

New Opportunities to “See” Our Environmental Relationships

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Understanding our relationship to our environment and natural resources markedly influences how—and how much—we value them. The tools and methods vary in a number of ways, but they all rely on how we “see” this relationship. In the case of places we’ll never visit, our imagination may be informed by pictures, maps, and other visual information. How we envision and understand physical spatial relationships also can inform our views on natural resources affected by human activity taking place hundreds of miles away, as well as the future effects of resource use on the environment.

For thousands of years, maps and the sense of distance they connote have contributed a spatial dimension to places unknown. But today’s technology enables us to “virtually” be anywhere, under nearly any condition or scenario. Tools such as Virtual Earth, Google Maps, and Geographic Information Systems (GIS) software have moved map making from the province of cartographers to anyone with access to a laptop or cell phone. These and other tools allow Earth science data (topography, geology, the atmosphere, and the hydrologic cycle) and social science information (population, income, and land-use data) to be combined with traditional maps. And merged with photos and three-dimensional, often near-time dynamic renderings, these maps allow us to virtually be in places we may never visit. We can walk around and explore or see the effects of proposed activities—say, pesticide applications that affect runoff transported to a watershed hundreds of miles away. And the visualization is informed, not hypothesized, because Earth and social science data are included in the representation.

The images in this article illustrate how visualization has evolved in recent years from simple maps and esoteric “remote-sensing data” to help us view, understand, and manage our environment.

Figure 1 is a set of images of the eastern United States during March 2000 taken by a satellite-borne instrument that, as its name (the Multiangle Imaging Spectroradiometer) suggests, uses different angles to observe features of Earth. The left panel shows the region from

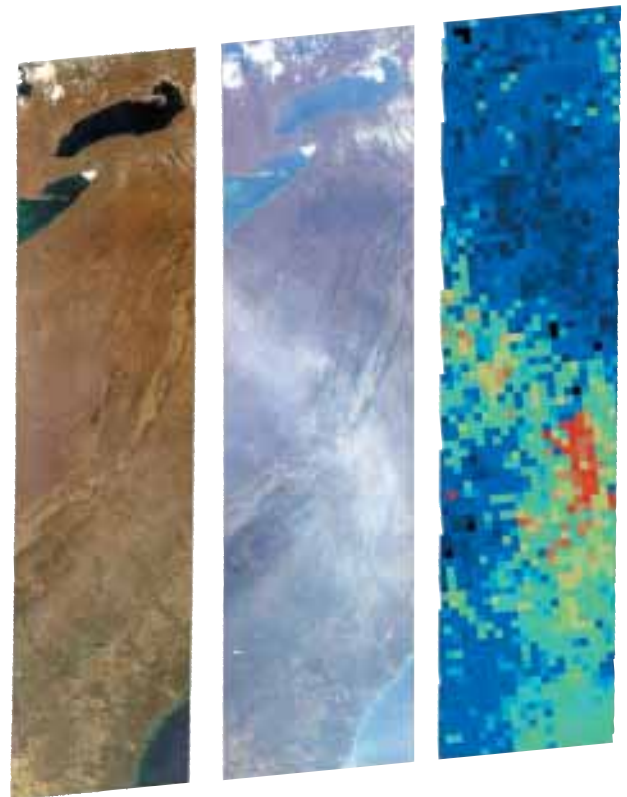


Figure 1. The Appalachian mountains and air pollution.

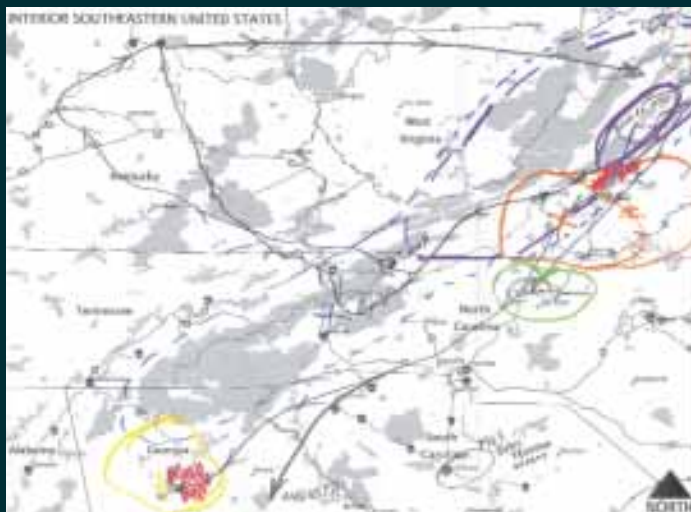
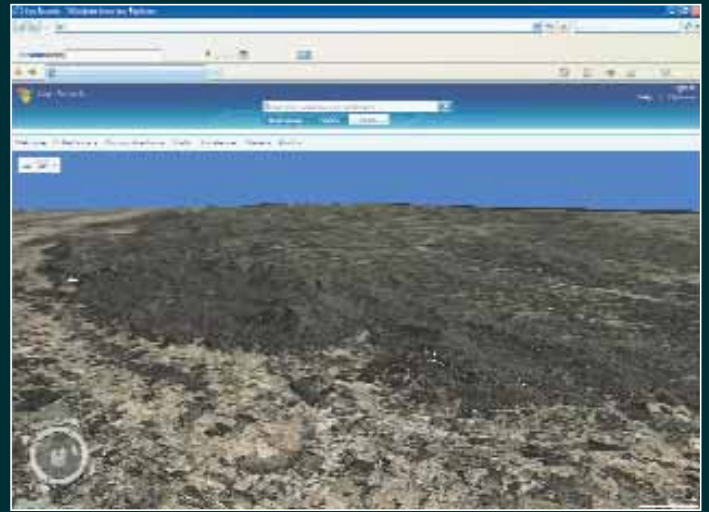
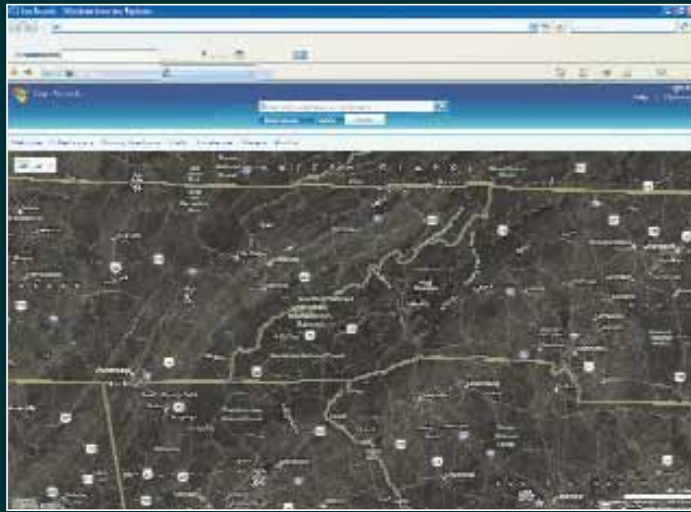


Figure 2. (left, top): An overlay of vector data on an image of the Appalachians from the Landsat satellite at a spatial resolution of 15 meters.

Figure 3. (left, center): GIS map of the region showing land uses and jurisdictional boundaries.

Figure 4. (left): A map showing how one resident defines key natural areas that he values in the region, indicated by the different colors.

Figure 5. (above, top) The Landsat imagery from Figure 2 layered on a 3D topographic model.

Figure 6. (above) An aerial photograph of the region.

Lake Ontario to northern Georgia, spanning the Appalachian mountains. The middle panel is an image taken at a slight angle to show the thin haze over the mountains and measure particulate pollution. The right panel shows, in gradations from blue to red, increasing amounts of airborne particles (aerosols). By showing how these particles interact with sunlight, the images enable better understanding of Earth's climate.

Figure 2 is an image of the Appalachians from the Landsat satellite at a spatial resolution of 15 meters, with vector data—lines and polygons—noting political boundaries, roads, and other features. The sources of vector data can be quite diverse: government records of property boundaries, companies with vehicles equipped with global-positioning technology to trace roads, corporate databases of store locations, and more.

Figure 3 is a GIS map of the region showing land uses and jurisdictional boundaries, including lands of the National Park Service and the U.S. Forest Service, as well as rivers and streams.

Figure 4 illustrates how one resident in this region perceive environmental degradation associated with acidification in the mountains. Using a process of cognitive or mental mapping, residents were asked to add information to a basic map. The figure shows map additions made by a study participant when asked first to identify places that she visited regularly while living in the region, then to add the center points and boundaries of five natural areas in the region that she thought were most important, and finally, to mark the locations and causes of improvement and deterioration in the region. Maps such as these provide a reference point for understanding how people define the areas they value, including the Great Smoky Mountain National Park and Shenandoah National Park (which, interestingly, nearly all respondents marked as larger than the National Park Service boundaries). Their perceptions were an integral part of an ongoing study of differences among residents of the extent of concerns about degraded resources in the states where they live, in neighboring states, on public lands, and more broadly across the region.

Looking toward the future, the transition from information to visualization leads naturally to new frameworks for communication. This future requires newly developing functionality of the web itself, particularly the ability for one website to query another and return not only data but software “snippets” that perform analytic functions. For example, a website with maps and other information about the Appalachians can allow us to query the status of a stream. That website will go to other websites to find imagery, news releases, even data on water quality and stream depth, and pres-

ent them all in a single package—not just as a set of links to follow. Many people can now use the web as a collaboration platform, working together (often in different places and at different times) to produce a single result. To this end, we might consider the first phase of the Internet to be individual publication, the second to be community publication, and the third to be community collaboration. The proliferation of “mashups” (the layering of highly individualized information, such as “my favorite hiking trails,” on basic maps or imagery) and the ease with which people everywhere access and update their contribution, is an example of this third phase—a phase that, as we look to the very near future, will provide further potential for the use of Earth science, visualization, and resource valuation.

Ultimately, we lead our lives in a three-dimensional world. Our ability to understand and visualize the world is best achieved with 3D rather than 2D representations. Figure 5 shows the Landsat imagery from Figure 2 layered on a 3D topographic model. The 3D perspective—readily available on the Internet—provides a much more intuitive sense of the role of topography in, say, the transition of land use from urban to rural to forests. As the fidelity of 3D Internet worlds approaches that of Figure 6, our ability to connect this information with our everyday understanding of the world will grow. For basic imagery this may seem trivial. But imagine being able to easily look at the higher level derivatives of basic imagery in this way—3D renderings of flood plains, temperature statistics, or wildlife habitats. And imagine the even greater power of viewing the world in “what if” scenarios—the same Smoky Mountains imagery modified as if the forests are replaced by a transportation corridor or altered by climate change. This ability to communicate remotely sensed information about the ecosystem, both in 2D form and in the “I am there” feeling of 3D, will enable us to both measure and understand ecosystem services much more effectively. ■

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