatial relations and location of objects are most important to learn about space, to act in space, to be aware of what is where and what is around us, or simply to be able to make good decisions. Cartography is also most contemporary, as new and innovative technologies have an important impact into what cartographers are doing. Maps can be derived automatically from geodata acquisition methods, such as laser scanning, remote sensing, or sensor networks. Smart models of geodata can be built allowing in-depth analysis of structures and patterns. A whole range of presentation forms are available nowadays, from maps on mobile phones all the way to geoinformation presented as augmented reality presentations.

The successful development of modern cartography requires **integrated**, **interdisciplinary approaches** from such domains as computer science, communication science, human-computer interaction, telecommunication sciences, cognitive sciences, law, economics, geospatial information management, and cartography. It is those interdisciplinary approaches that make sure that we work toward **human-centered application developments** by applying innovative engineering methods and tools in a highly volatile technological framework. A number of important technology-driven trends have a major impact on what and how we create, access, and use maps, creating previously unimaginable amounts of location-referenced information and thus putting cartographic services in the center of the focus of research and development.

Where are we heading? What we can expect in the near future is that information is available anytime and anywhere. In its provision and delivery, it is tailored to the user's context and needs. In this, the context is a key selector for which and how information is provided. Cartographic services will thus be widespread and of daily use in a truly ubiquitous manner. Persons would feel spatially blind without using their map-based services, which enable them to see who or what is near them, get supported and do searches based on the current location, and collect data on-site accurately and timely. Modern cartography applications are already demonstrating their huge potential and change how we work, how we live, and how we interact.

In this situation, it is of high importance that those who are interested in maps, mapping, and cartography are working together on an international level. This is exactly the role of the **International Cartographic Association** (ICA). ICA is the world authoritative body for cartography and GIScience. It consists of national members and affiliate members. Basically, we encourage every nation, company, government agency, or cartographer in the world to join the big family of cartography and GIScience, which makes the voice of ICA even more important (www.icaci.org).

I would like to **summarize with three key messages**:

1. **Cartography is relevant!**

Modern cartography is key to humankind. Without maps, we would be spatially blind. Knowledge about spatial relations and location of objects are most important for enabling economic development, for managing and administering land, for handling disasters and crisis situations, or simply to be able to make decisions on a personal scale on where and how to go to a particular place.

2. **Cartography is modern!**

New and innovative technologies have an important impact on what cartographers are doing. Maps can be derived automatically from geodata acquisition methods, smart models of geodata can be built, and a whole range of presentation forms is now available.

3. **Cartography is attractive!**

Maps and other cartographic products are attractive. Many people like to use maps; to play around with maps, for instance, on the Internet; or simply to look at them. We can witness a dramatic increase in the number of users and use of maps currently.

About the Author

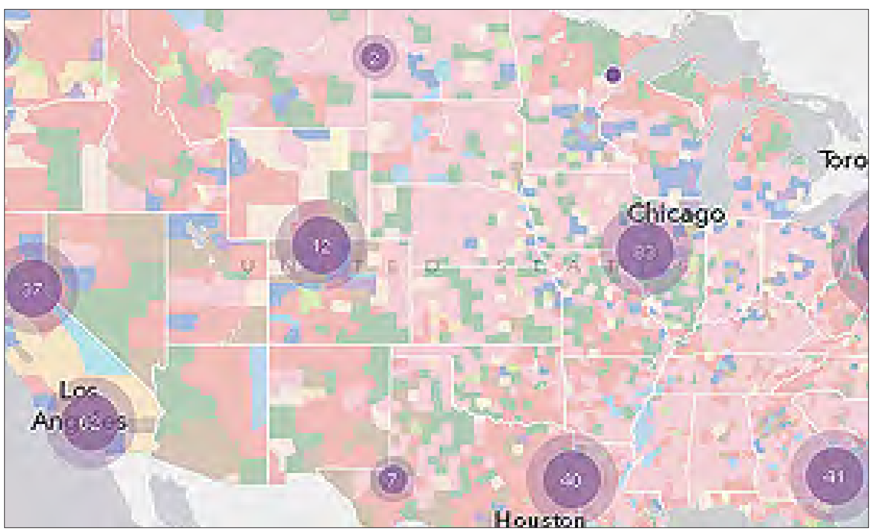
Georg Gartner is a full professor of cartography at the Vienna University of Technology. He holds graduate qualifications in geography and cartography from the University of Vienna and received his PhD and his Habilitation from the Vienna University of Technology. He was awarded a Fulbright grant to the University of Nebraska at Omaha in 1997 and a research visiting fellowship to the Royal Melbourne Institute of Technology in 2000, to South China Normal University in 2006, and to the University of Nottingham in 2009. He is dean of academic affairs for geodesy and geoinformation at Vienna University of Technology. He is a responsible organizer of the International Symposia on Location Based Services and editor of the book series *Lecture Notes on Geoinformation and Cartography* by Springer and editor of the *Journal on LBS* by Taylor & Francis. He serves as president of the International Cartographic Association.

(This article originally appeared in the Winter 2013/2014 issue of *ArcNews*.)

GIS Accelerates Big Data Discovery

Social Media Content Fuels Big Data Analytics for Esri and IBM

Opinionated consumers, take heart. Your Tweets are being read by people very important to you—the manufacturers of the products you buy. An exciting experiment recently pooled the knowledge of many disciplines to analyze your opinions buried in big data from the Twitterverse. Twitter content is now being mined and is used in analytics methodologies developed by Esri, IBM, and various stakeholders in the big data struggle. Recently, that collaboration kicked off a new era of research that combines Esri technology with IBM's linguistic and psychological analytics to decode virtual galaxies of information.



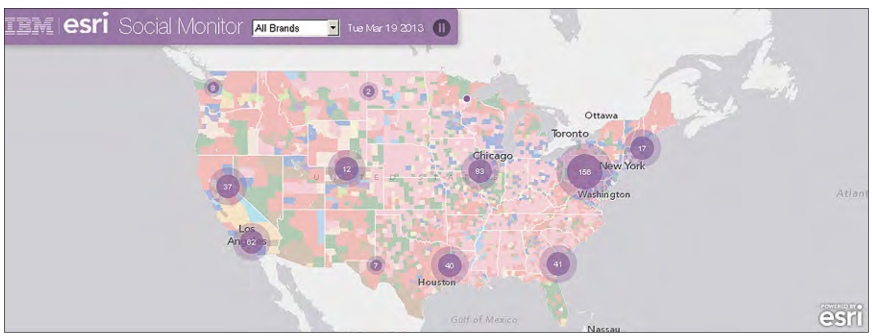
Mapping Social Media

We're bursting at the proverbial seams with data. Never have more IT gurus agreed so widely that data obesity is the biggest threat to human progress if we don't gain control of it soon. Taming big data requires the invention of new techniques to better understand the monster through analytics and visualization.

For years, social media has provided a rich source of data in Esri maps. In 2011, Esri launched the Japanese earthquake map—a proof-of-concept map that contained Twitter feed data composed of millions of Tweets from Japan. Tweets following the 9.0 Honshu earthquake helped reveal where resources were needed in the crisis. Since then, it has become commonplace to enrich maps with this social media content. Last year, Esri officially entered the big data space by integrating big data workflows into ArcGIS and launching a number of open-source projects on GitHub, including GIS Tools for Hadoop, that infuse big data with geospatial capabilities.

Monitoring Brand

Social media's high volume, variety, velocity, and veracity meet the defining four characteristics of big data. With more than 500 million Tweets and 3.5 billion "Likes" a day, social media is a perfect example of an extremely large and noisy data source. Within all that chatter, Twitter users share various opinions about their tastes. Filtered from the noise, those opinionated Tweets become a potential window into the buyer mind.



Esri Tapestry data reveals consumer lifestyle attributes for more informed brand management.

In collaboration with IBM Research Almaden's Accelerated Discovery Lab—a state-of-the-art facility for researching big data analytics across a variety of industries and domains—Esri built an interactive proof-of-concept map called the Social Monitor that uses Tweets and geospatial technology to understand customer sentiment and focus brand management.

"Just like GIS, big data analysis starts by asking the right questions," says Jack Dangermond, Esri president. "Through analytics, we extract the answers to help organizations know their customers better. The joint Esri/IBM Social Monitor demonstration combines GIS with the latest research in that area."

Decoding the Decahose

That Tweets are rich with consumer sentiment would explain why Twitter commoditized its daily user output back in 2010. Since then, Twitter has been licensing its Tweet streams so that companies and their consultants can pan gold from them. To begin its social media analysis, IBM licensed a Decahose of Twitter content (10 percent of daily Tweets) from a third-party reseller.

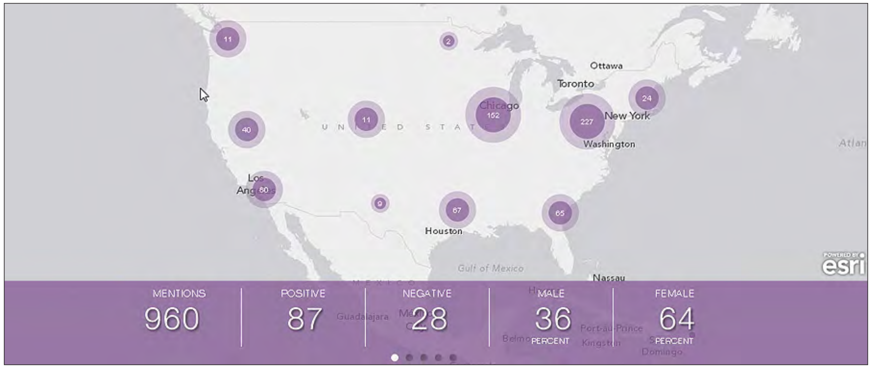
Could all that customer sentiment be monitored in a brand management tool for, say, clothing retailers? Equipped with the tools to analyze Tweets through multiple lenses, researchers at the Accelerated Discovery Lab plunged into an inaugural project to answer that intriguing question. For the Social Monitor demonstration jointly built with Esri, eight nationwide clothing retailers were chosen to be represented during March 2013.

To build the Social Monitor demonstration, an Esri developer visited the lab for a day to work side by side with the IBM researchers. All software, data, and expertise were available for his use. Using Portal for ArcGIS and ArcGIS for Server, Esri produced an interactive map application that visualized Twitter user data by location and time. This helped the lab identify patterns in the Tweets and provided insights about demographics and consumer type. IBM's social media analytics decoded sentiment, location, and psycholinguistic attributes to gauge retailer image according to region. Summary information about Tweeters not included in Tweets, including gender and personality traits, is all inferred by the Accelerated Discovery Lab's algorithms and is displayed on the bottom of the map. Participating brands can be selected on the pull-down menu, making it easy to compare Tweet mentions and customer characteristics between different retailers. For an even more granular perspective, the results of the lab's psychological analysis runs concurrently with demographics data from Esri Tapestry data. Being able to tease out data on an individual level that considers the intrinsic traits of buyers gives brand managers an extremely powerful customer relations management tool.

Scope of a Crisis

It was a week that felt like forever to one clothing retailer included in the Social Monitor experiment. Last year, the company was barraged with complaints about a defect in a signature line of clothing.

Predictably, Tweet activity mentioning the brand increased in certain areas of the United States, the locations of which are represented on the map in the Social Monitor. Displaying those



The IBM and Esri Social Monitor demonstration sorts positive and negative mentions of brand separately. Here, those mentions are represented in a chart graph.

Tweets geographically revealed consumer reaction to the defect by region, demonstrating the power of social media analytics to deliver real-time information for more immediate brand management.

"GIS can help identify the scope of a problem," says Mary Roth, research staff member and data integration expert at the Accelerated Discovery Lab. "Coupled with our analytics, Esri can quickly determine where the flurries of Tweets are coming from. If it's just from Rhode Island, for instance, the geoprocessed data will show that the problem is local rather than national. That information ultimately saves cost in response."

The Social Monitor demonstration is a simple and effective way of displaying analysis results extracted from Twitter feeds. Once this information is understood, brand managers can drill deeper into the data by studying Tweeters' personalities and demographics. Data displayed in the map is provided without compromising user privacy and gives companies a more thorough understanding of their customer bases. With that knowledge, they can tailor brand image and respond to negative situations faster and with more focus.

Big Data Analytics for Everyone

Although intimidating, the data deluge opens new opportunities for research not possible before with old, piecemeal analytics. The Social Monitor is just the tip of the iceberg in the quest for better data science. Esri and IBM are currently devising new methods for big data analytics that combine geographic analysis with methodologies born from collaborative research and development. This year, Esri will reveal innovative new tools and methodologies for studying big data as it expands further into this space.

(This article originally appeared in the Winter 2013/2014 issue of *ArcNews*.)

Defining Geography for Education

Geo Learning

By Daniel C. Edelson, Vice President for Education, National Geographic Society

Odds are that if I ask you and the person in the next office to describe the field of geography, I will get pretty different answers. And if I were to ask other members of your family—your mother, your brother, your spouse—I would get an even broader range of answers. And if I were to ask the people next to you on your morning commute, the answers would be more diverse still.

This diversity is, of course, an inherent property of human psychology. We all carry around our own personal understanding of words and concepts that result from our own particular set of experiences.

In most cases, the fact that there is such a broad range of definitions for the field of geography isn't a problem, but there is one place where it is a serious issue—in conversations about geography education.

In more than a decade of talking to people about how to improve geography education, I have learned that it is important to be explicit about the definition of geography that I am using.

While there are, of course, as many definitions of geography as there are people, there are three clusters that are important for discussions about geography education. I call these clusters of definitions "geographers' geography," "the popular perception of geography," and "school geography."

Before I go on, I should note that these definitions are all specific to the United States. From talking to geography educators from other parts of the world, I believe that these clusters exist elsewhere, but I have also learned that the specific definitions in each cluster and the similarities of the clusters to each other differ from place to place.

"Geographers' Geography"

While there can be no "correct" definition of a field, the cluster of definitions that I think of as geographers' geography has a status that sets it apart from the others. It reflects the way experts and practitioners in geography think of their field. Because geographers' definitions of geography are the product of academic study and discussion, they cluster around a set of conventional definitions, including geography as the study of place and space and geography as the study of spatial patterns and processes at the earth's surface. Geographers also commonly describe geography as encompassing human geography, physical geography, and human-environment interaction.

Unlike nongeographers, who often define maps, mapmaking, and map interpretation as the defining characteristics of geography, geographers tend to talk about maps as being instrumental to geography but not the defining feature. In my experience, geographers describe maps as tools that they use to understand and communicate about space and place.

The benefit of being able to refer to geographers' definitions of geography in discussions about education is that they make it easy to describe the specific advantages of geography in contrast to other subjects of study, and they highlight the societal goals that geographic understanding and practices support. It is easy to connect geographers' geography to the myriad activities of commerce, government, and community life.

The Popular Perception of Geography

Unfortunately, the popular perception of geography is very different. I find the understanding of geography that I encounter on a daily basis to fit the stereotype that geographers refer to as "place-name and location" geography frighteningly often. Most people I encounter, regardless of their level of educational attainment, view geography as a body of discrete knowledge about the world that includes names and locations of countries, cities, bodies of water, and major geological features and facts about those places.

Most people I talk to consider map reading and wayfinding to be the only skills that geography teaches, and if they are aware that one can study geography at an advanced level or practice geography professionally, they believe the focus of that geography is mapmaking.

From the perspective of geography education, the popular perception of geography is as pernicious as it is widespread. People are increasingly aware that factual knowledge is of limited value in the Internet age, so it is difficult to have a productive conversation about the value of geography education with someone who believes geography is about factual understanding and thinks its usefulness for careers is limited to the obscure profession of cartography. Unfortunately, it can be very difficult to change this perception of geography, especially in a single conversation, when the individual has had no personal exposure to systematic geographic reasoning or problem solving.

School Geography

The third cluster of definitions I encounter is what I call "school geography." This is what is taught in schools under the label of *geography*. School geography is typically a little broader than the popular perception of geography but dramatically narrower than geographers' geography.

In the United States, the overwhelming distinction between school geography and geographers' geography is that school geography focuses almost exclusively on human geography. To the extent that physical geography is taught as geography in the United States, it is taught as background and context for human geography. This is not to say that physical geography is not taught in American schools. Some physical geography is taught, but it is taught under the labels of *earth science*, *environmental science*, and *geoscience* rather than *geography*. Anything that is taught with the label *geography* is taught as part of the social studies curriculum and focuses on the geography of people.

The second characteristic of school geography is that it focuses primarily on factual knowledge. It would not be fair to modern curriculum designers, textbook authors, or teachers to say that geography education today focuses exclusively on facts, but it is fair to say that school geography is so dominated by the teaching of facts that it has not done anything to change the popular perception of geography as being about knowledge of discrete facts.

Geographers and geography educators have worked hard to change the definition of school geography through the development and dissemination of standards that reflect the subset of geographers' geography they believe K–12 students should learn. However, the impact of these efforts on the geography that is taught in schools is still limited.

Like the popular definition of geography, the school definition of geography is a problem for conversations about geography education. It leaves out the critical component of physical geography and makes it difficult to talk about the study of human-environment interaction. Likewise, the focus on factual knowledge makes it hard to make the case of the importance of geography education in our modern world.

The bottom line here is that the differences between these definitions represent both a challenge and an opportunity. The challenge is that it is very difficult to have productive discussions about improving geography education when the participants in these conversations have definitions that are limited to either the popular perception of geography or the school definition of geography.

On the other hand, it exposes an opportunity in the form of a specific issue to work on. If we could bring the geographers' definition of geography to a larger audience, it could make it much easier to bring about change in geography education. While it is difficult (I can't count the number of times when I have explained to people what I mean by *geography*, only to have them revert to their old understanding of geography a few minutes later), people can learn new definitions. It requires deliberate effort and clever communications strategies, but it can be done. In fact, I believe that it must be done if we ever are to make significant progress on the challenges of improving geography education and geographic literacy.

For more information about the efforts that the National Geographic Society, the Association of American Geographers, the National Council for Geographic Education, and Esri are making to increase popular understanding of geography, visit GeographyAwarenessWeek.org.

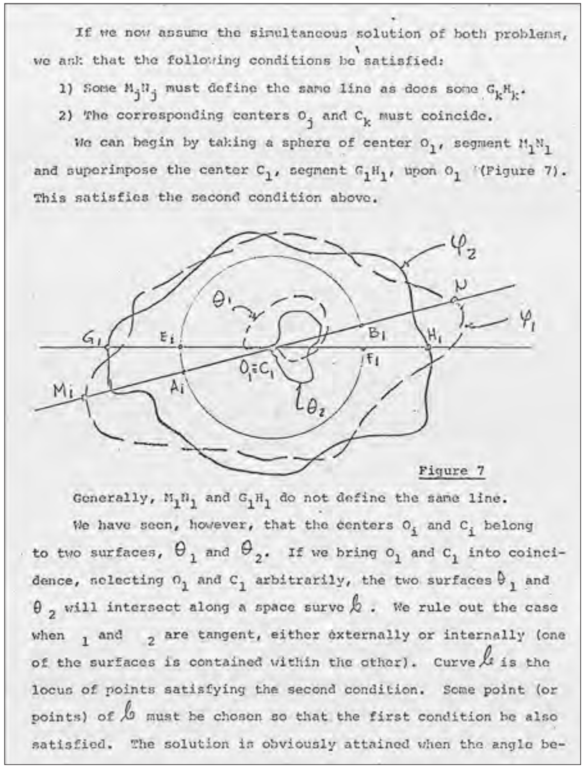
(This article originally appeared in the Winter 2013/2014 issue of *ArcNews*.)

History of GIS and Early Computer Cartography Project

By John Hessler, Cartographic Specialist, Geography and Map Division, Library of Congress

The Geography and Map Division of the United States Library of Congress is the largest repository of cartography and related forms of geographic representation in the world. Its collections include more than five million maps and tens of thousands of atlases. It also holds the archives of many important cartographers and geoscientists and manuscript materials related to mapmaking that date from the late 13th century through the modern era.

Recently, the library has undertaken a large-scale project to collect materials, technical information, maps, and algorithms from the earliest days of computer cartography. This project, which is being directed by the author, and which began as a series of lectures for graduate students at Johns Hopkins University, has resulted in the library's acquisition of a number of important archives from the earliest days of computer cartography. One recently acquired archive, of personal papers related to the development of geographic information systems, was that of Dr. Nicholas Chrisman. He was one of the many imaginative geographers, mathematicians, and computer scientists working at the Harvard Laboratory for Computer Graphics and Spatial Analysis during the time in the 1960s and



If we now assume the simultaneous solution of both problems, we ask that the following conditions be satisfied:

1) Some M_jN_j must define the same line as does some G_kH_k.

2) The corresponding centers O_j and C_k must coincide.

We can begin by taking a sphere of center O_1, segment M_1N_1 and superimpose the center C_1, segment G_1H_1, upon O_1 (Figure 7). This satisfies the second condition above.

Figure 7

Generally, M_1N_1 and G_1H_1 do not define the same line.

We have seen, however, that the centers O_i and C_i belong to two surfaces, θ_1 and θ_2. If we bring O_1 and C_1 into coincidence, selecting O_1 and C_1 arbitrarily, the two surfaces θ_1 and θ_2 will intersect along a space surve $\mathcal{L}$. We rule out the case when $_1$ and $_2$ are tangent, either externally or internally (one of the surfaces is contained within the other). Curve $\mathcal{L}$ is the locus of points satisfying the second condition. Some point (or points) of $\mathcal{L}$ must be chosen so that the first condition be also satisfied. The solution is obviously attained when the angle be-

Typical typewritten and hand-drawn page from *Harvard Papers in Theoretical Geography*, Number 37. Design-wise, the series is not much to look at, but the content shows the multidisciplinary range of the Harvard Lab at the time. (Nick Chrisman Collection, Geography and Map Division, Library of Congress.)

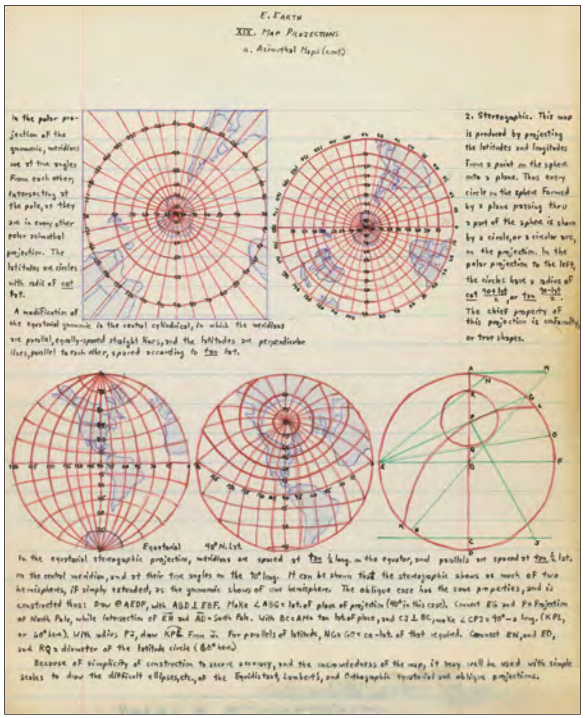
1970s that saw the beginnings of what would become modern GIS.

The research at the Harvard Laboratory was a cross section of geographic ideas circulating at the time, and Chrisman's archive contains his notes, computer programs, and papers, including most of the official publications from the laboratory. One set of papers in particular, which deserves much more attention from today's mapmakers, historians, and those interested in the foundations of current geographic thought, is the *Harvard Papers in Theoretical Geography*. These papers, subtitled, "Geography and the properties of surfaces," detail the lab's early experiments in the computer analysis of cartographic problems. They also give insight into the theoretical thinking of many early researchers as they experimented with theorems from algebraic topology, complex spatial analysis algorithms, and various forms of abstract algebras to redefine the map as a mathematical tool for geographic analysis. Reading some of the titles in the series today, for example, "Hyper-surfaces and Geodesic Lines in 4-D Euclidean Space and The Sandwich Theorem: A Basic One for Geography," gives one a sense of the experimentation and imaginative thinking that surrounded the breakthroughs necessary for the development of our modern computer mapping systems.

The *Harvard Papers* shows in stark mathematical detail the multidisciplinary thinking that surrounded many of the lab's projects. In an attempt to answer previously intractable geographic and cartographic questions, purely mathematical and geometrical concepts, like existence theorems, whose basic logical structure contains statements that confirm or deny the existence of particular sets of objects, were employed in various computer mapping schemes. The development of these programs injected high levels of topological and algebraic abstraction into geographic analysis and fundamentally changed the basic ontology of geographic and cartographic objects. However, although existence theorems provide logical proof for whatever mathematical entity they are claiming existence for, they do not necessarily provide a way to find or calculate those objects.

The authors of these papers, of which 57 were produced, and all of which have been collected by the library, look to us now like a who's who of the analytic turn that geography took in the post-World War II era. William Warntz, Ernesto Lindgren, Michael Woldberg, Waldo Tobler, Donald Shepper, Carl Steinitz, William Bunge, and Geoffery Dutton are just a few who added their insights and ideas to this highly theoretical series of papers.

Aside from the technical aspects that archives like this reveal, they also show deeper connections with cultural and intellectual history. They demonstrate how the practitioners and developers of GIS found themselves compelled to draw both distinctions and parallels with ideas that were appearing in the contemporary scholarly literature on spatial and temporal reasoning. Their explorations into this literature was not limited to geographic ideas on lived human space but also drew on philosophy, cognitive science, pure mathematics, and fields like modal logic—all somehow to come to terms with the diverse phenomena that have spatiotemporal extent and that might be mapped and analyzed.



Page from a notebook of John Parr Snyder that dates from his sixteenth year showing his early interest in map projections. (John Parr Snyder Collection, Geography and Map Division, Library of Congress.)

Because of these deeper connections, the Library of Congress is collecting quite broadly in the area of early computer cartography. It has obtained many other archives from cartographers like John Parr Snyder, who was the original developer of the space-oblique Mercator projection. It was Snyder who developed the equations for this extremely complicated projection using an early Texas Instruments programmable calculator. It is his equations for the projection that first allowed remote-sensing imagery from the earliest Landsat satellites to be made into low-error maps. In thinking through the geometry of the projection, Snyder had to take into account the various motions of the satellite and the earth, and in doing so, invented a dynamic and time-dependent map projection. His archive contains all his original notes, mathematical derivations, and also his calculators and the magnetic strips that stored his original programs. In addition to the technical material, there are several notebooks into which he copied his ideas on projections when he was 16 years old and that show him to be, perhaps, one of the few modern cartographic prodigies.

The study of cartography and its related geographic disciplines underwent profound technological and conceptual advancements in the last half of the 20th century. These advancements, brought about by the advent of computers, the development of newer and faster mathematical and computational algorithms, and the birth of satellite imagery, contributed to paradigm changes that can be considered revolutionary. Technological and conceptual improvements have generated new forms of data, maps, and artifacts that differ radically from those typically archived in map libraries. In the future, these new artifacts and materials will form the basis for the study of modern cartography and as such, their collection and preservation present new challenges to the archivist and the map librarian.

The Library of Congress's program of collecting computer software, new computational devices, hardware, and new forms of geospatial data is based on the assumption that all these need to be preserved in a way that allows future researchers to access not only data but also the techniques, data structures, and algorithms used by today's mapmakers. Many of these ephemeral materials are disappearing, through either obsolescence, scholarly neglect, or the inevitable degradation of all magnetic media. These fragile parts of our history need to be collected now, before they disappear, for even though we are talking about materials from the recent past, the one thing we do not have in the preservation of this history is the luxury of time.

About the Author

John Hessler is a specialist in Modern Cartography and Geographic Information Systems in the Geography and Map Division of the Library of Congress and teaches the history of cartography at the Johns Hopkins University. The author of many books and articles, he is currently working on a forthcoming book, *Cartography in the Age of Computer Simulation: Lectures on the Historical and Mathematical Foundations of GIS*.

(This article originally appeared in the Winter 2013/2014 issue of *ArcNews*.)

Citizen Science and GIS

By Matt Artz

> *Citizen science is scientific research conducted, in whole or in part, by amateur or nonprofessional scientists, often by crowdsourcing and crowdfunding.*
>
> —*Wikipedia*

Applications of geospatial technologies have already proven themselves invaluable for scientific research and understanding. But is there an opportunity for citizen scientists to leverage geospatial technologies in their quest for knowledge and entertainment and still make valuable contributions to society?

Citizen scientists have a strong interest in some facet of science, but they pursue this interest outside of mainstream academic, research, and industrial organizations. These self-directed individuals might very well be using their own resources, working in their garages to develop "the next big thing." But more often they are networked, working together with fellow citizen scientists. And this is where they become a powerful force to be taken seriously within the scientific community.

Scientists, as well as "professionals doing science," are often the ones organizing these citizen science networks; they realize the great value a group of eager volunteers can bring to a project.

Some examples of harnessing the contributions of citizens in the earth science and geospatial arenas include the following:

- Climateprediction.net (CPDN) is investigating how small changes affect climate models by running hundreds of thousands of climate models using the volunteers' PCs. The result: a better understanding of how models are affected by the myriad of small changes in parameters known to influence the global climate.
- Atmospheric Process Simulator@Home (APS@home) is looking at atmospheric components of climate change. Everyday citizens can download and install a model onto their PCs. The model calculates atmospheric dispersion and how it affects the accuracy of estimates used in global climate models. It runs in the background using idle CPU time, so it doesn't affect normal computing activities.
- OpenStreetMap is a model for creating a global geospatial dataset by citizen volunteers. Organizationally it provides a good example of a successful structure for managing the creation and distribution of the data, as well as maintaining quality standards.

Amassing large numbers of volunteers to work on geospatial problems such as climate change is already taking place as shown by the CPDN and APS@home examples. What is needed next is something at a much larger scale, where not just physical, but also biological, social, cultural, economic, and political data and models are integrated to give a more accurate depiction of the complexities of our planet.

First, we need to create an environment that successfully brings together a plethora of data sources and modeling systems—a noble vision for GIS technology, but not something to be tackled by citizen scientists. Once the data and technology are in place and a clear framework is established, then comes the opportunity to organize a large group of volunteers who would do the work of tackling this challenge.

The challenge for GIS practitioners is to ensure the usability of citizen scientist-created data in a GIS workflow or to turn this crowdsourced data into useful geographic knowledge. This can mean checking the data to make sure it is authoritative; it can also mean getting involved in data collection, structuring the process to ensure that the collected data has meaning and is appropriate and authoritative.

Imagine a framework where tens or even hundreds of thousands of citizen scientists log in to a website and download geospatial datasets and work task lists, then use a focused geospatial app to run different analyses and modeling scenarios as defined in the task list, and then share the results of their analyses back to the website for consolidation.

If properly structured and managed, the integration of citizen science and GIS will enrich geospatial infrastructure, giving GIS practitioners new types of data to use, manage, interpret, and incorporate into their work. More importantly, it could significantly advance our understanding of the planet.

Geoenabling Citizen Science

By Joseph Kerski

Every issue from pollution to habitat to biodiversity and beyond has a geographic component and thus can be studied in the field. Because the world is rapidly changing, and because large organizations have cut back on many of their field staff, much of the critically needed field data can and should come from citizen scientists.

Educators collect data on invasive weeds in a field in Iowa.

What is "citizen science"?

> *Citizen science is scientific research conducted, in whole or in part, by amateur or nonprofessional scientists, often by crowdsourcing and crowdfunding.*
>
> *—Wikipedia*

Consider the major environmental issues of our twenty-first century world: coastal erosion; air, soil, and water pollution; urbanization; desertification; habitat loss; invasive species; and deforestation, just to name a few. Each of these issues occurs somewhere, and often in multiple locations and at multiple scales. For example, climate change is a global phenomenon that also impacts local weather and crop yields. Each phenomenon exhibits a spatial pattern in its source and in its diffusion. Each affects multiple facets of both the human and physical environments. Therefore, the geographic perspective is key to understanding those issues, and citizen science initiatives provide data that can be used within a GIS environment. In such an environment, multiple variables can be displayed and analyzed as map and image layers, at multiple scales, in two dimensions and in three dimensions.

Those who use GIS in tandem with field-collected data through citizen science initiatives develop key critical thinking skills. These skills include understanding how to carefully evaluate and use data. This is especially critical in assessing environmental data due to its increasing volume and diversity and given its often sensitive and politically charged nature.

In addition, crowdsourced data is appearing from citizen science initiatives all over the world on subjects such as pine beetle infestation, the appearance of monarch butterflies in their community each spring, and the date of the first frost. This data is more frequently being tied to real-world coordinates, mapped, and analyzed. Students and others using GIS who are grounded in environmental studies will be in demand to help make sense of this deluge of incoming data.

Fieldwork has such a long and rich history within earth and environmental studies that it is almost like stating the obvious. However, in a world where outdoor education is often cut due to budgetary constraints, and when a frighteningly large proportion of the population has almost no connection with the outdoors, it bears emphasizing. In earth and environmental studies, the "offices" of many educators actually are in the field—in nature centers, museums, parks, and wildlife reserves.

In the field, students can collect data on a myriad of phenomena, such as tree species, water quality, weather, and soil chemistry. In so doing, they gain a better understanding of processes, scale, and the environment in a way that they might not be able to do in the classroom. They can sketch, record video, take photographs, or simply use their five senses.

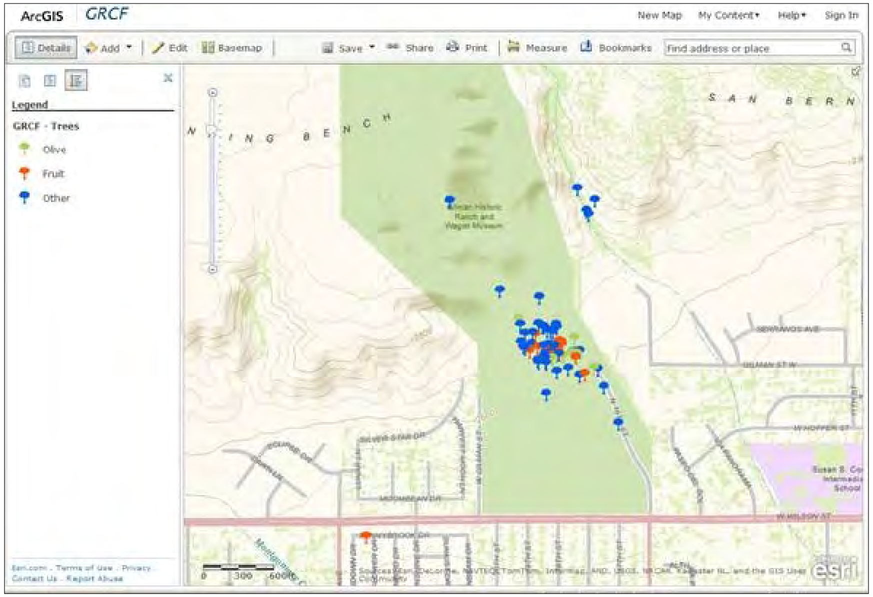
Beyond data collection, they develop an appreciation for the balance of nature, or the "unbalance," depending on where they are and the connectedness of the hydrosphere, atmosphere, lithosphere, and biosphere. Studies show that if students do not receive repeated and deep immersion in natural places while young, they will not value nor appreciate natural places nor their associated environmental processes or issues as adult decision makers.

Given the widespread environmental concerns faced by the modern world, it is imperative that the general public study and understand these issues—not only to equip them for life in the twenty-first century but to ensure that we emerge at the end of the twenty-first century in a sustainable way. How can we expect decision makers to care about the planet unless they have learned about the planet while out in the field? Citizen science is one way of engaging the mind and all of the senses while taking part in important research that benefits people and the planet.

So can citizen science-gathered data be used within ArcGIS Online?

Absolutely.

Every electronic piece of information in our world, whether photographs, text, sketches, videos, or web links, is increasingly geolocatable with a latitude-longitude coordinate pair or with an ordinary street address. Thus, it can be mapped. This geocoded data can be added as multimedia map notes in ArcGIS Online. Because these web maps are created in the cloud, they can be saved, shared, embedded in web pages, and used in a myriad of other ways.



This web map in ArcGIS Online is for a historical ranch in Southern California, created from data collected in the field by citizen scientists.

These same sorts of multimedia can be published as Esri Story Map apps via storymaps.esri.com and become a new platform for explaining a specific topic from local scale (such as land-use change in a city) to regional scale (such as coastal erosion) to global scale (such as invasive plant species).

In addition, data can be simultaneously gathered using the Collector for ArcGIS or Explorer for ArcGIS app on a smartphone, and it can automatically populate a continuously updating ArcGIS Online map. Setting up such a map is shown at http://www.youtube.com/watch?v=8qciLuWwgZo, and collecting data in the field is shown at http://www.youtube.com/watch?v=C6dNfeQkTGo.

GIS has already proved to be invaluable for scientific research and understanding, but now there are a number of opportunities for citizen scientists to leverage geospatial technologies in their quest for knowledge and entertainment and still make valuable contributions to society. If properly structured and managed, the integration of citizen science and GIS will enrich geospatial infrastructure, giving GIS practitioners new types of data to use, manage, interpret, and incorporate into their work. More importantly, it could significantly advance our understanding of the planet.

About Joseph Kerski

Joseph Kerski is a geographer who believes that spatial analysis through digital mapping can transform education and society through better decision making using the geographic perspective. He serves on the Esri education team, is active in GIS communication and outreach, creates GIS-based curriculum, conducts research in the effectiveness of GIS in education, teaches online and face-to-face courses on spatial thinking and analysis, and fosters partnerships to support GIS in formal and informal education at all levels internationally. He is the coauthor of *Spatial Mathematics*, *The Essentials of the Environment*, *The GIS Guide to Public Domain Data*, and other books. Follow him on Twitter @josephkerski.

Citizen Geography with National Geographic FieldScope

"Geo Learning"

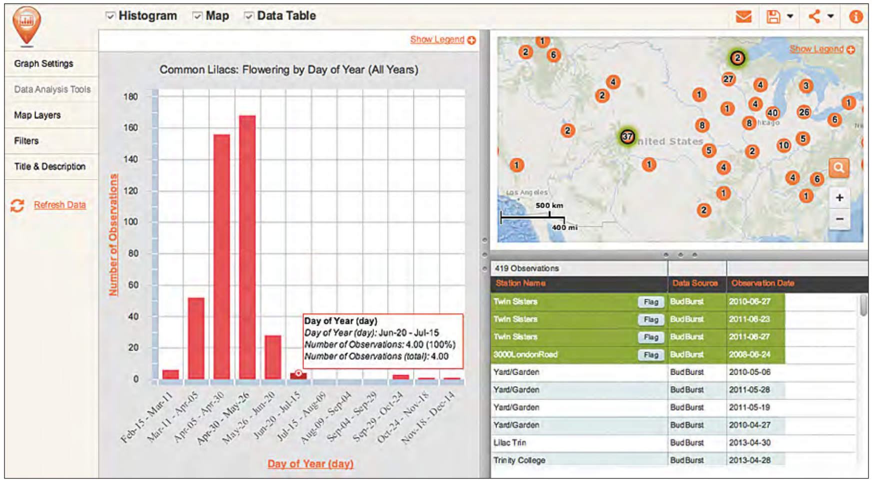
By Daniel C. Edelson, Vice President for Education, National Geographic Society

Six years ago, the Center for Geo-Education at National Geographic launched a project with a simple premise: Public participation in scientific research, commonly known as "citizen science," shouldn't end with collecting data. It should include data analysis, as well.

Using the ArcGIS suite of developer tools, we began to build National Geographic FieldScope, a platform for citizen geography (citizen science projects focusing on geospatial data). FieldScope's goal is to put geospatial data visualization and analysis into the hands of ordinary people who participate in citizen geography projects.

We've developed FieldScope by working with three test bed projects, whose goals and audiences informed the software's design. The three test bed projects are

- **Project BudBurst** (National Ecological Observatory Network), a plant phenology project in which members of the general public report their observations of seasonal changes in plants.
- **FrogWatch USA** (American Zoos and Aquariums), an amphibian population study in which volunteers who are trained to identify frog and toad calls report on the distribution of different species.



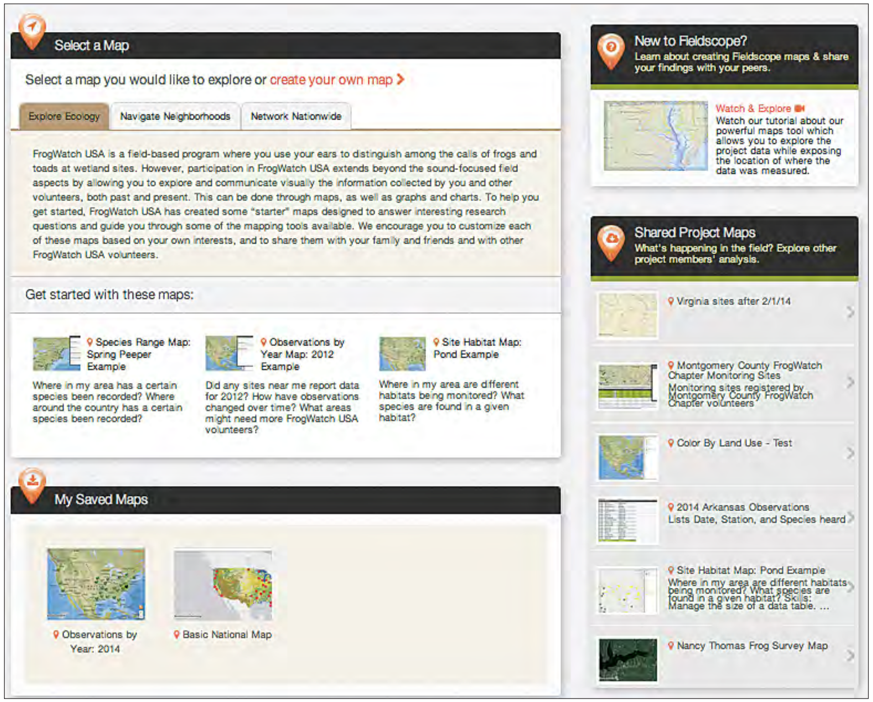
A histogram of observations from Project BudBurst.

- **Trash-Free Potomac** (Alice Ferguson Foundation), a regional conservation initiative in which volunteers participating in trash removal from natural areas report on the quantity and types of waste removed.

In each of these long-standing projects, the organizers had a preexisting interest in providing their participants with the

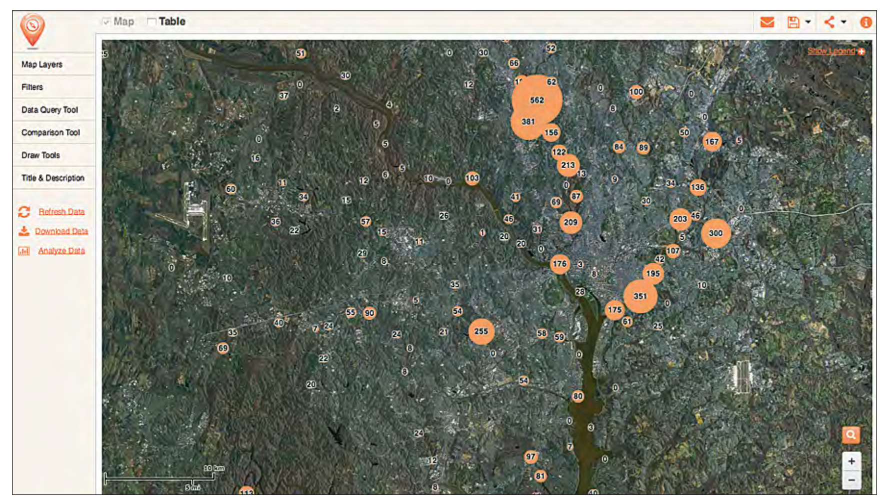
With FieldScope, we have allowed the organizers of these projects to provide their participants with access to GIS functionality for exploring their data through a novice-friendly user interface. Through our work with these test beds, we have developed an architecture for rapidly constructing and deploying citizen geography project websites. This spring, we are launching a set of FieldScope Project Builder tools that will enable nonprogrammers to set up a new FieldScope project through a forms-based interface that allows them to describe the data collection protocol and select the data and analytical functions to include in their project.

With the launch of the FieldScope Project Builder tools, we are excited to be approaching our vision of enabling any citizen



The home page for the FrogWatch USA FieldScope project.

opportunity to view and work with the datasets they were contributing to. However, none of them had the resources or expertise to provide that functionality to their participants. In this respect, they were typical of citizen geography projects. Most citizen geography projects are only able to provide participants and visitors with a static map or a simple interactive map of their data. Only a very few, unusually well-funded projects are able to provide maps with thematic layers, customizable symbolization, or geospatial analysis.



A FieldScope map showing bags of trash collected as part of the Trash-Free Potomac Project.

science project involving geospatial data with the opportunity to provide geospatial data visualization and analysis to its participants.

More information about FieldScope is available at fieldscope.org.

This material is based on work supported by the National Science Foundation under Grants No. GEO-0627923 and DRL-1010749. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the National Science Foundation.

(This article originally appeared in the Summer 2014 issue of *ArcNews*.)

Roger Tomlinson, Geographer

By Jack Dangermond

It is with great sadness that I relay the sudden passing of our dear friend and colleague, Dr. Roger Tomlinson, on February 9, 2014, at the age of 80.

Roger was above all else a geographer and was always proud to say that. He loved GIS, the field that he invented, and was so pleased to come to Esri and help us in thinking through difficult problems. He had a passion for staying current with the most recent technologies and always had insights that none of the rest of us had. He also loved attending the annual Esri User Conference and the opportunity to both see and acknowledge the great work of GIS professionals from around the world. He always said that giving out the Special Achievement in GIS (SAG) Awards was his favorite day of the year.

Roger both created and dignified our field with his strong yet graceful spirit and insight. He invariably knew what was important. His vision of first thinking about and then designing and building practical systems that created meaningful information products will be part of his legacy.

With his passing, a beautiful and bright light has gone out in the world. Nevertheless, I know that his spirit and passion will live on in all of us.

He was my friend. I will miss him greatly. And his spirit will be missed by all of us.

Dr. Roger Tomlinson (Photo: Tomlinson Associates.)

Dr. Roger F. Tomlinson (1933–2014)

"The Father of GIS"

It was Dr. Roger F. Tomlinson who first coined the term *geographic information system* (GIS). He created the first computerized geographic information system in the 1960s while working for the Canadian government—a geographic database still used today by municipalities across Canada for land planning. Born in England, he settled in Canada after military service and attending university, where his work in geomorphology led to applying computerized methods for handling map information. Tomlinson has had a distinguished career as a pioneer in GIS and developed Tomlinson Associates Ltd., which provides geographic consulting services. For 12 years, he was chairman of the International Geographical Union GIS Commission. He was also president of the Canadian Association of Geographers and most recently was recipient of the prestigious Alexander Graham Bell Medal, awarded only once before by the National Geographic Society. Tomlinson was also the author of *Thinking About GIS: Geographic Information System Planning for Managers*, one of the most widely read books on the subject.

Dr. Roger Tomlinson.

(This article originally appeared in the Spring 2014 issue of *ArcNews*.)

Redesigning Geospatial Education

By Anthony C. Robinson, Lead Faculty for Online Geospatial Education, Pennsylvania State University

Geospatial education is experiencing a new age of challenges and opportunities. Demand for a spatially aware work force remains strong, and the constant evolution of the geospatial domain provides an imperative for lifelong learning. To meet these challenges, geospatial educators are developing new approaches for teaching, ranging from intensely individualized lab experiences all the way up to Massive Open Online Courses (MOOCs), which reach thousands at a time around the world. While there is much promise in both the needs we face, as well as the means we have to meet it, there remains a critical challenge to appropriately design geospatial education experiences to reach their full potential in terms of quality, value, and access.

In cartography, we teach students to consider three key questions when designing maps:

- What is the purpose of the map?
- Who is the audience that will be using the map?
- What is the output format for the map?

In my view, the problem of designing effective geospatial education experiences can be seen through a similar lens. As our domain experiences rapid change through pressures imposed

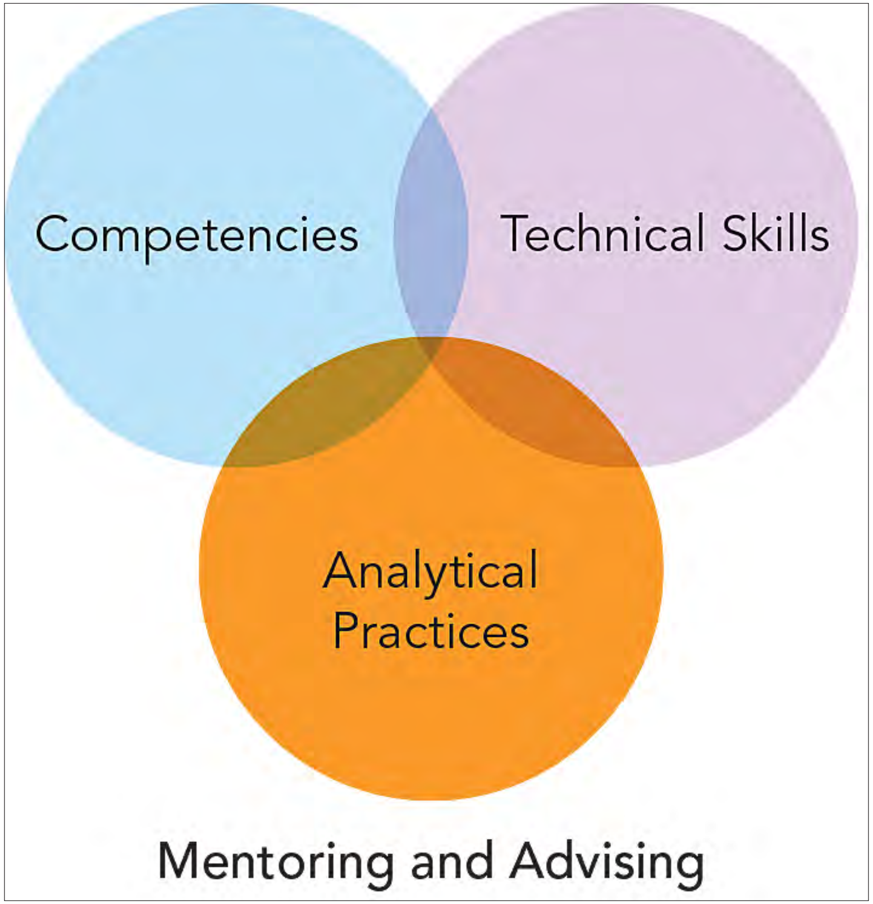
by new technical paradigms, new areas of focus for geospatial analysis, and new types of educational experiences, it is time for us to rethink the purpose of geospatial education, the learners we intend to reach, and the ways in which we engage with those audiences.

Bridging Competencies, Technologies, and Applications

While debate continues among educators and professionals regarding what ought to constitute a rich and rigorous geospatial education, there are three key areas of overlapping needs that all learners share. *Learner success in our discipline depends on achieving the right blend of core geospatial competencies, technical skills, and analytical practices grounded in real-world problems.* And each of these three areas is synthesized by mentoring through professional and academic advising.

Much effort has been made in recent years to develop and share collections of core competencies for geospatial professionals. The GIS&T Body of Knowledge (2006), offering more than 1,600 educational objectives, is now undergoing revision for its second edition and is expected to cover a broader range of areas than the original. The US Department of Labor has sponsored the development of the Geospatial Technology Competency Model (2010) and, more recently, the Geospatial Management Competency Model (2012) to describe core competencies for geospatial professionals, and the former model is now under further development. These resources provide important scaffolding for use in the development of new courses and the revision of existing curricula.

As nice as these basic competency sets are for setting the scene, they (rightfully) eschew much of the technology-specific capabilities that we expect learners to have in order for them to enter the work force. Academic purists will say that so long as a learner demonstrates core competencies, they will adapt just fine to whatever technology comes next. Employers, meanwhile,



Learner success depends on achieving the right blend.

will often ignore submitted resumés that show no expertise with common and emergent industry technologies. In higher education, it remains a serious challenge to develop and sustain high-quality courses that introduce relevant contemporary technologies and best practices in the context of learning about core competencies.

What should make it possible to achieve both goals is to focus on the contexts of geospatial work—analytical practice that is grounded in real-world problems. Core competencies taught in a vacuum are unlikely to engage learners. Technology training alone is not sufficient to develop critical spatial thinking skills. The most positive synthesis of all three key elements comes when the focus of geospatial education is on solving relevant, real-world problems that require one to bring together technical skills and core competencies to actually achieve something.

The way this combination can come to life for geospatial educators is through the deliberate evolution away from curricula centered on generic classes like Introduction to GIS and Advanced Spatial Databases toward courses that provide similar underpinnings in the context of problems that actually matter, like Understanding Disasters Using GIS or Geodesign to Improve Public Spaces. Instead of thinking of these application courses as mere electives that learners take long after they have made up their minds to study geography, we could begin to think of those grounded-learning experiences as parts of a new core for our learners from the very start.

Evolving Learner Engagement

The ways in which we engage with learners have changed dramatically in recent years. While distance education has precedents all the way back to surface mail correspondence courses, today's technologies make it possible to engage with learners on mobile devices and through web-based class experiences that challenge the established norms of same-time, same-place educational interaction. Learners have high expectations for us to develop flexible courses of study and to use flexible modes of engagement to access course content and interact with instructors. All the while, the potential audience for our courses has become far more diverse in terms of age, experience, and global reach.

At Pennsylvania State University, the vast majority of resident undergraduate students now take fully online or blended online/classroom courses as part of their normal semester course load. At the same time, the fastest-growing student population for us is our fully online cohort through Penn State World Campus. New educational paradigms, such as the MOOC, provide students with minimal barriers to entry and challenge instructors to develop content and assessments that will scale to tens of thousands of learners around the world. Geospatial education can (and already does) take place in each of these modes of learner engagement.

One challenge for us is to determine which instructional modes match well with particular pieces of the geospatial education experience. For example, my experience with teaching an MOOC on mapping leads me to believe that such courses will work well as teasers to draw new people into our discipline and get them up to speed on the basics but that MOOCs would not be good for tackling higher-order educational goals, such as the iterative refinement of a learner's cartographic design skills.

In addition to diversification in the ways we teach, what defines a student today is also increasingly hard to generalize. In the engagement types I reference above, students may include traditional 18- to 21-year-olds taking blended courses on campus, midcareer professionals taking fully online programs while working full time, and retirees who are exploring a topic for the first time in the form of an MOOC. Each of these groups can also be globally diverse. In the MOOC I taught, about 70 percent of the students enrolled came from outside the United States. In teaching students across the spectrum of age, background, and geography, it has become clear to me that we need to be much more explicit when we talk about designing classes and curricula to support students. We have to design geospatial education around which student cohorts we are trying to serve and to respond to their unique needs.

Flexible Futures

The good news is that we have a problem serving so many different types of people with quality geospatial education. Many other disciplines wish they had this problem. The bad news is that when we try to meet these needs today, we are often held back by inflexible legacy policies and frameworks that overlay our teaching. For example, credit hours are an antiquated way to measure the achievement of our learners. Schools like Western Governors University and the University of Wisconsin are using competency-based models in place of credit hours to certify that their graduates have demonstrated abilities in key areas of expertise in their field. There is also a wide range of new approaches for educational badging to show mastery of skills and methods regardless of where those skills have been obtained.

Whether or not badging and competency-based models become commonplace is not clear, as both methods have their own limitations. What seems clear to me, however, is that the future of geospatial education will require flexible views of what constitutes a course, what types of educational attainment will matter when one looks for a job, and in which life stages we expect learners to seek education. And yes, we can also expect there will be major changes in who is considered an educational provider. Students are already learning from each other through peer exercises in classes of all sizes, and professional expertise is increasingly valued in educational contexts, signaling a shift away from a value system that places formally trained educators at the top for every learning context.

It is hard to envision a future 15 years from now where most geospatial education happens when you are 18–21 years old, is delivered only in a physical classroom under the auspices of a traditional institution, is provided in semester-long chunks measured by the hours in which you spend taking that class, and is only auditable via a short title and letter grade on a paper transcript.

On the flip side, it is very exciting to imagine a future where geospatial education happens throughout your entire life, using a variety of modes, and is auditable based on the problems you are actually capable of solving. If the status quo in geospatial education is akin to command-line, desktop GIS software with a narrow user base, the future could be its web-based, scalable counterpart that is usable by everyone.

About the Author

Dr. Anthony C. Robinson serves as the lead faculty for Online Geospatial Education programs and assistant director for the Department of Geography's GeoVISTA research center at Pennsylvania State University. Robinson directs Penn State's Online Geospatial Education efforts, including its master of GIS and postbaccalaureate GIS certificate programs, which have served more than 5,000 students since 1999. Robinson teaches Maps and the Geospatial Revolution on Coursera, an MOOC that is now open for enrollments for its second offering beginning on April 30, 2014. For the GeoVISTA Center, Robinson's research focuses on the science of interface and interaction design for geographic visualization software tools. He has developed interface design and usability assessment methods for integrating geographic visualization tools with work in epidemiology, crisis management, and homeland security.

(This article originally appeared in the Spring 2014 issue of *ArcNews*.)

MOOCs, GIS, and Online Education: Quo Vadis?

"Crossing Borders"

A column by Doug Richardson, Executive Director, Association of American Geographers

Online teaching and learning is poised to radically change the institutional structures and traditions of education in the United States and worldwide. The advent of Massive Open Online Courses (MOOCs); the growing and widespread implementation of online teaching at all levels of education; and new, free and open-access publishing requirements for most scholarly research are combining to create the "perfect storm" preconditions for seismic shifts in our educational systems. These changes are already impacting geography, GIS, and geospatial education, as well.

How will the trends impact traditional educational offerings? In what ways might new online educational technologies improve access and new learning opportunities, and what might be lost in the process? What is the promise of the online transformation in education, and what unintended consequences might it entail?

Most geography departments and many other university programs currently offer an extensive array of GIS and related geospatial technology courses, ranging from introductory and applications-specific classes to advanced GIScience courses that address cutting-edge research, complex dynamic systems, spatial modeling, and cyber GIS infrastructure approaches to geographic information sciences and technologies (GIS&T). The number of online GIS and related geospatial courses within geography departments is also rapidly growing. Most of these online courses offer college credits for undergraduate or master's-level college degrees, while others provide certificates of achievement.

New Opportunities: Obviously, online education offers significant promise in terms of access, scale, and lower-cost provision of educational courses. It offers access to those who cannot afford the high tuition and living costs of many universities today. It also is a powerful way to reach students in developing regions around the world, many of whom have little access to higher education. It also will play a role in expanding adult education and for ongoing professional development. Online courses crafted specifically for specific employment requirements and for vocational and technician employment opportunities will also fill an important gap in current educational offerings. And for those who simply wish to explore a particular field, it offers a low-cost and convenient way to learn more about nearly any topic.

With continued research, it is likely that collaborative educational technologies and teaching methods will create more interactive and personalized online courses. Content will proliferate and address nearly every subject now taught in the classroom, and online pedagogy and student learning assessment procedures will be developed to function well within the online learning environment.

Potential Structural Consequences: What are some of the potential structural consequences of the online education explosion that we might want to think about, address, adjust to, or shape as these seismic shifts take place in traditional education over the next few decades?

Shift to the Private Sector: Because multiple education business models are changing simultaneously, including free, open access to research and publications of academics, as well as weakened copyright protection models for academic scholarship and curricular materials, in addition to the new Internet technology delivery systems for online education, I anticipate there will be a significant shift in the provision of educational services from existing colleges and universities to the for-profit private sector. The combination of free product (open access online courses, MOOCs, curricular materials, supplemental readings now including free academic journal articles, etc.) and free delivery systems (the Internet) will be attractive to private companies. These companies soon will be able to sell content developed by academics without having to create or purchase these open-access educational products themselves and can also avoid the brick-and-mortar facilities and other costs of universities, providing them with a competitive edge in the provision of educational services vis-à-vis many traditional colleges and universities, which must bear both of these costs.

Concentration of Higher Education: Online education approaches will also likely foster a concentration of university higher education in the United States to large, central state universities and to more prestigious universities. This shift to economics of scale or prestige recognition will entail closing many smaller colleges and regional state colleges, or their conversion to satellite tutoring centers for online courses provided from larger universities or private companies. Accompanying this trend will be the hiring of fewer senior or tenured faculty nationwide and an increase in the existing reliance on contingent faculty and, in the case of online courses, on tutors.

The Student Experience: While it is clear that online education is advancing in both technology and pedagogy and aspires to a "human" experience, many remain concerned about networking and the social and intellectual development that can be an important part of the student campus experience. While campus-based education is characterized as a luxury by some these days, it is important that online education not become the only route for students without financial means. It is often the less privileged student who may benefit most from face-to-face learning.

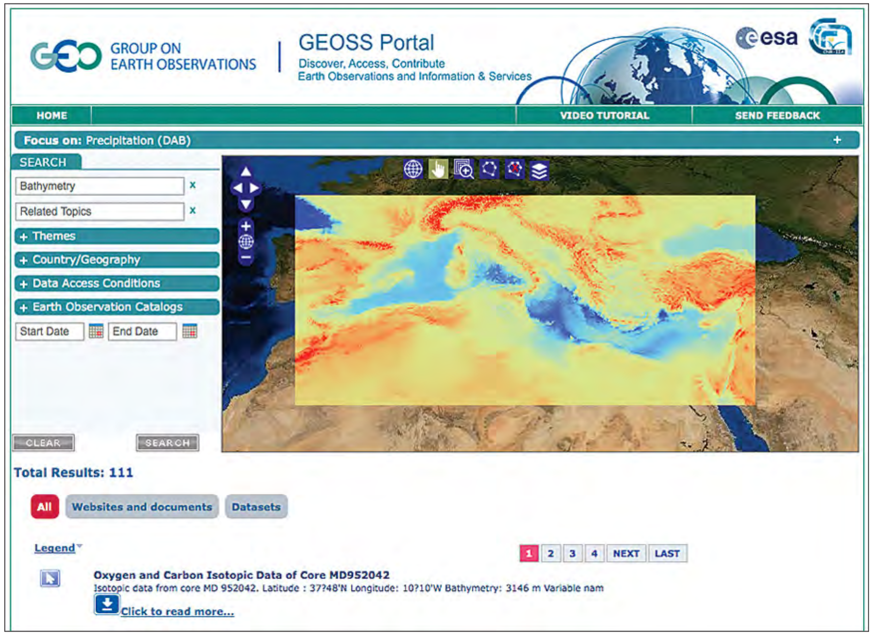
Also, learning in the context of related courses and within a broad and diverse intellectual environment cannot easily be replicated in an online-only setting. For example, an education in GIScience may be greatly enhanced in the context of a broader education in both related and less-related fields (e.g., statistics and geographic concepts, certainly, but also the humanities or environmental science).

It is clear that the online education transformation is here to stay and that it offers tremendous potential and opportunity, particularly if we shepherd it carefully and shape it with thought given not only to all that it can achieve but also to what it may not be able to achieve.

(This article originally appeared in the Summer 2014 issue of *ArcNews*.)

Earth Observation Platform Benefits Planet

Sensors, satellites, radar, and other earth observation technologies are used to monitor typhoons, oil spills, deforestation, and more. This data makes it possible to track, learn, and take action when events threaten the environment and human safety.



The GEOSS Portal: Here an analyst overlays GEOSS oxygen, carbon, and climate sensor data on Esri's Mediterranean bathymetry to study precipitation.

Recognizing a growing and critical need for improved, near-simultaneous observation of the planet, many governments and organizations are collaborating to coordinate their earth observation systems. A voluntary partnership called the Group on Earth Observations (GEO) works together to share earth observation data and science. It includes 90 countries, the European Commission, and 77 intergovernmental, international, and regional organizations.

GEO initiated one of the most comprehensive efforts to monitor the entire face of the earth by building a Global Earth Observation System of Systems (GEOSS). The GEOSS program brokers various forms of earth observation data and information via its online platform and a Discovery and Access Broker (DAB). The platform interconnects relevant information systems and infrastructures throughout the world.

Esri has long contributed to GEOSS, primarily as a member of the Open Geospatial Consortium, Inc. (OGC). The company is now collaborating with GEOSS Earth to make observation data and services available to the ArcGIS Online community.

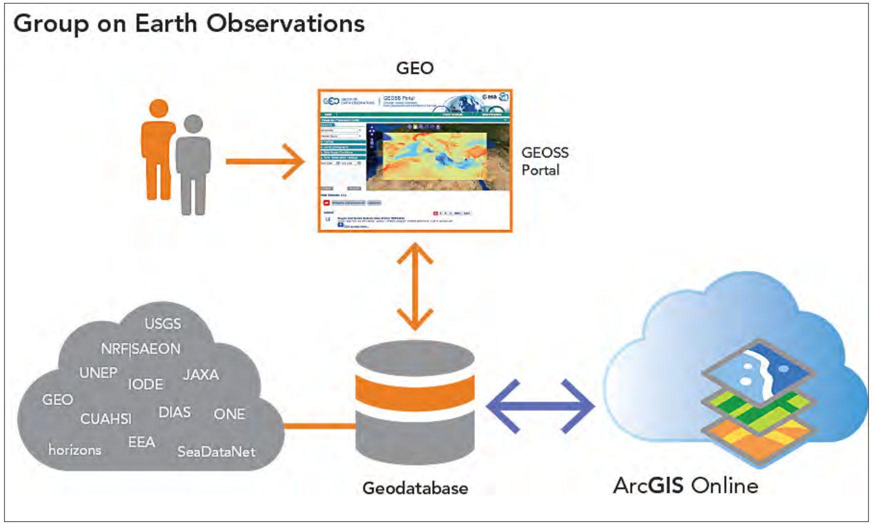
Many GEOSS contributors are already using Esri technology in their services, such as the European Environment Agency, the

United Nations Environment Programme, and the Food and Agriculture Organization of the United Nations. This makes their systems and data inherently interoperable.

Esri recently entered into a partnership with GEOSS by way of a memorandum of understanding (MOU) between Esri and the Earth and Space Science Informatics Laboratory of professor Stefano Nativi at the National Research Council of Italy Institute of Atmospheric Pollution Research (CNR-IIA). CNR-IIA and Esri are designing brokering arrangements and direct dataset access technologies, as well as open standards for data interoperability and cataloging. Through this collaboration, ArcGIS Online will become one of the significant infrastructures brokered by the DAB. ArcGIS Online subscribers can discover and access the resources published by GEOSS, use GEOSS data services, and build applications.

GEOSS categorizes earth observation data into nine societal areas: sustainable agriculture, biodiversity conservation, climate change and its impacts, natural and human-induced disasters, ecosystem management, energy management, environmental sources of health hazards, water resources, and weather forecasting. Millions of Esri's GIS customers whose work intersects these societal areas will find GEOSS data directly applicable to their projects. They can use it to establish baselines, monitor change, analyze problems, and design solutions.

"GIS becomes a platform for understanding when people use it to build on top of existing knowledge and measurements and share new ideas," Esri president Jack Dangermond says. "We are trying to create understanding out of measurement, knowledge, and science so that people can act. These measurements provide the basis for interpreting science for design work such as land-use planning."



Organizations can broker their earth observations through the GEOSS Portal, and users can combine data with Esri ArcGIS Online services.

CNR-IIA and Esri are building a two-way interoperability technology between the GEOSS DAB framework and ArcGIS Online by way of the ArcGIS Online DAB APIs. Developers will engineer Esri and DAB interfaces and build interoperable web services that interconnect the two systems via several paths.

One path starts from an Esri portal and leads the user to discover the main systems of services provided by GEOSS. ArcGIS Online users will access networks brokered by GEOSS DAB, such as the Committee on Earth Observation Satellites (CEOS), the International Council for Science (ICSU) World Data Center PANGAEA, the National Aeronautics and Space Administration (NASA) Global Change Master Directory (GCMD), and the World Meteorological Organization's Information System (WIS).

Another path starts from the GEOSS portal, leading the user to discover Esri services. All public content from ArcGIS Online, such as Esri basemaps and imagery, freely contributed datasets and maps, and tools, will be discoverable through the GEOSS DAB. ArcGIS Online is a resource for authoritative basemaps for the world, as well as topographic and hydrographic imagery. Users can overlay operational data from the GEOSS on these basemaps, along with other ArcGIS Online datasets. This allows specialized communities to fuse knowledge atop common geography.

"I have often called GIS a platform for understanding," Dangermond says. "People use geographic measurements to create knowledge and take action. GEOSS serves as an earth measurement platform for monitoring change on the planet. Making GEOSS content available in ArcGIS Online increases opportunities for scientists and other communities to visualize information in greater context. Moreover, because the platform supports authoritative and crowdsourcing information, GEOSS members can build networks into other disciplines."

Because earth systems are interconnected, they challenge scientists to reach beyond their specialized domains. Designing technology that bridges scientific disciplines is complicated. Sensor data and sensor measurement systems are highly variable. Data capture, measurement, and quality differ. For instance, sensors and methods used to measure weather are quite different from those used to measure stream flow. Furthermore, scientists manage data differently. Some use manual approaches, and others patch together pieces of software to combine different datasets from different sources. Scientists should not have to spend time learning and modifying technology.

These concerns served to formulate Esri and CNR-IIA objectives for platform design. First, develop a specialized search engine for discovering datasets that allow users to obtain raw data for scientific or other work in a remote workstation or server environment. Second, design a flexible architecture that supports continual inclusion of interoperability with the DAB. Third, devise tools to transform data services that can be harmonized, making it possible to integrate sets of measurements.

"Basically, GIS takes different layers of information or scientific measurements and integrates them analytically, visually, and/or dynamically into various forms," Dangermond explains. "Fusing the platforms sets up a work environment to access data and information sets, see them in context with GIS, and use them for modeling or in various applications."

The GEOSS and ArcGIS Online service is unique. One reason is because GEOSS and Esri's relationship diverges from the traditional scientific relationships between government and public agencies. Since ArcGIS Online is operated by Esri, a private company, it has more flexibility than platforms offered by government-driven or single government initiative programs. Furthermore, ArcGIS Online holds shared geospatial and imagery data of the entire planet rather than for a specific region or area of interest. Data available in ArcGIS Online does not belong to Esri. Rather, the data belongs to hundreds of thousands of organizations that choose to share their basemaps and other kinds of information via the platform.

Esri customers are but one of the communities that GEOSS brings together. It connects atmospheric and biodiversity, as well as many other sciences. Bringing GEOSS data into ArcGIS Online will help these communities extend their scope and work together to meet some of earth's critical challenges.

Learn more about GEO and GEOSS at www.earthobservations.org. Use the GEOSS Portal.

(This article originally appeared in the Spring 2014 issue of *ArcNews*.)

Creating Our Future

New Tools Will Help Us Meet the World's Challenges

By Jack Dangermond

We try to predict the future every day. You think about what the weather might be like. You think about what might happen with your favorite sports team. You think about what the future might hold for you.

2014 Esri User Conference Plenary Session: GIS—Creating Our Future.

Beyond prediction, some of us are actually engaged professionally in creating the future. Because as Peter Drucker said, "The best way to predict the future is to create the future."

We live in two worlds.

We live in the ordinary world—a world where we go to work, we eat, we have our family, and we have our friends. We operate in this world in a stimulus-response mode—things happen, we respond, and then we go about our daily lives.

At the same time, we live in an extraordinary world of imagining, thinking, dreaming, and creating.

We live in these ordinary and extraordinary worlds at the same time.

A good example of this is the life of an architect. An architect imagines, plans, and designs, and then creates.

But you and I also do this every day in our own lives. We imagine buying a house, or we imagine a new career . . . we imagine all sorts of things. And when we *act* on our imagination, we *create* something: we create a new future.

We are also living in a world facing serious challenges, such as population growth, urbanization, pollution, natural resource depletion, and climate change. These challenges not only impact us as individuals but affect *everything*. This in turn is also affecting our social world in terms of social controversies, conflicts, and migrations.

From severe climate events to drought to food production challenges, the world we live in is a complex, interconnected web. We live in an unprecedented time where the work that you do with geography is more important than ever.

GIS is integrating geography into everything we do, changing the way we think and act.

Geography as a science provides us with the context and the content of our world. It provides a framework for understanding our world by bringing all our measurements together, analyzing and visualizing them, and ultimately results in a new *understanding*. And GIS is the medium that helps us to understand.

Today, GIS is integrating geographic knowledge into virtually everything we do. It's changing the way we think by helping us see and understand things differently, within our own organizations as well as at the planetary level. And it's also changing how we *act*. As Richard Saul Wurman says, "Understanding precedes action."

—

GIS itself continues to evolve and, as a result, your individual systems are now becoming part of a larger interconnected platform. Your servers are connecting, your desktops are connecting, and your apps are being fed by shared community content. This *web GIS* is a new pattern that's coevolving with faster machines, web services, open environments, open policies, and networks.

Web GIS is bringing together all our data, technologies, and people. It lets you share your own focused work in the form of web maps and web services, throughout your organizations as well as on the web to the world. This creates a framework where we can collaboratively work to address the complex challenges facing our world.

Web GIS integrates all types of information, organizing and sharing your work both internally and on the open web.

Web GIS is also leveraging advancing technologies—the world of measurement, the world of computing, and the world of networks—and layering on top of that infrastructure. This "nervous system of the planet" brings our world's information to life.

In addition, the app revolution is making this web GIS and all of its content available everywhere. Anyone can now access this new medium of web services and web maps anytime, anywhere, on any device, bringing GIS to life in whole new ways and transforming how GIS professionals work.

—

Fundamental to this idea of creating the future is the concept of geodesign. Geodesign takes geographic information and links it to the design, decision making, and planning processes using collaboration. It does this by building the power of GIS into each process, allowing alternative plans to be visualized, compared, and evaluated. The end result is better, more informed decisions.

I was first introduced to this methodology almost 50 years ago by my professor, Carl Steinitz, and it set me on a course I've followed for my entire career. And it's much more than just a landscape architecture concept or a planning concept. Geodesign is equally important for businesspeople wanting to locate stores as it is for farmers who want to plant crops. In fact, geodesign has a role to play in almost every activity.

For the GIS professional, geodesign extends your work from the science side into the creative side—from the ordinary world to the extraordinary world. I would like everyone to think about becoming geodesigners. It's the right time for us all to move in this direction, because the technology is here now and it can play an important role in helping us to solve the world's problems.

—

The mission of creating a better future depends heavily on GIS professionals. It is you who can envision what's possible, understand and embrace and fully leverage these new web GIS and geodesign tools, show leadership, and do the difficult work we have ahead of us.

Creating a better future requires GIS professionals.

Seeing the work you do, and knowing what I know about the technology and where it's going, this isn't just a possibility. I think it's actually inevitable. As GIS professionals, you are already imagining the future and working hard to create it. You are the future.

About Jack Dangermond

Jack Dangermond founded Esri with a vision that computer-based mapping and analysis could make significant contributions in the areas of geographic planning and environmental science. The recipient of 10 honorary doctorate degrees, he has served on advisory committees for the National Aeronautics and Space Administration, the Environmental Protection Agency, the National Academy of Sciences, and the National Science Foundation.

(This entry was posted to *Esri Insider* [blog], July 18, 2014.)

Geoempowering Design

Geodesigning Our World with Nature and Technology

Kongjian Yu is the son of a Chinese farmer. He grew up on a commune and worked in the rice, wheat, and sugarcane fields with his father until he left for college at age 17. Today Yu, 50, is a well-respected, award-winning urban designer and landscape architect whose firm Turenscape often turns neglected land and polluted waterways into wetland parks filled with flowers and teeming with fish and birds.

This urban landscape, including the flowers, was generated using tools in Esri CityEngine.

Yu showed photographs of these lush parks during his keynote talk at the 2014 Geodesign Summit at Esri, where he advocated for a fresh way of thinking in landscape architecture and design: Use geodesign, which incorporates design, geography, and geospatial technology such as GIS, to help create an ecological infrastructure for communities.

An ecological infrastructure reflects the natural environment rather than something built out of concrete and steel. Many of Turenscape's park projects in China let nature take its course. Rather than diverting storm water from a river during the rainy season with pipes or channels, it's captured and filtered in ponds in a terraced wetland system. Areas that flooded historically are allowed to flood again. Nature takes hold, and reeds and flowers spring to life. Birds flock to these wetlands again, and so do the bird watchers, Yu said.

"Design for an ecological infrastructure to create an ideal relationship between man and nature," said Yu. "It's a new way to make a beautiful landscape."

Geoempowering Design

Yu and a roster of other speakers gave presentations to almost 300 people from diverse fields, such as architecture, academia, urban design, ecology, health, banking, biology, mining, and marine sciences. Nearly half were new to the event, now in its fifth year. Geodesign Summit organizers believe that reflects a deepening interest in geodesign.

Emcee Thomas Fisher, dean of the College of Design at the University of Minnesota, said the definition of geodesign continues to be shaped but offered one of his favorites. "It's a marriage of the incredible spatial power of GIS, geography, and design. It marries the data-rich analytical power of GIS with the creative synthesizing methods of design. GIS helps us understand what is and design what could be."

Esri president Jack Dangermond spent about 30 minutes outlining why he thinks using geodesign—whether in urban planning or other fields—will be a linchpin in solving sustainability issues, including the changes that population growth is having on land use and the climate. "What is the counterbalance to these trends?" he asked. "I think it's in this emerging world of geodesign. Collectively we need to create a better future."

Dangermond said geographic information system (GIS) technology is essential as a foundational technique to geodesign. "GIS provides a platform for the integration of science, providing the practical means for geoempowering design."

Esri staff gave the audience a short demo of the geodesign tools in Esri CityEngine, which creates 3D models of buildings and entire urban landscapes using procedural rules. Eric Wittner, the 3D technology evangelist at Esri, and the 3D team also previewed the 64-bit ArcGIS Pro, a desktop application with fast displays, 2D and 3D views, and powerful spatial analysis. ArcGIS Pro is slated for release later this year.

In the demo, the team showed how it was possible to use Pro to design a green rooftop garden. For example, they used tools in the application to add a glass fence to the perimeter of the roof, access for an elevator, shrubs, and a fountain. "This will be a new tool to do design and blend the 2D and 3D world," Wittner said.

Esri technology evangelist Bern Szukalski demonstrated a new browser-based web app called Esri Landscape Planner that will be available soon in ArcGIS Marketplace. This ArcGIS Online powered app contains sketching and analysis tools and gives designers the ability to bring in landscape and demographic layers and imagery. The app also lets them collaborate together and edit designs.

Szukalski used the app's tools to sketch a park and a proposed light-rail line in a town. "I think this will be an exciting piece of technology to add to your geodesign portfolio," he said. "Landscape Planner helps put all the pieces together to create a true, open geodesign platform."

Designing with Nature in Mind

Though technology was front and center at the summit, the idea of designing with nature in mind was omnipresent in the Esri auditorium.

Renowned biologist and natural sciences writer Janine Benyus took the stage to talk about biomimicry, a science in which nature provides a model for landscape and urban design. "I live in the Bitterroot Valley in western Montana," she said showing pictures of the bucolic rural countryside. "It's so healthy . . . when I walk back there, I see what we could be," she said.

Benyus said much can be learned from nature about how to design for urban areas. "It's nature as mentor," said the author of the book *Biomimicry: Innovation Inspired by Nature*. "What would it take for a city to function as elegantly as a forest?"

She spoke about how plants and animals evolve and adapt to a changing and often harsh environment, using a 1,500-year-old tree with strong, deep roots and branches that are designed to shed as an example of the resiliency in nature. "That 1,500-year-old tree—it has seen many hurricanes," she said. "Generosity is one of the standards of nature. How does nature create more and more opportunities for life?"

In a follow-up conversation with Dangermond and Fisher, Benyus said that metrics need to be collected in order to create ecological performance standards for designing sustainable cities. She also envisions the creation of an in-depth database or information portal that inventors, designers, and others involved in biomimicry could access to obtain scientific information about their areas of interest. Benyus said she looked forward to learning more GIS and the role it could play in developing and hosting a business information system.

"You've been searching for GIS for a long time," said Dangermond.

The Art of Survival

Yu learned to use GIS two decades ago, and today his staff at Turenscape uses Esri ArcGIS software for topographic modeling and analysis.

Kongjian Yu.

Before he founded Turenscape in 1997 and became professor and dean of the College of Architecture and Landscape Architecture at Peking University, Yu attended Harvard University, where he earned a doctor of design at the Harvard Graduate School of Design. He also interned at Esri, working in the prototype lab.

Yu said geodesign using GIS technology is essential to the work of his company, which has completed 1,300 projects in 200 cities, including China Town Park in Boston. But he credits his early years working on the commune with a grounding in geography, topology, and soil. The words *Tu Ren* in Turenscape mean "earth man."

The man did not really wander far from the farm.

"Many of these designs are inspired by my experience on the farm," said Yu. "In the city, you don't know how to grow rice. You don't know how to work with dirt; you don't know how to irrigate."

He said he and Dangermond are sympatico when it comes to believing that geodesign will change the world for the better and that our survival will depend on it.

For example, geodesign played a role in cleaning up a once polluted waterway in Liupanshui City, China, and creating a biodiverse wetland park.

Turenscape used geodesign to develop the Shuicheng River and Minhu Wetland Park project. Concrete embankments along the river were removed, and natural vegetation was planted and allowed to thrive. Storm water is no longer diverted away from the river. Water no longer goes to waste. A once polluted waterway is fishable again. People stroll along walkways that wind around terraced ponds. Beautiful orange flowers flourish around the wetland's perimeter.

"Now, it's become a beautiful place," Yu said. "People love it. The biodiversity has increased. It has now become a national wetland."

(This article originally appeared in the Spring 2014 issue of *ArcNews*.)

Planning an NSDI for the Future

"Crossing Borders"

By Doug Richardson, Executive Director, Association of American Geographers

The creation and continuous evolution of the United States National Spatial Data Infrastructure (NSDI), under the leadership of the Federal Geographic Data Committee (FGDC), has provided a crucial foundation for the development of today's GIS community and the many GIS applications that now abound in our world. Planning is now under way for a new NSDI future, one that responds to evolving mobile GPS/GIS data collection and use technologies and the resultant explosion of real-time spatiotemporal data availability and its dynamic, interactive applications. One step in adjusting the NSDI to this changing world of pervasive real-time geographic data is the recent Strategic Planning process undertaken by FGDC for the NSDI.

The National Spatial Data Infrastructure has been defined as "the technology, policies, standards, and human resources necessary to acquire, process, store, distribute, and improve utilization of geospatial data." (Executive Order 12906: "Coordinating Geographic Data Acquisition and Access," 1994.)

For the past two decades, FGDC has worked to develop policies and partnerships to advance the development of the NSDI. To achieve this, FGDC has contributed to the evolution of federal and national geospatial initiatives. Several of these initiatives have been sponsored as US governmental priorities, and their milestone evolution and key themes are highlighted in the following figure:

A New NSDI Strategic Plan*

As Anne Castle, assistant secretary of the Interior Department and a leader throughout the NSDI strategic planning process, points out, "the NSDI strategic plan describes a broad national vision for the NSDI and includes goals and objectives for the federal government's role in continued sustainable development of the NSDI. The plan has been developed with input from a variety of sources, including FGDC member agencies and geospatial partner organizations. The National Geospatial Advisory Committee (NGAC) has played a critical role in the development of the plan by providing extensive input and comment."

The plan is thus a collaborative effort, led ably by FGDC but involving many federal agencies, the private sector, and state and local governments, among others. The plan recognizes the revolutionary changes in geographic science and technologies and the growing applications of geospatial information across all sectors of the global economy. In response, US public sector agencies must realign their geospatial strategies and investments to meet the needs of rapidly expanding real-time geospatial information and technology users. And increasingly, citizens expect governments to provide geospatial data and services to them in their specific areas of interest or need.

The new NSDI plan focuses on adapting to a rapidly changing set of external factors, such as these ongoing and future trends:

Work Force: There will be increasing demand for skill sets positioned at the intersection between the traditional IT and geospatial realms, such as application and services development, geoinformation fusion, crowdsourcing, social networks and human geography, identity management, visual analytics, and forecasting/modeling.

Technology: Geospatial technologies will be called upon to organize a much larger information domain, provide trusted analysis of complex "big data" holdings, and effectively visualize and communicate knowledge so that it can be turned into operational efficiencies. The "Internet of Things" will connect billions of stationary and mobile sensors with human users.

Communications: Systems for information delivery will become ubiquitous and highly mobile, will utilize web-based services, and will be integrated components of more advanced information workflows. Harnessing content provided by sensors and social media, particularly in the form of feedback to enhance authoritative processes and products, needs research and strategy. Additional attention is needed with regard to the measurement and expression of the uncertainty inherent in geospatial information and related analytical products.

Legal and Policy Contexts: State, tribal, regional, and local geospatial resources will continue to improve and, in many areas, may provide the best sources for ongoing current and accurate information. Integrating these diverse datasets involves coordinating numerous legal and policy frameworks. Thoughtful approaches are needed to develop consensus terminology; develop policy; and educate citizens and decision makers with regard to geospatial data gathering, dissemination, and usage. Geolocation privacy, confidentiality, and security issues may need to be addressed for sensitive geospatial information.

Full details on the assumptions, analysis, and recommendations of the new NSDI Strategic Plan are available online, and the plan itself can be accessed [PDF]. While this plan focuses primarily on the federal role in achieving the shared national vision for the NSDI, the successful implementation of the specific goals and objectives in the plan will require coordination with a wide range of nonfederal partners and stakeholders, including you.

How You Can Help Shape the Future NSDI

FGDC plans to work closely with NGAC and other organizations and individuals to collaboratively develop and maintain the nation's critical geospatial infrastructure. Anne Castle emphasizes that "we will work with FGDC member agencies and partners to develop more detailed project plans and milestones for the goals and objectives in the [NSDI] plan." I join Assistant Secretary Castle in inviting all of you in the Esri GIS community to participate in the ongoing process of developing implementation plans for the NSDI. Contact FGDC or members of your GIS community on the National Geospatial Advisory Committee to make your voice heard. (Additional information about NGAC, including a list of committee members, is available.) I now serve on this committee, and Jack Dangermond has provided highly valued guidance to this committee for many years.

And, perhaps most importantly, continue to push forward with all the innovative GIS development work that has long characterized the vibrant Esri GIS community, as it is with our continued work to create and innovate and develop the field of GIS and geographic technologies, and their new applications, that we will most directly shape, tangibly and on the ground, the future of the NSDI.

*Federal Geographic Data Committee, 2013, National Spatial Data Infrastructure Strategic Plan 2014–2016: Reston, VA; Federal Geographic Data Committee, 19 p. Some of the descriptive text and the figure contained above in this column are from the final plan.

(This article originally appeared in the Spring 2014 issue of *ArcNews*.)

Managing Your Ambition: Contributions to Professional Organizations

"Managing GIS," A column from members of the Urban and Regional Information Systems Association

By Ryan E. Bowe, GISP, and Wendy Peloquin, GISP

Word on the street is that professional organizations are dying. One would think that in this unstable economic time, professional organizations would be thriving. Not only do they provide a common place to meet other professionals with similar interests, they also provide connections to career opportunities. One of the major concerns is that they are becoming irrelevant, especially when there are many organizations doing ostensibly the same thing. This concern resulted in several professional organizations reinventing themselves to focus on their "brand." But many individuals are no longer able to justify the cost of being part of an organization in the absence of tangible benefits.

Sometimes advantages made through professional organizations are direct (career listings, resumé boards, mentoring); other times, benefits are more subtle. Many professional organizations provide professional development through certifications and continuing education programs. Beyond opportunities for career connections and professional development, these organizations also provide camaraderie in the form of a friendly environment to test ideas. Although you may not want to take your work home with you, there are few times when a GIS professional can sit down with someone who has the same base level of knowledge. Many of these organizations are also the first place to learn of new technologies and trends within the industry. They help disseminate information by publishing journals and newsletters highlighting the innovative use of technology by their members.

Professional organizations are vital to the life of the profession itself. Many professional organizations take the lead in developing industry standards. For example, the Urban and Regional Information Systems Association (URISA) authored and maintains The United States Thoroughfare, Landmark and Postal Address Data Standard, and the American Society for Photogrammetry and Remote Sensing (ASPRS) standards committee has authored Accuracy Standards for Large-Scale Maps, LAS specifications (Version 1.4-R12), and Vertical accuracy reporting for LiDAR (Version 1.0). If industry experts do not take the initiative to develop and set standards, who will? These organizations also provide a unified voice for their members by advocating for issues within the industry.

No one ever wants to be in a position where they have to use a safety net, but it is comforting to know one is there. Building connections within a professional organization allows people to become familiar with your work ethic. In return, your list of potential references should continue to grow. Organizations are all looking for contributors who do more than pad resumés.

Not convinced you should join a professional organization? Not sure how or where to start? Here are a few tips on how to become active within professional organizations:

Do your research. Are there professional organizations that are tailored to your interests within the GIS industry? Spatial professionals are needed in what may seem obscure places, such as the Association for Unmanned Vehicle Systems International. Maybe some organizations fit your personality more than others. When you research the different opportunities, you are going to feel as if you are in the land of alphabet soup with all the different acronyms. Be patient, though, and look at each organization's mission statement to see if it is going to advocate for your concerns.

Start local. It helps to be able to get to know people face-to-face. And, it is possible to get a good idea of the "mother" organization through the local groups. However, this is not always the case. If there are no local professional organizations in your area, consider working with colleagues to champion a local chapter or organization.

Check for reduced membership rates. Many organizations are also offering student or young professional discounted rates. You can also check to see if your school or employer may already have a membership or sponsorship, as you may be able to become a member through your organization without paying a dime!

Go to a conference. Conferences are a great place to meet people with similar interests. It is common for user groups to have a meeting during a conference. Many conferences have mentoring opportunities, physical resumé boards for employers who are looking to hire, or employer meet and greets. Giving a presentation may help your current employer justify sending you to the conference, and it will definitely help build your credibility within the profession. It is also another opportunity to gain valuable critiques from your peers.

Become involved. Are you currently a member of a professional organization or looking to get more involved? Scour their websites for working groups and initiatives; organizations are always looking for free labor since essentially none of the professional organization positions are funded. If you volunteer and do what you say you are going to do, providing a quality "product" in a timely manner, more opportunities will become available. Consider sitting on the conference planning committee (once you've attended one, of course). Most of the time, professional organizations will put out a call for participants in their initiatives. These calls will often be on their website or monthly newsletter. If you can't find something that fits, try to contact an active member in the organization. How do you find them? Their name will be on the website! People who are passionate about their professional organizations will be more than happy to talk to you and may also be able to help find a place for you because they may know about initiatives that are just beginning.

Do not overcommit yourself. Most organizations will let you sit in on conference calls or group meetings at conferences to see if they fit you. Have a goal in mind of how much time you are willing to spend with the organization. Know your limits. Once word gets out that you are not only willing to volunteer but you also provide quality input, others will come knocking on your door. But that knocking will stop if you don't show up and deliver what you promised!

To help restate one of the points of this article, this very article itself only came about because we met through URISA: yet another example of the camaraderie that comes about from participating in professional organizations!

Many good things can come from professional organizations, but in order to continue to be relevant, they need volunteers who are passionate and not just there to advance their personal agenda, or professional organizations really will become extinct. Professional organizations are realizing that networking is not the only selling point to retain and attract new members. Now is the time to become involved and help shape the professional organizations into something that is truly for the profession!

About the Authors

Ryan E. Bowe, GISP, has been working at Photo Science, a Quantum Spatial Company, for eight years as a GIS technician, as well as an alternate sensor operator. She was recently recognized as URISA's Young Professional of the Year for 2013. Wendy Peloquin, GISP, is a GIS analyst at RS&H in Jacksonville, Florida. She serves as a member of URISA's Vanguard Cabinet, Georgia URISA's Event and Conference chair, and Florida URISA's northeast regional director.

(This article originally appeared in the Spring 2014 issue of *ArcNews*.)

What *IS* GIS?

By Matt Artz

It seems like a simple question. It should be pretty easy to answer.

You're a GIS professional. You've been around the technology for years, and you use it every day. You present your work at conferences and leave with a stack of business cards from like-minded geogeeks. You and your peers have lengthy discussions about the finer points of isolines and your latest adventures in kriging over burritos at lunch. But you struggle when a friend, neighbor, spouse, sibling, grandparent, or child asks:

> *What is it exactly that you do?*

Why GIS, of course! Which is inevitably followed by a quick

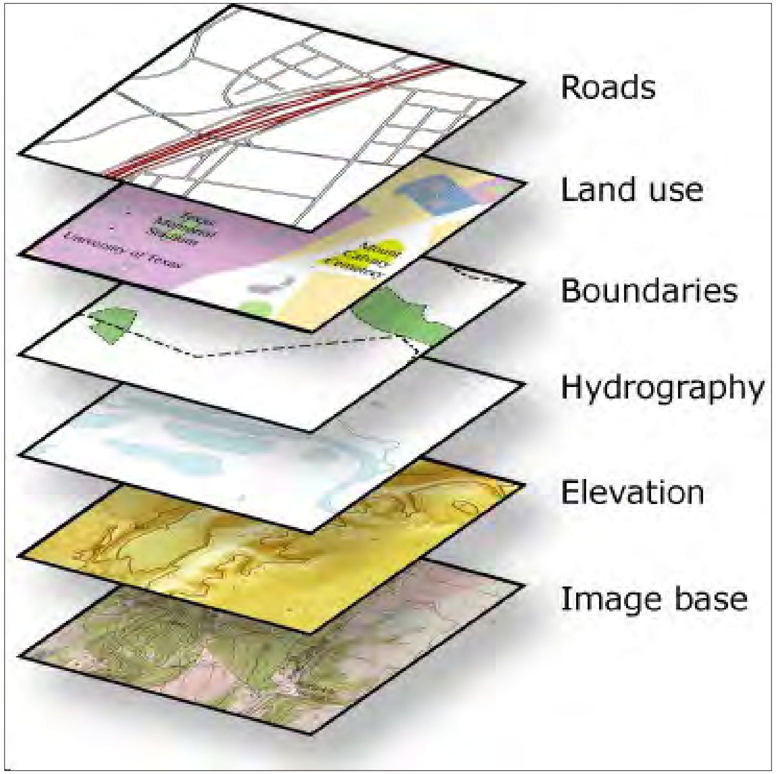
> *What* **IS** *GIS?*

There are at least as many definitions of *GIS* as there are GIS professionals. Perhaps you're an old school paleogeographer and prefer a classical definition:

> *GIS is a tool that can access, integrate, and distribute layers of map information. The five parts of a GIS include hardware, software, data, procedures, and people.*

Ah, yes! Who can forget the "five parts of a GIS"? And layers! Layers are the reason we're all employed! Thank you, Ian McHarg!

GIS and layers: like peanut butter and chocolate.



But maybe you prefer a little more modern definition:

> *GIS lets us visualize, question, analyze, interpret, and understand data in new ways. This can reveal relationships, patterns, and trends.*

It might be easier for some people to understand what GIS is if you first gave it some context:

> *A transformation is taking place. Businesses and government, schools and hospitals, nonprofit organizations, and others are taking advantage of it. All around the world, people are working more efficiently because of it. Information that was limited to spreadsheets and databases is being unleashed in a new, exciting way—all using GIS.*

Or perhaps it's easier for you to describe GIS in terms of a simple workflow:

> *People intuitively understand maps. When a decision needs to be made, GIS helps us gather information and place it on a digital* ***map****. We then use GIS to* ***evaluate*** *the decision geographically. Once we fully understand the geographic consequences of the decision, we can* ***act*** *in an informed, responsible manner.*

Maybe you prefer to talk about GIS in terms of the types of questions it can answer:

> *Where are my customers and potential customers? Which areas of my town are most vulnerable to natural disasters? Where should we locate a new elementary school? GIS can help answer questions such as these by combining data from many sources and producing customized maps.*

Some people find it more effective to communicate GIS as a value proposition in terms of the benefits it can bring to an organization:

> *GIS benefits organizations of all sizes and in almost every industry. There is a growing interest in and awareness of the economic and strategic value of GIS. The benefits of GIS generally fall into five basic categories:*
>
> - Cost savings resulting from greater efficiency
> - Better decision making
> - Improved communication
> - Better geographic information recordkeeping
> - Managing geographically

Or do you like to take more of a philosophical approach?

> *Remote-sensing satellites and earthbound sensors are providing us with vast amounts of new data about our planet. With the availability of easy-to-use GIS tools to display and analyze this data, now **everyone** can be a geographer. This has far-reaching benefits to both society and the environment, ushering in a new era of understanding our world.*

Sometimes, depending on who is asking the question, your only hope at getting anything other than a blank stare may be an overly simplistic definition, even if it loses some of the most important characteristics of what GIS does:

> *GIS is computer software that makes maps.*

My personal favorite definition, at least this week, is

> *GIS helps us see where things are—and decide where they should be.*

Or maybe the "father of GIS" was right when he said

> *"A simple definition is not sufficient."*
>
> —Roger Tomlinson

The truth is millions of people use GIS, and there are almost as many definitions of GIS as there are people who use it.

So, I ask you:

> *What is it exactly that you do?*
>
> *What* **IS** *GIS?*

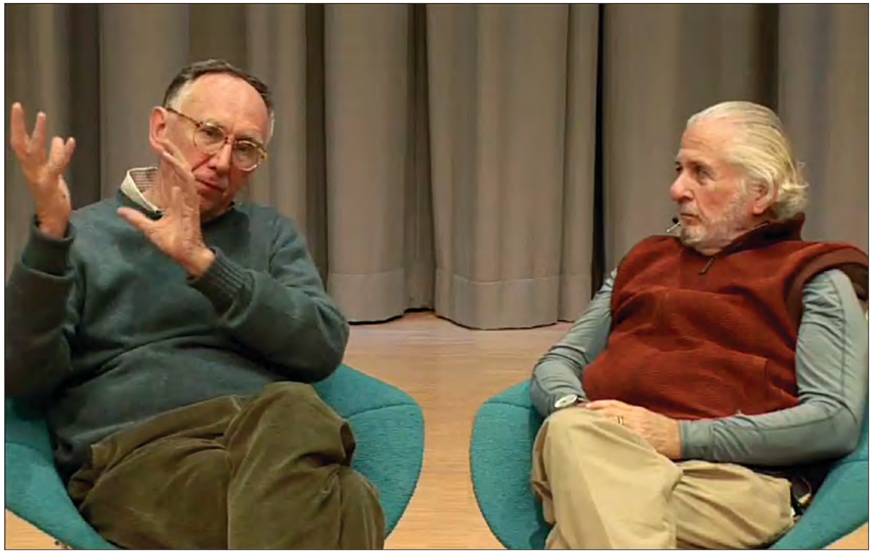
(This entry was posted to *GIS and Science* [blog], May 27, 2014.)

Understanding Precedes Action—And Geography Maps the Course

TED Founder Richard Saul Wurman Applies Singular Ideas to Projects Past and New to Enlighten and Engage

Among the heavily trafficked, wonderfully crafted exhibits on display at the 2013 Esri International User Conference Map Gallery, perhaps the most striking was the Urban Observatory.

The immersive experience took the ArcGIS location platform to new heights. People interacted with large screens and colorful maps to directly compare cities on numerous subjects, such as demographics, land use, infrastructure, and transportation. The Urban Observatory's creator, Technology/Entertainment/Design (TED) Conference founder Richard Saul Wurman, sought to build an experiential web application that would, as he put it, provide understanding through comparison and contrast to complex questions facing 21st-century life. Fellow creators Jon Kamen of @radical.media and Esri president Jack Dangermond also wanted to give attendees a visual context that gives way to meaning—and, most important, action.



Jack Dangermond (left) and Richard Saul Wurman (right).

"A map is a pattern made understandable," Wurman said. "And understanding precedes action. This is at the heart of the Urban Observatory. It's a simple idea."

Yet simple is not necessarily reductive. In fact, it can be edifying. That's how Wurman sees it. The simple phrase *understanding precedes action* was coined by Wurman years earlier in Kamen's office.

"I didn't make a big deal of it. I didn't think they were words coming down from Mount Olympus," says Wurman.

It's the idea behind the Urban Observatory. It buoyed projects past (like the WWW Conference) and new (Wurman's latest offering: 555 Conference 2015).

It's a principle for GIS professionals and anyone interested in maps. Esri's own mantra, Understanding Our World, is woven of the same fabric: carefully analyzing and viewing information first to make better, more accurate decisions.

"GIS is the key to the kingdom," says Wurman. "It brings mapping into a universal language and gives you the opportunity to ask questions and find answers visually."

Understanding the Meaning of *Understanding Precedes Action*

What does this expression mean, anyway?

Wurman has spent a lifetime mulling over how people can develop a language of performance in urban planning so that cities could consider unintended consequences.

A perfect example—for years, as cities incur more traffic, they add more freeways and highways. Yet does that actually solve the problem? Or does it spur the purchase of more cars, which keeps freeways congested with more vehicles while consuming more fuel and generating more pollution?

"Adding more lanes only invites more traffic," says Wurman. "The problem wasn't understood, but action was taken."

This is where geography and GIS help people develop a greater comprehension of issues before taking steps.

Perhaps the best explanation of the expression is an exploration of how the principle manifests itself throughout Wurman's work.

A prime example is the Urban Observatory. The exhibit and website made their debut at the 2013 Esri User Conference. More than 16 cities contributed data, and the creative and technical forces at @radical.media and Esri built the first iteration of the exhibit using the latest software, hardware, fiber optics, custom kiosks, and high-quality monitors.

The Urban Observatory.

ArcGIS Online allowed people at the exhibit to interact with datasets for each participating city. People used the Urban Observatory web application to easily compare cities on their own via a simple web browser. As an individual zoomed in to one digital city map, other city maps zoomed in parallel, revealing similarities and differences in density and distribution. For instance, what if you wanted to simultaneously view traffic density for Abu Dhabi and Paris? Or view vegetation in London and Tokyo? No problem. A mouse click and scroll was all that was needed.

The Urban Observatory exhibit and application are continuing to evolve beyond the first prototype. From concept to creation, the goal has always been to provide a clear grasp of modern challenges facing today's cities. And supplying that awareness to people, government, and business prior to making decisions was a central driver.

"There's a notion that the more you put on the map, the better the map is," says Wurman. "There's a case where the opposite is true. Put two patterns together and you'll discover a third. The maps where you pile more and more information on them, you can't discover a pattern at all."

Then there's the WWW Conference. The event, hosted by Esri, was a type of "anticonference." TED talks today have a polished and somewhat scripted approach that's different from their initial iteration in 1984. The WWW Conference sought to achieve "intellectual jazz" through improvised conversation.

The conference provided three days of dialog featuring dozens of celebrities and thought leaders. Wurman paired individuals together to spark conversation with a simple question, idea, or premise. Then he let the conversation evolve, naturally and organically, without rehearsal, preparation, or planning of any sort. Participants faced each other, not the stage.

Dangermond, a keynote speaker, spoke with botanist and environmentalist Peter Raven. The two discussed biodiversity, sustainability, and climate change.

Understanding—and geography, science, GIS, and mapping from human cells to space to the atom—were themes and topics of their conversation and of multiple speakers.

The success of the WWW Conference served as the springboard for the 555 Conference, which is scheduled for the first quarter in 2015. Featuring five speakers in five cities located around the world, the conference will showcase experts sharing their predictions five years in the future. Each of the people making a prediction would be given as much assistance as desired to develop a presentation and take advantage of video, slides, data analysis, and visualization (including GIS). The forum for speakers would be spontaneous—not read or rehearsed but natural conversation backed up by extraordinary audiovisual elements.

Then 555 will help launch the WWW2 Conference, which will build on its original concept of bringing in artists, entertainers, scientists, and others to talk about the predictions revealed at 555. The thought leaders and icons could then talk about the unintended consequences that could result from the five-year forecasts.

Which takes us back to the beginning. Whether it's Urban Observatory, 555, WWW2, or Wurman's yet-to-be-named next creation, the axiom that *understanding precedes action* is at the core. And GIS, mapping, and geography are the underpinnings.

(This article originally appeared in the Spring 2014 issue of *ArcNews*.)

From NIMBY to NOPE: Overcoming the Location Dilemma

By Bill Meehan

There's an old saying: Everyone wants to go to heaven, but no one wants to die.

Everyone wants low-cost, environmentally friendly energy. But people don't want to look at transmission towers, pumping stations, power plants, substations, and wind farms. More than that, they don't want any of these things located anywhere near them. We used to call this situation NIMBY or Not In My Backyard. Today, we have gone from NIMBY to NOPE (Not On Planet Earth).

Transportation organizations have the same problem as utility companies. Everyone complains about traffic jams, lack of public transportation, not enough flights, lack of access to ports, and emissions from freight trains. Yet when a project comes along to provide relief, there is an outcry of opposition.

Why are people so sour? Why can't people simply understand that these things are good for them? The short answer is, in the vast majority of cases, these projects have had many unintended consequences—many of them bad. The problem is that in the conception and design of these projects, the focus is on meeting the mission, such as providing sorely lacking transmission capability, increasing throughput at a port, or relieving freeway congestion. Often the proponents don't focus on the total impact on society. It's only during the long and arduous permitting stages that objections are raised. Objections come from organized groups, some with political agendas, and others with legitimate concerns. Often, though, the objections are not well prioritized and are often incomplete. By the time the objections become known, the project proponents have already spent a fortune on planning, engineering, and conceptual design.

At this point, careers are at risk. There is so much political and physical capital involved that the stakes are huge. The process then turns into a win-lose situation. The project goes ahead; the folks with the objections lose. The project is delayed or the mission never materializes; the proponents lose big time.

Let's face it: We need more transmission lines if we are ever going to leverage renewable resources in a big way. There are wind resources in the middle of nowhere that we cannot take advantage of because we can't ship the power. We need better ways of managing our water resources. We have droughts in one region at the same time as we have floods in other regions. We need more rail lines and better public transit.

We need these projects, yet opposition is often too strong. How can we overcome this dilemma?

Rethinking the Process

There is no simple answer. There is a better way to rethink the process. Conceptual designs for projects need to have much more information about potential impacts than ever before. These impacts can be environmental, social, demographic, and political as well as technical. The good news is that unlike at any other time in our history, up-to-the-minute information is now widely available over the web.

One of the best sources of information on potential impacts comes from maps. There are maps of nearly everything, from customer satisfaction maps to shifting population maps, income maps to voting habit maps, flood maps to weather history maps. You name it, there's probably a map for it. The problem in the past has been that access to these maps was difficult. Not so today. With modern web GIS, nearly everyone today can publish a map of their particular field of interest. By using a simple concept called spatial analysis, GIS can take a number of maps and compare them to discover patterns, identify potential issues, make the needed corrections, and do all of this well before a project is heavily invested.

Sharing Maps

Consider this simple example. Suppose an electric company wants to build an extension of an overhead pole line. Staff check for any potential issues and find none. They dig the holes for the poles. However, in the meantime, the local conservation commission just completed a vegetated wetland survey in the same area. The wetland delineation has increased, now putting the pole locations within the wetlands. As a result, the electric company has to relocate the poles or replicate the wetlands—and they will probably pay a fine as well. And, of course, this whole mess ends up in the local newspaper.

Instead, what if both the conservation commission and the electric company published and consumed each other's web maps? Then as soon as the electric company's designers attempted to design a new pole location within the wetlands, the GIS would set off alarms well before any holes were dug and the company executives were forced to show their red faces in the local news channel.

GIS isn't just about making maps. It's about sharing actionable information, providing analysis, and helping to make better decisions to mitigate those unintended consequences. GIS is about sharing, communicating, and collaborating—like social media, only the media is in the form of a map.

Bringing GIS-based map data in during the conceptual design process helps planners to uncover things they might never had seen or considered in the design. It helps them model consequences. It helps them provide the best project to support the mission, to help society fully understand impacts and benefits, and it significantly increases transparency.

Is it enough to stop NOPE? Nope. But maybe it can get us from NOPE back to NIMBY. At least that will be an improvement.

About Bill Meehan

Bill Meehan, P.E., heads the worldwide utility practice for Esri. Author of *Empowering Electric and Gas Utilities, Power System Analysis by Digital Computer*, and numerous papers and articles, he has lectured extensively and taught courses at Northeastern University and the University of Massachusetts. Follow him on Twitter.

(This entry was posted to *Esri Insider* [blog], August 12, 2014.)

Why Maps Matter

"The Relevance of Cartography," A Cartographer's Perspective

By Georg Gartner, President of the International Cartographic Association

This is the first of a regular column of the International Cartographic Association (ICA) in *ArcNews*, reflecting the long and outstanding cooperation between Esri and ICA. Issues related to the world of cartography and ICA and reflecting a variety of topics will be discussed and presented here. You can expect a broad range of themes, such as the history of maps; cognitive processes in cartographic communication; and the application of the newest technologies on cartography, for example, currently augmented reality, applications for location-based services, and service-oriented cartography.

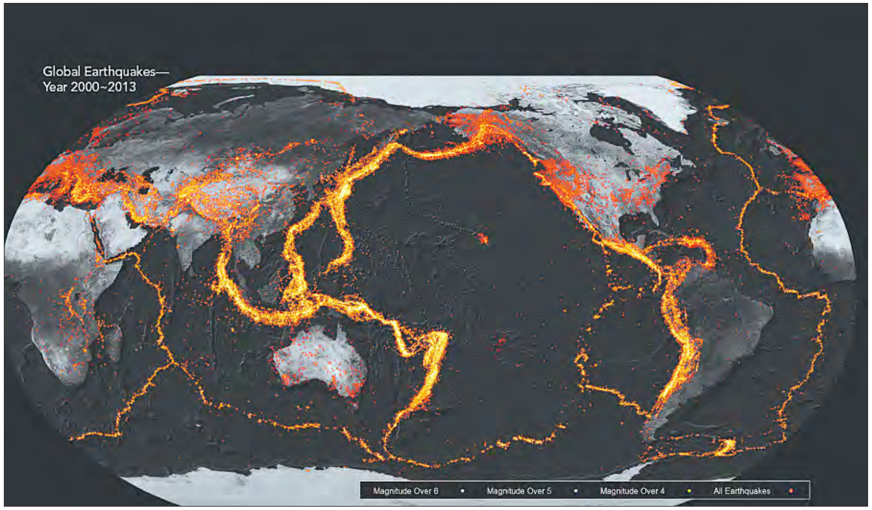
Why would reading this column eventually be beneficial to you? And what is the International Cartographic Association, and why could that have something to do with your interests?

Why Will This Column Be Beneficial to You?

For this first question, I would like to refer to my contribution to the *ArcNews* Winter 2013/14 issue, where I argued that the domains dealing with spatial data are growing fast. There are more and more techniques, algorithms, sensors, and software available that can contribute to data acquisition, data modeling, and data analysis. There is huge potential in spatial data, and we are definitively not short of data. Rather, it's just the opposite. The problem is often not that we don't have enough data but too much. We need to make a greater effort to deal with all this data in an efficient sense, mining the relevant information and linking and selecting the appropriate information for a particular scenario. We are also not short of technologies. Here, too, it is the opposite. Just as we are learning to fully employ the potential of a particular new data acquisition, modeling, or dissemination technology, new technologies are developed and need to be considered. New technologies become available more quickly and need to be evaluated, addressed, and applied.

But how is the world participating in all our developments and improvements? How will a new sensor solution or new algorithms be of benefit to a decision maker? To a tourist? To a citizen? At the end of the day, maps play a key role in this context. Whenever we talk about spatial data or geoinformation, and whenever this information needs to be presented and communicated to a human user, the interface and all the intelligence behind it can very often only be "unleashed" through a map. I would go as far as arguing that investing in maps means investing in the overall success of spatial data handling.

This is because maps are most efficient in enabling human users to understand complex situations. Maps can be understood as tools to order information by their spatial context. Maps can be seen as the perfect interface between a human user and all that big data and thus enable human users to answer location-related questions, to support spatial behavior, to enable spatial problem solving, or simply to become aware of space.



Maps help humans understand big data: Earthquakes primarily occur along tectonic plate boundaries with many events happening in proximal locations. Visualizing these overlapping events is a challenge that is met using a "glow" effect obtained with multilayer symbols and varying levels of transparency, an approach developed by John Nelson of UDV Solutions. Applying this effect in ArcGIS allows the thousands of earthquakes to offer us a vivid depiction of the global pattern of these explosive events.

In the near future, we can expect that information will be available anytime and anywhere. In its provision and delivery, it will be tailored to the user's context and needs. In this, the context is a key selector, determining which information is provided and how it is provided. Cartographic services will thus be widespread and of daily use in a truly ubiquitous manner. Persons would feel spatially blind without using their map-based services, which enable them to see who or what is near them, get support and do searches based on the current location, and collect data on-site accurately and timely. Modern cartography applications are already demonstrating their huge potential and changing how we work, live, and interact.

Investing in cartography means to make sure that the interface between a human user and the data and geoinformation—with all the efforts being done to derive, model, or analyze it—works, allowing the data and information to be used!

What Is the International Cartographic Association?

The International Cartographic Association is a forum for those who work with, produce, and use maps; are interested in map design; want to know about cartographic generalization; want to be informed about the newest mapmaking technologies; or simply love maps. Basically, the organizational structure of ICA welcomes nations as members, as well as companies and institutions as affiliate members. In addition, the ICA provides its commissions—where aficionados of a particular topic meet and discuss their area of interest—which are open to everybody who is interested and wants to participate. Check out your area of interest at www.icaci.org/commissions.

ICA is especially interested in linking those who deal with maps and promoting the importance and power of maps as instruments to communicate spatial information to everybody. In this sense, instruments like the Barbara Petchenik Children Map Drawing Competition are very popular, as well as cartographic exhibitions, cartographic conferences, and the planned International Map Year. This means that through ICA, any cartographic product or outcome of spatial data handling can eventually attract a more dedicated audience, while members have the benefit of having their maps evaluated and tested through connection to the global community of cartography that is ICA, leading to the development of the skills, knowledge, and competencies needed to make great maps.

Find out more at www.icaci.org.

About the Author

Georg Gartner is a full professor of cartography at the Vienna University of Technology. He holds graduate qualifications in geography and cartography from the University of Vienna and received his PhD and his habilitation from the Vienna University of Technology. He was awarded a Fulbright grant to the University of Nebraska at Omaha in 1997 and a research visiting fellowship to the Royal Melbourne Institute of Technology in 2000, to South China Normal University in 2006, and to the University of Nottingham in 2009. He is a responsible organizer of the International Symposia on Location Based Services and editor of the book series *Lecture Notes on Geoinformation and Cartography* published by Springer. He is also editor of the *Journal on LBS* by Taylor & Francis. He serves as president of the International Cartographic Association.

(This article originally appeared in the Summer 2014 issue of *ArcNews*.)

A Framework for Resilience: Four GIS Building Blocks

By Bern Szukalski

Temperature shifts, stronger and more frequent storms, drought, fire, and floods . . . We're already seeing the effects of climate change manifested in many ways. These changes are placing critical habitats at risk, shifting ecosystems, reducing water supplies, creating health concerns, and generating significant economic costs. And they present significant challenges in terms of preparation, response, and mitigation.

In the not too distant past, we were at the mercy of these changes, and we handled them poorly. But by leveraging new tools and capabilities, we're in a better position than ever before to predict, prepare for, and respond to these changes.

What does it take to address and mitigate these challenges to become resilient? Here are four key GIS building blocks that form the framework.

Access to Great Data

One of the key ingredients for resilience is to have access to the right data to gain understanding, to plan, and to act—data that represents the best of our knowledge, is reliable, and is authoritative. This essential data can't be locked up and hidden on our servers; it needs to be discoverable and open.

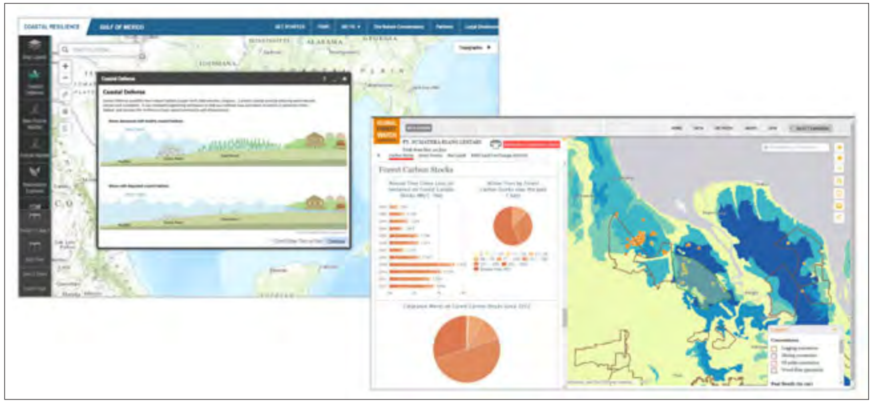
There are already many examples of community portals that provide access to great data. The Group on Earth Observations—GEOSS—is one such community, and Data.gov is another. Many other examples can be found, and their numbers are growing as the task of creating open data portals becomes easier.

Esri recently released ArcGIS Open Data as a configurable part of every ArcGIS organization. This new capability will make it easier for all GIS organizations to make their data more open and available, and for anyone to find it.

Services and Applications

Along with opening up data, we also need to unlock the potential of that data—to tap into the knowledge contained within. This requires tools, best implemented as services, which can be applied to that data to leverage its intrinsic knowledge. Great tools can amplify and make "just data" more useful and valuable.

But tools alone don't make it possible to reach our intended audience; we also need to frame them in larger user experiences—as applications. These applications should be finely tuned to our intended users, whether they be scientists, GIS colleagues, decision makers, or the public.



Examples of good tools that work against good data that are targeted to specific audiences effectively through applications include The Nature Conservancy's Coastal Resilience 2.0 and the World Resources Institute's Global Forest Watch-Commodities platform.

Communication

To become resilient, we also need to open up communication and create awareness. We need to deliver information about important topics and issues and, most importantly, begin conversations about them. And we can do that by telling stories with maps.

Esri Story Map apps are a very popular and effective way to communicate, and you've probably already made a few of your own. Story Map apps combine interactive maps and multimedia—text, photos, videos, even 3D web scenes, and more—to create elegant user experiences. And they make it easy to use the power of maps to tell your stories.

Collaboration

The essence of driving change, making better decisions, and becoming more resilient is rooted in collaboration. And when you apply GIS to that collaboration process, something powerful happens: you enable deeper understanding and more informed decisions; you open minds and open opportunities.

GeoPlanner for ArcGIS provides a GIS-based platform to support all the steps of land-based planning. From project creation and data management to creating and evaluating scenarios and preparing project reports, you can manage all aspects of your planning process more efficiently and collaboratively by applying the principles of geodesign.

Building a Resilient Future

As GIS practitioners, we face many different challenges, and those brought on by climate change are among them. With a GIS framework built on access to great data, services and applications, communication, and collaboration, we now have available the tools and capabilities to meet these challenges and build a more resilient future.

About Bern Szukalski

Bern Szukalski is chief technology advocate and a product strategist at Esri, focusing on ways to broaden access to geographic information and helping users succeed with the ArcGIS platform.

Follow him @bernszukalski.

(This entry first appeared in *Esri Insider* [blog], August 8, 2014.)

GIS and Beyond!

"Managing GIS," A column from members of the Urban and Regional Information Systems Association

By Jennifer Egan

Oftentimes, when young professionals coming out of college utter the words, "I'm pursuing a job in GIS," many friends and family become instantly confused. I am no different. While I was in school, my own friends and family could not understand why I was going from a secure job focus in secondary education to a focus in something no one had ever heard of.

GIS has been nothing but a blessing in my career. Having a love of maps and how the world works and making it into a creative and innovative career move has brought many great opportunities to me and continues to even now.

Many young professionals exiting college just know GIS as a geography discipline, or at least I did. They assume that for the next 30 years of their life, they will either help a municipality do city planning and zoning, collect water samples and save wetlands with a conservation group, or find their way into teaching geography in a middle school. In 2014, that could be the farthest from the truth!

GIS has become one of the largest arenas and skills in analyzing truly how the world works—from utility companies to business to government to computer software companies. If you love data and how the world is changed by it on a grand scale, GIS is a discipline that now allows you to expand this passion into many industries. With experience in the utilities, telecommunications, and gaming industries, I have been able to not only learn where GIS can be utilized but also how it can solve greater public and private sector problems without it being strictly limited to a geography or environmental focus.

The next question for young professionals coming out of college should be, "If I don't want to focus strictly in geography, how do I gain greater knowledge to get GIS jobs in other disciplines?" One route I recommend is adopting, if you haven't already, the fact that geography affects every walk of life. Having geography influencing how the world works on a grand scale allows you to think of how GIS can integrate into the many industries throughout peoples' professional careers. In the telecom world, for example, the location of a tower will affect what type of service you receive on your phone or through your Internet service. In terms of utilities, locating electric and gas lines to not be interfered with by trees and other obstacles affects the service of these resources to customers. If you are developing a game with the intention of referencing real-time landscape geography, there is no question GIS can be a major player. The list of industries goes on, but knowing that GIS and geography touch on many different categories in life helps to explain that your very niche skill set can be very exciting when it comes to paving the way for your career.

Another thing to consider is what kind of job would make you happy on a daily basis. Many would look confused wondering how this applies to just having a job in GIS. It's very valid and important not only for your career but also the longevity of GIS as a discipline in the professional world. If you are not passionate about GIS and your job, the field of GIS remains limited. The purpose of GIS in the world today is not to solve geography problems. It is there to ask questions, push possibilities, and explain something that is not necessarily GIS-centric. GIS simply is the tool to help solve the problem or get to the answer more easily.

To gain perspective of how GIS is integrated in small, medium, and large businesses/agencies throughout all industries is tough. One thing that is in your court is that you are the "specialist," even if you are just entering the work force. This means that you are in a very niche skill set that many employers both don't understand and may not be well versed in. So for those who have no idea what GIS is, this gives you the opportunity to sell yourself as an employee and possibly bring something new and innovative to that business. There is nothing limiting you from doing on-site visits to companies/agencies (using business etiquette, of course) to research companies, ask questions, and meet the personnel that already work there. One note: do your research of the company before going blindly into a visit. Employers who are familiar with GIS as a technology will find you to be a commodity because, even though you are new to the work force, you hold a unique skill set today!

As a prospective GIS analyst, engineer, or technician, congratulations on taking a risk and graduating in a focus that is still a mystery to some and a desire for others. Congratulations on graduating in something that you are passionate about! Take that passion to pave the way (much like you did in college) to find the job that you are equally passionate about. The reward will not only satisfy your career right off the bat but will also increase the longevity of a still niche but very interesting field!

About the Author

Jennifer Egan was born and raised in Washington State. She graduated from Western Washington University with the intent of going into secondary education in social studies but chose to pursue a career in GIS instead. Now she is in her eighth year of GIS, and her career has covered multiple industries. She has enjoyed working in the utilities, gaming, and wireless industries, with wireless being her overwhelming favorite. The ability that GIS has to integrate into a number of industries is what drives her most, because GIS is a universal tool (although geographic-centric in many cases) to help people understand and articulate the world in a different way, unlike any other specialty skill sets. Looking into the future, she is excited to be soon obtaining her GISP certification and continuing to add skills to her GIS resumé and contribute to the GIS community.

(This article originally appeared in the Summer 2014 issue of *ArcNews*.)

Resilience: Building Smarter, Not Stronger

By Shannon McElvaney

In Al Gore's latest book, *The Future: Six Drivers of Global Change*, he points out that it took nearly all of human history—some 200,000 years—to create the first billion people. It took only 12 years to create the last billion. We currently welcome about 1.5 million people to the planet every week, mostly in developing countries.

For the first time in recorded history, more than 50 percent of humanity now lives in cities. By 2050, some 80 percent will live in cities. Urbanization is already having a profound impact on our lives, yet we have little understanding of the unintended consequences.

When Hurricane Sandy hit New York, then Mayor Michael Bloomberg called extreme weather the "new norm." Since then, 500-year floods have hit many parts of the world, taking communities completely by surprise as their existing infrastructure failed.

Recently, I've heard the phrase "we will *rebuild stronger*" used by some cities as they struggle to recover from catastrophic events, but I would argue we need to rebuild smarter, and that requires some serious planning. And as the former Mayor Bloomberg, now Special Envoy to the United Nations, pointed out at the World Urban Forum in Medellin recently, it may be that "the norms that guided the planning of the past no longer apply."

Michael Bloomberg speaking at the World Urban Forum in Medellin.

Think about that for a minute. The norms of the past—building codes, policies, and regulations—that protected human life and property are no longer up to the task. From a planning perspective, that is quite scary to me. It means that "business as usual" will not work much longer.

If we are to make smart, livable, resilient cities, we need to reexamine our outdated assumptions and reboot our thinking about what it means to plan for a rapidly evolving world.

The poor are the most vulnerable to catastrophic events.

We need to take a systems approach to planning and calculate the cumulative impact of many small acts across disciplines and departments. We need simple tools to help us minimize risk while reducing resource use. We need apps that help us diversify and strengthen our local economies and build redundancy into our many systems, from transportation to food and water. We need to go beyond the status quo.

Imagine an app that relates carbon sequestration to lowering rates of childhood asthma, increased accessibility to social equity, and planting more trees to lowered dropout rates for schoolchildren. We need apps that show us the money and lives saved by restoring our ecological infrastructure and designing cities for the benefit of people rather than cars.

That everything is interconnected has become painfully obvious now. Ironically, vast quantities of data are already being collected on demographics, traffic movement, air and water quality, water and power usage, waste production, traffic accidents, disease, crime, where we go, and what we buy. We have mountains of data. Why don't we break down the silos, start connecting the dots, count what's important, and plan accordingly?

That's how you build resilient cities.

About Shannon McElvaney

Shannon McElvaney is the community development manager at Esri and a geodesign evangelist working on developing tools, processes, and techniques that will enable people to design, build, and maintain livable, sustainable, healthy communities. He has more than 20 years of experience applying geospatial technologies across a variety of industries. He writes a quarterly column and is on the Editorial Advisory Board at Informed Infrastructure. Most recently, he is the author of a new book, *Geodesign: Case Studies on Regional and Urban Planning*.

(This entry first appeared in *Esri Insider* [blog], April 28, 2014.)

Train the Trainer

Building GIS Capacity Across the Globe

By John Schaeffer, GISP, and Karen Beardsley, PhD, GISP

Resource shortages, population growth, and climate change are just a few of the critical problems facing society today. The solutions will require the best that science and technology can offer, and GIS is an essential tool for those solving many of these pressing issues. Many opportunities exist for GIS training in the United States, but this is not always the case in developing countries, especially for those working in conservation-based organizations. To help address this deficiency, Esri Silver Tier Partner Juniper GIS of Bend, Oregon, and the Society for Conservation GIS (SCGIS) have joined forces to strengthen GIS capacity among conservationists around the world with their Train the Trainer (TTT) program.

The challenges in underdeveloped countries include access to the technology and expertise to implement these tools. Over the past 10 years, hardware and software pricing have come down due to economy of scale and market competition, and the Esri Conservation Program has gone a long way toward making the software easily accessible to qualified conservation groups. But the challenges of finding competent personnel to implement and take advantage of these advances in technology still remain.

Since 1997, SCGIS has been providing intensive GIS training in the United States to 15 to 20 international participants (Scholars) from around the world each summer. While this is a very successful program, there is still a need to provide a cost-effective method to grow capacity for hands-on GIS training in environmental and conservation applications, especially in developing countries. The TTT program is one option to meet this need by helping future trainers develop skills and course materials for teaching GIS. This is intended to supplement and extend the SCGIS Scholars training program by providing previous scholars with the opportunity to become qualified trainers. At the end of this program, the Scholar/trainee possesses improved GIS skills, improved teaching skills, and a complete set of course materials for teaching a one-week core GIS class.

Since 2009, John Schaeffer *[one of the authors]* of Juniper GIS, who has more than 20 years of experience using and teaching GIS, has been the lead instructor for the SCGIS Scholars program. He has developed an integrated in-depth series of conservation GIS courses that are used in the SCGIS international Scholars program, as well as other trainings. In cooperation with SCGIS, he has been working to develop other trainers to use this material in their home countries. He has also been involved with several other TTT programs funded by the National Science Foundation and other organizations.

John Schaeffer discusses teaching issues with Ela Šegina as Ilona Zhuravleva prepares for her lecture at the ArcGIS for Environmental Analysis class in Moscow.

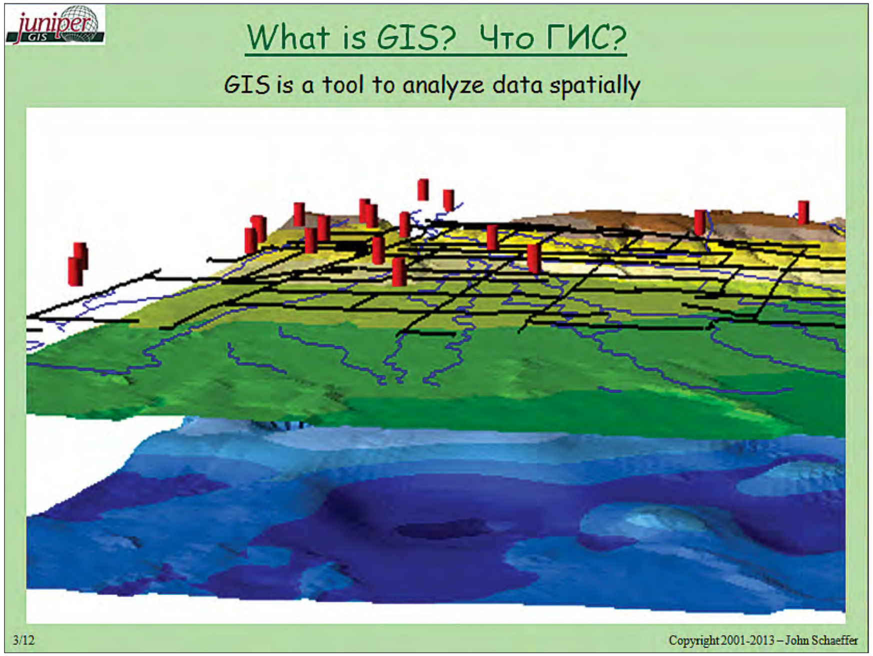
The SCGIS/Juniper GIS TTT program began in 2011. SCGIS leaders established an application process and created a formal contract with the trainee to become a Juniper GIS Authorized Instructor with full access to Juniper GIS course material. The first TTT candidate was Cecilia Cronemberger, a 2009 Scholar from Brazil. During the more than two-week Scholars training program, she assisted in the class as a helper and presented lectures, and during breaks, she and Schaeffer discussed how the class and course material work, typical problems students might have and how to solve them, and classroom management. Each evening, they worked together on class preparation, teaching skills, how to design a class and develop course material, and all the other details that make for successful teaching. Upon completing the program, she was granted her Juniper GIS Instructor certificate, along with the official Juniper GIS uniform, her own Hawaiian shirt. Since her graduation in July 2011, she has taught eight classes to approximately 100 students in Brazil, greatly helping expand GIS training.

In 2012, SCGIS selected Carlos de Angelo ("Carlitos"), a 2011 Scholar from Argentina, to be the TTT candidate. His training was the same as Cronemberger's, and in July 2012 he was awarded his Juniper GIS Instructor certificate and shirt. Since then, he has taught two classes to 29 students in Argentina, with several more classes planned for 2014.

To expand the TTT program, in 2013 a new approach was taken, which was to send Schaeffer to the SCGIS Scholars in their home regions to provide the TTT training. This program, for two to four trainees, consists of a three-day advanced GIS class for the trainees and GIS users from local conservation groups, a five-day ArcGIS for Environmental Analysis (AE) class in which the trainees served as helpers and gave some presentations, and three to four days during which Schaeffer and the trainees work together on teaching skills and issues. After reaching out to the SCGIS International Chapters, Schaeffer and the SCGIS International Committee chose SCGIS Russia from among several offers, for this first effort.

SCGIS provided $2,500 to help pay for Schaeffer's airfare and expenses. SCGIS Russia, especially Ilona Zhuravleva and Anna Komarova, in cooperation with Greenpeace Russia, where they both work, organized training facilities and home stays for Schaeffer and another trainee in Moscow. By keeping all the activities in Moscow and having home stays, this program was affordable.

Three trainers were chosen for this program: Ela Šegina, a 2013 Scholar from Slovenia; Zhuravleva, a 2011 Scholar from Russia; and Kamarova, a 2012 Scholar also from Russia. They are all now authorized Juniper GIS instructors who have received all

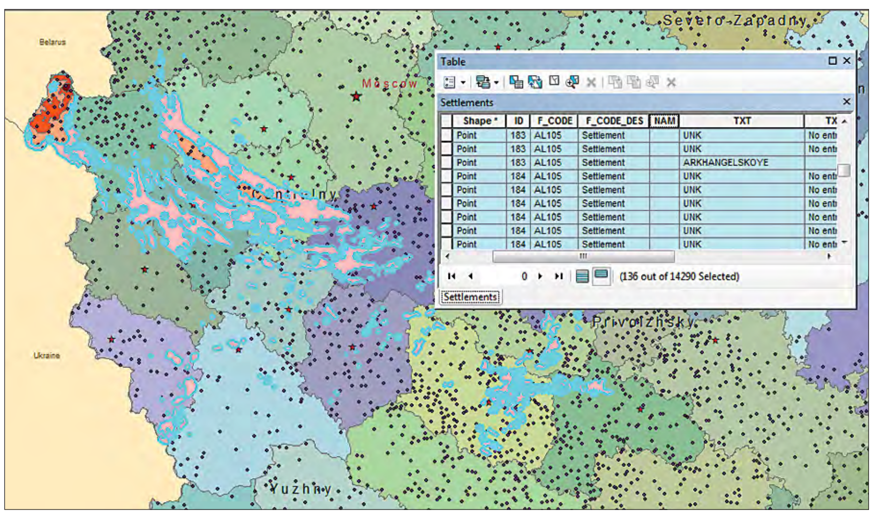


A slide used in the Introduction to GIS course, with some Russian titles added. The trainees will have access to all the Juniper GIS PowerPoints to use when teaching their own classes.

the Juniper GIS supplied teaching materials needed to teach the ArcGIS for Environmental Analysis course, plus a variety of introductory and intermediate-level courses. Eventually, these instructors will adapt this course to their own needs and with their own data, but a very important result of this program is they have a complete set of course materials and are familiar enough with the class to teach it right now.

The two previous TTT Scholars, de Angelo and Cronemberger, have been teaching two or more classes each per year to about 25 to 30 students. With five Scholars who have now completed the TTT training, one should easily expect to have at least 100 new students learning conservation GIS each year because of these efforts. Because this program used two classes as part of the teacher training, 23 people in various levels of conservation GIS were also trained.

The three former Scholars recently trained in Russia are now ready to teach the AE class, both in terms of their skills and having the material. As they gain experience and confidence, they will add more classes to their repertoire, with the continuing support of Juniper GIS for teaching material. Over the next five years, we would expect to have as many as 300 or more people learning how to use GIS in conservation applications from these three new instructors, which is quite a multiplier effect.



In the first exercise, students see how GIS can be used by doing some simple analysis. In this example, students selected areas with high radiation near Chernobyl and then found which settlements were inside these areas.

It was very important that the trainees had been through the SCGIS/Juniper GIS course for the SCGIS Scholars so they were familiar with the material in the AE class, were familiar with working with Schaeffer, and that he knew their strengths and weaknesses. This allowed him to concentrate on teaching how to be effective trainers and not worrying about their GIS skills.

The other important part of this program is that Juniper GIS is willing to share its tried and tested conservation GIS training material with these instructors so they can concentrate on training and not on having to write and update material. Anyone who has developed courses knows how time-consuming this can be.

While it might not always be possible to do a program like this for so little money, even at three to four times the cost, this program provides an incredible value and goes a long way toward increasing opportunities to learn GIS outside the United States, where this is needed most.

About the Authors

John Schaeffer is the lead instructor, consultant, and analyst for Juniper GIS Services and has more than 21 years of experience working with and teaching GIS and related technologies to a wide variety of audiences. In 1994, he started one of the first two-year GIS programs in the United States at Central Oregon Community College. He has also been the lead instructor for the Society for Conservation GIS Scholars program for several years and teaches for many conservation groups all over the world. He is also a GIS Professional (GISP) as certified by the GIS Certification Institute, an Esri Certified Instructor, an Esri Certified Desktop Associate, and a CTT+ (Certified Technical Trainer).

Karen Beardsley, PhD and GISP, serves as managing director for the Information Center for the Environment in the Department of Environmental Science and Policy at the University of California, Davis. She has more than 25 years of experience working with GIS in the management of natural resources, land use, and environmental information for the UC Davis Information Center for the Environment and international conservation organizations. Since 2010, she has coordinated the SCGIS Scholar Training in Davis, and in 2013 she became a certified Juniper GIS instructor.

(This article originally appeared in the Summer 2014 issue of *ArcNews*.)

The Geodesign-Biomimicry Connection

By Shannon McElvaney

Jack Dangermond studied under Ian McHarg and Carl Steinitz, the combination of which took the manual overlay method of *designing with nature* from paper to the digital world using computers in 1969. His hope was that GIS would become a framework for modeling the earth's systems so they could be managed more sustainably. In 1995, Jack called GIS "the nervous system of the planet," foreshadowing what I think GIS is on its way to becoming. Geodesign—an iterative design method that uses stakeholder input, geospatial modeling, impact simulations, and real-time feedback to facilitate holistic designs and smart decisions—is the natural evolution of that vision.

Design itself is about intent and creativity. **Geography** is the science of our world. **Geodesign** is the fusing of design and geography to create a holistic, iterative design methodology whereby we inform design with evidence-based information drawn from a place's geographic context—its environment and people. In most cases, geodesign is used in an urban planning setting, optimizing both form and function to enhance performance such as walkability.

Biomimicry is also about designing with nature, but with a slightly different twist. Biomimicry looks to biology as a way to stimulate

Artists and creative design: a roving green intervention/vertical food garden in Nantes, France.

Photo by Shannon McElvaney.

creative thinking and technological innovation, calling on nature's treasure chest of 3.8 billion years of evolution for inspiration. The strength of the spider web, the self-cleaning leaf of a lily, and the clinging burdock burr (seed) have all spurred technological innovations.

Imagine if we combined biomimicry with geodesign. The goals are similar: both require design thinking, both consider nature, and both aspire to create a better world, one that is more in harmony with nature's processes.

The biomimicry and geodesign workflows are incredibly well-aligned, and we have much to learn from each other. Urban form and structure are currently out of alignment with natural systems. Ecological services, the urban metabolism, and sustainability indicators are all ill-defined or fragmented. We can learn from nature, but we need a common language—and for us, that common language is geography: the patterns, relationships, and flow of things on the earth.

What might such collaboration look like? How about an application that uses the power of geoenrichment to drill down through countless datasets to, in short, find everything that is known about a given location—looking vertically, across all disciplines, in order to find meaning. Suddenly, weather and climate are important to housing location and position, the white hairs of a sage leaf inform the required reflective value of roofing material, and the ability of the desert tortoise to store water during long months without rain inspires water catchment systems for your neighborhood.

And this is just the tip of the iceberg. Over the coming months, we will dig deeper into the potential for synergy between geodesign and biomimicry. To be a part of the discussion, join Janine Benyus, cofounder of Biomimicry 3.8, and Jack Dangermond, president of Esri, next month at the Geodesign Summit in Redlands, California.

Janine Benyus, cofounder of Biomimicry 3.8.

About Shannon McElvaney

Shannon McElvaney is the community development manager at Esri and a geodesign evangelist working on developing tools, processes, and techniques that will enable people to design, build, and maintain livable, sustainable, healthy communities. He has more than 20 years of experiencwe applying geospatial technologies across a variety of industries. He writes a quarterly column and is on the Editorial Advisory Board at Informed Infrastructure. Most recently, he is the author of a new book, *Geodesign: Case Studies on Regional and Urban Planning*.

(This entry first appeared in *Esri Insider* [blog], December 19, 2013.)

The Key to a New Wave of Enterprise GIS Users

By Christopher Thomas, Director, Esri Government Markets—Federal, State, and Local

In my early days as a GIS administrator, one of my number-one priorities was to build an enterprise, or organization-wide, GIS program.

I worked hard to figure out how to get GIS software directly into the hands of people in fire, planning, building and safety, engineering, public works, finance, parks and recreation, economic development, airports, code enforcement, housing, and any other discipline who would take a moment to listen to the benefits of GIS. As the Esri tools and supporting technologies progressed, the GIS team was able to achieve a vision of "no department left behind."

We went from mainframe applications, extended through emulation software on dumb terminals, to stand-alone and networked desktop software, and eventually to Internet and mobile devices. My team and I moved closer and closer to this vision each and every day. And along the way came a lot of firsts: from GIS use on fire trucks to nonsurvey uses of GPS for public works asset data collection, from public access to GIS via the public library to the use of GIS for 3D statistical modeling, and from using GIS for revenue auditing to being one of the first local governments to use GIS on the Internet. The journey we took led us to a greater understanding of the return on investment of GIS, and we realized a lot of innovation by becoming creative as we sought to reinvent government.

Some of my peers in information systems and GIS, both inside and outside the organization, openly and critically questioned why I would want to encourage others to use the technology themselves. I was puzzled by this question. These peers would go on to ask, If everyone else was able to use the power of GIS, what would we do?

These were the same peers who could not understand why the GIS profession could not gain significant traction inside their own organizations. I simply did not see the logic in this line of thought. After all, there were so many other things we could work on: creating new datasets, developing data repositories, integrating GIS into mainstream applications like 911 and permitting systems, building kiosks and front counter applications, building citizen engagement websites, increasing operational efficiency through in-vehicle and mobile applications, and developing regional cooperatives, to name a few. There was just so much more to do.

And the more GIS was embraced by the various departments and the public, the more GIS became mission critical to the organization, and the more important we became to the organization. While the question my peers asked so many years ago still exists, we have been presented with an even greater opportunity to extend the power of GIS to every discipline in government.

More important, there's an opportunity for GIS personnel to become even more mission critical to their organizations. The key today just might be Microsoft Office 2010. Think about the number of individuals who use Excel spreadsheets and PowerPoint presentations in your organization. There are millions of Microsoft Office users worldwide. What if you could harness their work to extend GIS through a tool they are already familiar with? With respect to Microsoft Excel, what if instead of performing analysis through pie charts or scatter diagrams, people could show their information on a map by clicking an Esri Map button on the toolbar?

Well, that's exactly what your users can do with Esri Maps for Office, a simple plug-in for Microsoft Office. The power of mapping comes through an ArcGIS Online subscription extended through the add-in. Microsoft Office draws from basemaps and leverages the data you and your colleagues have been developing and maintaining for decades.

Public works professionals could take spreadsheets of capital projects and create interactive maps of the locations of those projects ranked by cost, time to completion, or any other factor and perform their own analyses. Finance directors could take spreadsheets of delinquent payments by billing route or by month and build heat maps of the patterns to better understand their businesses and citizens' payment habits and set course corrections. Or the same department could show where money was being allocated across a community. These maps and analyses could be used for internal review or, with the click of a button, turned into web maps that could be embedded in public-facing accountability and transparency websites.

Consider the hundreds of PowerPoint presentations created each year. While these presentations are impactful and professional, what do you do if someone asks a question about the information in a map image and the map itself doesn't contain the answer? You may come off as unprepared, or you may have to have another meeting. With Esri Maps for Office and ArcGIS Online, you can create presentations with live maps embedded in them. When an elected official raises a question, you simply click the live map inserted into the PowerPoint to navigate to the answer. You move from presentation to interaction.

These are simple routines that GIS professionals have performed on behalf of other disciplines for years. Now everyone can make his own maps. Try ArcGIS Online and Esri Maps for Office yourself—or better yet, show them to the finance director. See esri.com/maps4office.

(This article originally appeared in the Winter 2014 issue of *ArcUser*.)

Ancient Rituals and Modern Technology

By Bill Meehan

The electric and gas utility business is complex. Some say the electric grid is the most sophisticated technology in the world. Natural gas networks are not far behind. Diving deep into the business, there is probably one of nearly every kind of technological wonder at play. Control systems; artificial intelligence; lidar; sensor networks; augmented reality; and, of course, GIS. Utilities, to some extent like the space industry, drive innovation of technology. Yet overlaid with all this sparkling technology are some old patterns of behavior.

Every industry strives to improve. Utilities can improve by getting rid of old habits.

Two old behaviors linger: working in silos and heavy reliance on institutional knowledge.

—

Utilities have been around for more than a century. As they grew, they needed to organize into groups, teams, departments, and divisions. Engineers did the engineering. Accountants did the books. Customer service representatives took the outage and billing calls. The more people specialized, the less the specialist from one group communicated to the specialist in another group. The troubleshooters in a line truck or the gas repair service workers checking for a gas leak would never talk to or even know the names of the tax accountants.

As utilities computerized, they automated these silo processes. Like their predigital counterparts, these automated systems did not talk any more to other systems than the old timers ever did. This created information and workflow silos. It is not surprising that when a line crew replaces a pole that an intoxicated driver knocked down at 2:00 a.m. after the bars closed, members may fail to record the details of the work. This gets even worse after a major blizzard, hurricane, or earthquake, when the crews are so stretched and stressed. The last thing they (and many of their managers) care about is the accounting.

The other problem is that due to institutional knowledge, utility workers *"sort of knew"* where things were, how to fix things, and how to prioritize their work. They relied partially on documentation and probably more on their accumulated knowledge of the system. This led to missing and inconsistent information. Things worked pretty well. Engineers *"had a good idea"* about the condition of the assets. Tax accountants *"had a good idea"* about the state of the tax liability. This all worked pretty well until the folks with all this institutional knowledge retired.

—

Ironically, while utilities have been able to apply technology to complex problems, they may not know the answers to two simple questions:

Where are my assets?

How many of them do I have?

Recently, a large utility in the Southwestern US spent a fortune literally counting their overhead assets. Why? Because their engineering records in their GIS did not match their accounting records.

How could this happen? Simple. They continued the same rituals within silos of departments and relied too heavily on people having *"a good idea"* about where things are.

Improvement requires that we recognize the ancient rituals. Then we decide which are valid and which are obsolete. We then apply the technology to improve upon the good rituals.

The opposite of running the company in silos is to create a framework for collaboration. And the way to deal with the institutional knowledge gap is to make it easy for all employees to create and share data. The way to correct the sins of the past is to build a culture and technology for collaboration. People do that all the time *"outside of work"* with social media. People call social media "collaboration platforms."

Maps make an ideal collaboration tool. People have been using maps since the beginning of recorded history. Esri has taken the concept of using a map to share, communicate, and collaborate to a new level. Esri has developed a mapping platform that helps manage the issue of silos by making it trivial to share maps from one group to another. Engineers can simply share their gas network maps with the tax accountants. Substation planners can share their requirements for new substations with the real estate person. Customer service folks can share maps of outages with their customers. Easy and simple.

While GIS is one of those wonderful technologies that utilities use, it is now taking on a new role. Instead of using the GIS as a tool for automating the ritual of mapmaking, utilities are using GIS to answer the simple questions of how much stuff do I have and where is it. That's a ritual worth keeping.

About Bill Meehan

Bill Meehan, P.E., heads the worldwide utility practice for Esri. Author of Empowering Electric and Gas Utilities, Power System Analysis by Digital Computer, and numerous papers and articles, he has lectured extensively and taught courses at Northeastern University and the University of Massachusetts.

Follow him on Twitter.

(This entry first appeared in *Esri Insider* [blog], July 24, 2014.)

Understanding our world.

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

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

Contact Esri

380 New York Street
Redlands, California 92373-8100 USA

1 800 447 9778
T 909 793 2853
F 909 793 5953
info@esri.com
esri.com

Offices worldwide
esri.com/locations

esri.com/ebooks

Printed in USA

G65754 ESRI9/14sp