INTEGRATING MARINE DATA INTO NASA WORLD WIND

3D Web-Mapping

While Google Earth is the best known 3D web-mapping viewer currently in the public domain, there are alternative virtual globe viewers available. In particular, this article focuses on the NASA World Wind viewer, using OGC data-dissemination standards and multi-beam sonar data from the Irish National Seabed Survey to illustrate its potential.

The creation of a range of innovative GIS tools and systems is enabling the harmonisation and electronic sharing of geospatial data and services across distributed networks. 3D web mapping viewers, such as NASA World Wind, are perhaps some of the most visible of these products.

OGC Standards
Such developments are putting in place some of the key building blocks that underpin the development of Spatial Data Infrastructures (SDIs). The Open Geospatial Consortium (⏩1) has published a number of interoperability standards ('OpenGIS' specifications) which are major components of SDI. Important OGC standards include Web Map Service (WMS), Web Feature Service (WFS) and Web Coverage Service (WCS). The WMS standard facilitates web-based dissemination of map imagery, while the WFS and WCS standards facilitate the dissemination of feature and coverage/raster data respectively.

MarineGrid Research
In the September 2006 edition of Hydro International (volume 10, issue 7) we demonstrated the use of the WMS standard as part of the MarineGrid research project. This project is funded by the Irish Higher Education Authority and involves researchers from the National University of Ireland, Galway (NUIG) and the Coastal and Marine Resources Centre at University College Cork (UCC). An in-house WMS server was developed to disseminate shaded relief bathymetric imagery of Dublin Bay from the Irish National Seabed Survey. The article illustrated how it is possible to integrate large imagery datasets into Google Earth using WMS and KML (Keyhole Markup Language). However, it is possible to integrate WMS imagery into other 3D viewers too.

NASA World Wind
NASA World Wind is an interactive, web-enabled 3D-globe viewer. It was first released by NASA's Learn-ing Technologies project in August 2004 and is similar to the Google Earth viewer, where you can zoom in to any place on Earth. However, the viewers are aimed at different audiences. World Wind was originally designed as a scientific educational tool, while Google Earth was designed as a geographic location-based search tool. Both viewers have their own unique capabilities. Google Earth principally uses commercial high-resolution satellite/aerial imagery, while World Wind uses public-domain satellite/aerial imagery. World Wind also supports 3D-globe visualisation of other planets such as Venus and Mars, and the Moon. World Wind is open-source, allowing developers to modify the source code or develop plug-in or add-on tools. For example, free plug-ins have been developed that can access imagery and maps from the French GÃ©oportail and Microsoft's Virtual Earth, although in these cases data licensing can be more restricted.

WMS Streaming
Similar to Google Earth, World Wind downloads small portions of imagery corresponding to a user's virtual view, using a hierarchical tiling technique. For any given area, regional low-resolution tiles are first downloaded, followed by medium-resolution tiles and finally local high-resolution tiles. Hierarchical tiling enables the visualisation of multi-terabyte datasets. Once downloaded, the data is cached on local disk. Due to the open and public nature of World Wind this cache is not encrypted. World Wind directly supports WMS delivery of data. It is therefore possible to connect the viewer with any WMS-compliant service. This is accomplished by configuring a single configuration file, i.e. based on the @Images.xml file. This was done for the MarineGrid project, where the reconfigured World Wind viewer can directly access shaded relief imagery from the Dublin Bay WMS server.

Elevation Streaming
World Wind supports 3D visualisation of both land and ocean. It is therefore possible to explore the Earthâ€™s mountains or the

oceansâ€™ continental slopes in 3D. This terrain data is streamed from a NASA server as required, also using a hierarchical tiling technique. The data is sourced from the SRTM+ dataset, a relatively low-resolution dataset. While the WMS standard supports map-imagery streaming, the WCS standard can support elevation-data streaming. However, World Wind does not use this standard. Instead, terrain tiles are pre-built, placed on a NASA server and accessed through a non-WCS compliant web service. As World Wind is open-source, the API to this terrain web service is known.

High-Resolution

A useful World Wind feature is the ability to stream higher spatial-resolution elevation models with up to one-metre vertical resolution using the terrain API. A 'posting' tool for generating terrain tiles is available online. As part of the MarineGrid project, this tool was used to generate high-resolution bathymetry tiles for Dublin Bay. These tiles were placed on an in-house server adhering to the terrain API. After reconfiguration (i.e. the Earth.xml file), the viewer automatically streams higher-reso-lution terrain from the in-house server. Figure 2 illustrates the imported seabed terrain for a region of Dublin Bay. Note the cursor in the centre of the screen that identifies the underlying seabed as thirty metres in depth.

Time-Series WMS

World Wind supports time-series WMS imagery through the 'WMS browser' feature, where time-series imagery is visualised as an animation sequence. However, this feature does not use a hierarchical tiling technique. Therefore, it does not support the visualisation of large time-series im-agery datasets. It is possible to connect the 'WMS browser' to a WMS-compliant service storing time-series data, i.e. the wms_server_list.xml configuration file. The browser automatically builds a list of available data layers from the remote server through a WMS GetCapabilities request. This feature has also been used by MarineGrid to visualise time-series imagery generated from a 4D hydrodynamic model of the Northeast Atlantic. Figure 3 illustrates sea temperature animation at one thousand-metre depth. Support for legends, e.g. temperature scale, is also supported but not illustrated here.

Vector Support

Support for importing vector data into World Wind is currently limited. For example, vector objects such as polygons are not rendered directly but instead rasterised and rendered as a texture. Basic ESRI Shapefile and KML are supported, but these features are still under development. Better vector-object rendering is required and planned for future re-leases. WFS support is also planned.

Other 3D Viewers

ArcGIS Explorer is an upcoming 3D web-mapping viewer developed by ESRI. It is still in beta production but will be available with the forthcoming release of ESRI ArcGIS 9.2. The viewer streams data from ESRI proprietary servers: ArcGIS Server, ArcIMS and ArcWeb services. However, it also supports some open standards: the WMS standard and the de-facto KML standard. Finally, an official 3D version of the French GÃ©oportail is expected next year. The list of web-enabled virtual globe viewers is growing.

Concluding Remarks

Three-dimensional web-mapping viewers using a virtual globe to portray the world have helped to popularise GIS, transforming a flat 2D world into a more stimulating experience for the general public. Along with faster computers, their success has been greatly helped by the broadening availability of broadband, helping faster data streaming. Viewers like NASA World Wind have helped to highlight and demonstrate the importance of OGC standards in building SDIs. However, there is a need for viewers to fully support these standards. As the existing features of the current wave of 3D web-mapping products are strengthened, it is important to look at their future evolution. Support for metadata is very important. How often does a user ask how old is this satellite image of my city? True 3D support is also required. The ocean is not a surface but a volumetric space. For example, to better visualise and interpret a volumetric hydrodynamic model, slicing and profiling tools are needed. The wish list for new features is probably endless. However, it is the marketplace that will determine the additional functionality that is actually realised.

Acknowledgments

Thanks to the Irish National Seabed Survey team for providing the Dublin Bay multi-beam data. This survey is managed in partnership with the Geological Survey of Ireland (GSI) and the Marine Institute and funded by the Irish Government. Thanks to Ahed Al-Sarraj, Civil Engineering Department, National University of Ireland, Galway for developing and providing the 4D hydrodynamic model data of the Northeast Atlantic. Thanks to ESRI Ireland for producing the ArcGIS Explorer image from their test environment.