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Think global

'Virtual globe' software is transforming our ability to visualize and hypothesize in three dimensions. Educators take note.

Millions of people across the world are zooming in from space, flying across continents, and swooping over mountains and through cities, thanks to Google Earth, NASA's World Wind and other free virtual globes.

The ability to model the Earth in exquisite three-dimensional detail was previously only approached on the desktops of professional users of geographical information systems (GIS). But even they were unable to publish high-resolution globes on the Internet, because of the sheer volume of the data — a globe with a resolution of one metre would take years to download using even a fast Internet connection. Virtual globes overcome this problem with elegant engineering, using a tiling structure that sends progressively higher-resolution data as one zooms in. This and other tricks drastically reduce the size of file transfers, and allow visualization with almost zero latency on a decent broadband connection.

Scientists are already experimenting with these tools to showcase their research to the public in visually appealing ways and to speed responses to natural disasters (see pages 776 and 787). Ultimately, such accurate digital representations promise to anchor and unify much digital information about the Earth, while also helping to integrate the efforts of researchers from many disciplines.

Rita Colwell, a microbiologist and former head of the National Science Foundation, has described GIS as the "ultimate, original, multidisciplinary language". Her own research is a shining example. Realizing that cholera epidemics spread inland from the coast, she correlated them with seasonal plankton blooms, discovering on the way that the *Vibrio cholerae* bacteria that cause cholera associate with gravid copepods, helping to break open their egg sacs by secreting chitinases. She went on to use remote sensing for a global predictive system for epidemics. As she has said, a major need is "to appreciate the complex reactions that characterize ecosystems — it is too complex for any one discipline".

By making it child's play to share and view multiple large data sets, virtual globes lower the barrier to entry for scientists with little GIS experience. Visualization itself can lead to new insights. Having tasted such visualizations, many researchers will be tempted to go beyond them to exploit the full capacities of GIS science to analyse vast arrays of disparate data in their spatial context.

The opportunities and power of GIS are expanding rapidly because of converging technological trends. The quality of spatial and remote-sensing data is sharply increasing in many fields, as are data-mining techniques, which can help lead to new hypotheses. Mobile global positioning system (GPS) devices are raising the prospect of collecting location-specific information quickly and cheaply, making it possible for large networks of intelligent devices to map and monitor a release of toxic gas, for example, and predict its spread.

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To meet such spatial opportunities, researchers and students will need training in spatial sciences. The risks of using computational packages as 'black boxes' are well known, and are even greater, if anything, with GIS. As GIS experts have noted: "The production of visually appealing, even statistically sound, results that do not reveal anything useful about either pattern or process is perhaps the greatest danger facing newcomers to this powerful technology" (*Nature Rev. Microbiol.* **1**, 231–237; 2003). It is therefore encouraging to note that last week the US National Academy of Sciences called for the introduction of "spatial thinking", including GIS, into school curricula, and for government research agencies to launch research into the nature of the cognitive processes involved in such thinking.

Many outstanding minds, including Einstein, Faraday, Kekulé and Heisenberg, have attributed their key insights to the ability to think spatially. Let's hope that the upcoming generation of three-dimensional gamers and Google Earthers will yield even more spatially adept prodigies ready to confront global challenges. ■

It's academic

The development of scientific academies could help to put science to work in Africa.

The medical, scientific and environmental challenges facing the continent of Africa can seem simply overwhelming. Some of them, such as the provision of health care and basic scientific education, are bound to be expensive to address. But others could be tackled by less expensive and more subtle means: the development of properly functioning scientific academies in African nations.

The US National Academy of Sciences, under its former president Bruce Alberts, began a laudable, long-term project to build up the prowess of such academies in three African nations: Nigeria, South Africa and Uganda. But as a meeting in Amsterdam of African academy officials heard earlier this month, rapid progress could be made in other countries too, if scientists, government officials and donor nations would step up to the plate.

Self-elected bodies of accomplished scientists make a significant contribution to public discourse in most wealthy nations. In Britain, the Netherlands and the United States, for example, academies have long played a broadly productive role in raising the level of public discussion on technical issues. They also provide governments