Hurricane Katrina map visualisation display.
(Image courtesy GEO as taken from the 2006 ESRI International UC, San Diego)

VIRTUAL GEO-BROWSING

BRIAN TIMONEY SHARES HIS THOUGHTS ON HOW AND WHY VIRTUAL GLOBES ARE BECOMING MORE POPULAR AND USEFUL BASED UPON HURRICANE IMPACT VISUALISATION.

During the 2005 hurricane season in the Gulf of Mexico the public's attention was justly focused on the human costs of the devastation. However the impacts on energy production in the affected areas were broadly felt in the form of price spikes and highlighted the region's particular vulnerability to storm events that some predict will increase in both intensity and number in the near future[1].

In launching a website that examines the geography of energy production in the Gulf and assesses the impacts of Hurricanes Rita and Katrina (http://www.gulfimpact.com), The Timoney Group—a data visualization and analysis consultancy based in Denver, Colorado—chose to explore the topic exclusively through datasets and analysis tools tailored for the Google Earth interface. We discuss below how, in putting together the content of the site, the capabilities of the platform gave rise to fresh possibilities for data visualization, information sharing and communication, and broadening the use of traditional spatial analysis tools.

Virtual Globes as the New Geo-browsing Environment

Google Earth is the most popular example of an emerging class of interfaces collectively referred to as "virtual globes" or "geo-browsers." Other well-known members of this group include NASA's World Wind and the new ArcGIS Explorer from ESRI. Unlike traditional web mapping applications that run inside standard web browsers, virtual globes are self-contained environments that use advanced streaming and caching techniques that provide a more immersive, seamless user experience, enabling one to 'fly' around 3D terrains overlaid with satellite or aerial imagery. In addition to being able to engage a broader audience with these new platforms, geospatial professionals have a broader array of tools and techniques at their disposal that can enrich the information communication process in ways previously not possible.

3-D Is Not Just For Landscapes

While the implementation of digital elevation data and the use of building models in urban landscapes are the most obvious touchstones of the 3-D experience inside Google Earth, there are interesting possibilities for more abstract data representations that wouldn't work nearly as well in a two-dimensional display environment. According to user feedback, one of the most popular display effects is the use of stacked 3-D bars to compare production for both oil and natural gas (Fig.1). By overlaying a grid of 25km x 25km cells and extruding the height of each cell as a function of the sum of gas or oil production in that cell, the viewer has an immediately recognizable of visual comparison that is also spatially referenced. While information design experts such as Edward Tufte warn against the visual distortion inherent in 3-D effects used in 2-D mediums[2] (e.g. the printed page), the ability to tilt and rotate the landscape in Google Earth *encourages* absorbing the display from multiple viewing angles, increasing the understanding of the data pattern being presented. Additionally, mousing over any individual column reveals the quantities being charted while clicking on the top of any column will launch a pop-up with a detailed table listing the production metrics for each major operator in the area. On a cognitive level, this presentation of information follows the efficient data investigation strate-

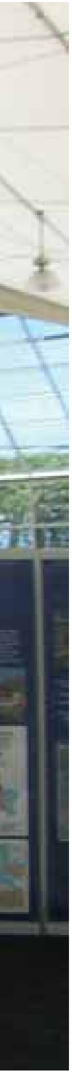

Fig 1

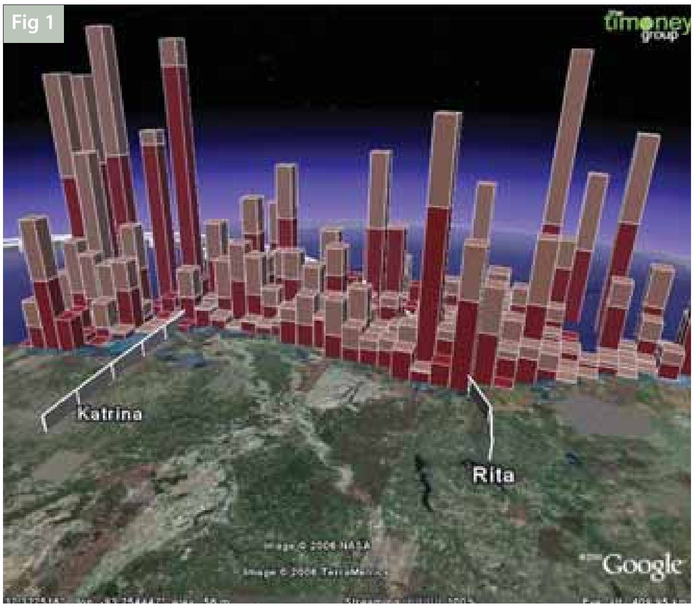

Fig. 1: A comparison of November, 2004 natural gas production (dark red) with November, 2005 production (light red) in the Gulf of Mexico.

gy of *"overview first, zoom and filter, then details-on-demand"* [3] while minimizing visual clutter.

Data Portability: the One-Click Email Attachment

Custom data is brought into Google Earth via KML (Keyhole Markup Language): an XML-based file format whose unique strength is that geometry, styling, display behavior, and feature attribute information are all contained in a single, standalone file that can be compressed using standard zipping technologies. Further, HTML-formatted data can be embedded in the pop-up description, including tabular information, images (e.g. graphs, logos, etc.), and hyperlinks. On a practical level, one can embed a wide variety of information content quite efficiently (all of the layers depicting 3-D production are less than 100kb apiece) in a single file, send to a client or co-worker, and be confident that with a single click the recipient will be 'flying' to the intended area of interest in the interface. In a professional environment where data is shared among a wide range of technical aptitudes, the importance of a very simple information sharing mechanism cannot be overemphasized.

Adding Analytical Muscle via Server Links

One of the criticisms of the Google Earth interface among those in the GIS community was that it was merely a viewer with no intrinsic analysis capabilities. However, in addition to standalone KML files, the interface both accepts KML-formatted data streams from remote web servers as well as communicates the user's viewing position back to a server. In practice, this opens up possibilities for accessing large datastores of information as well as taking advantage of the geoprocessing capabilities of advanced spatial databases (e.g. Oracle, DB2, PostGIS, etc.) to enable the general user to perform common GIS functions such as buffering, clipping, and intersecting.

In integrating the PostGIS open-source spatial database with the web server, visitors to GulfImpact.com have the ability to get answers to basic questions such as "what was the decrease in oil production within 'x' miles of Katrina's path or within 'y' miles of the Gulf coast?" (Fig. 2). Instead of using special GIS software to perform the requisite buffering, clipping, and intersecting, the user simply issues a simple web query and gets an answer returned in the form of a custom .kml file that is automatically loaded into the viewer. By making "bite-sized" chunks of geoprocessing capabilities available in a specific analytical context, a general user can get an answer to their spatial questions without negotiating the steep learning curve of specialized software.

Linking the viewer to a web server also creates the opportunity for the user to analyze the impacts of *future* hurricanes based on hypothetical hurricane paths. Using the paid versions of Google Earth, one can simply digitize their own path in the Gulf of Mexico, upload the new file to the online PostGIS spatial database, and perform analysis to determine not only possible aggregate production impacts but also which companies' assets would be most vulnerable (Fig. 3). Again, a trained GIS professional could do something similar very quickly with their desktop tool of choice: but putting this type of analytic capability within reach of a more general audience over the web opens up new avenues for more meaningful information interrogation and communication.

Conclusion

The emergence of virtual globes as a new type of visualization platform represents a valuable opportunity to the geospatial professional to reach an ever-widening non-technical audience who can now meaningfully view and interrogate spatially referenced information in a compelling, immersive browsing environment. From 3-D data representations on the landscape to geo-processing tools for server-side spatial analysis, the general user is able to quickly establish visual relationships among multiple technical datasets and ask spatial questions of the data without extensive software-specific training. Finally, efficient self-contained file formats facilitate the true goal of the any analysis: the direct, immediate, and accessible communication of information.

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References

[1] National Oceanic and Atmospheric Administration (NOAA), *2006 Atlantic Hurricane Outlook* (press release), issued May 22, 2006. Available at http://www.cpc.noaa.gov/products/outlooks/hurricane.shtml.

[2] Tufte, Edward. *Envisioning Information*. Cheshire, CT: Graphics Press, 1990.

[3] Few, Stephen. "The Surest Path to Visual Discovery" *Business Intelligence Network*: April 11, 2006. Available at http://www.b-eye-network.com/newsletters/ben/2674.

Fig 2

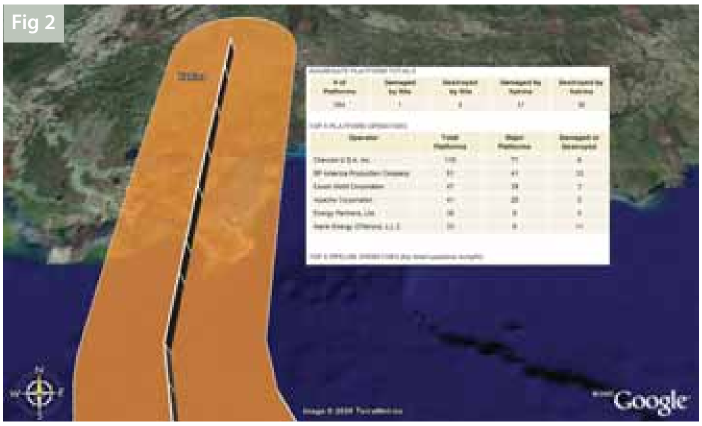

Fig. 2: A 50-mile user-defined buffer of Katrina's path with associated statistics.

Fig 3

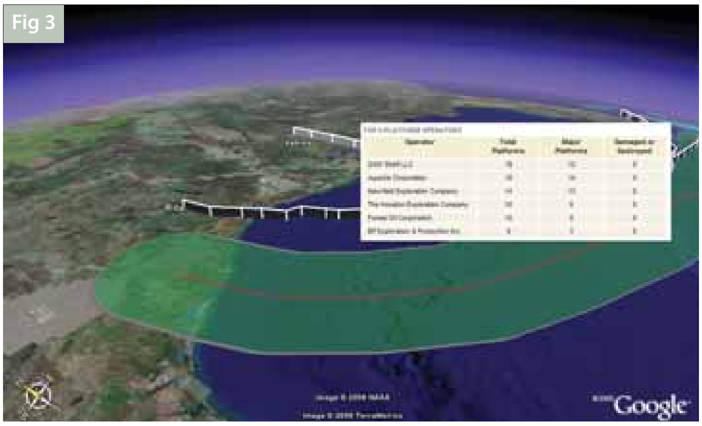

Fig. 3: A 75-mile buffer of a user-defined hypothetical hurricane path, with a list of operators with vulnerable assets.