

# Dynamic Model-based Environmental Visualization on the Internet

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Visualization has long been an important component of GIS for supporting spatial decision making, from static map display to animated maps and from analysis result display to exploratory visualization (Kraak 1998; MacEachren *et al.* 1999). However, the current centralized visualization manner still needs further development into the distributive manner for collaborative planning and decision making; visualization needs to combine analytical models (Bishop and Karadaglis 1996) in order to set up virtual labs for exploring the complex dynamic phenomena, particularly in environmental modelling - an active research field in GIS. In this paper, we seek to pursue an optimal solution to exploratory visualization using various Internet techniques.

Various schemes have been introduced to achieve a well-balanced load between the server and client sides for visualization purposes. However discussion so far is mostly limited to data visualization, not exploratory visualization by which we mean that analytical models is mounted on the Internet for the real time simulation of complex phenomena. In the course of exploratory visualization, it may involve various parameters input for interrogation, to conduct "what-if" modelling.

To have analytical functionality mounted on the Internet is not a straightforward task, as it requires high interactivity between the client and the server sides, particularly for the applications with high frequent communications between the client and the server sides. When dealing with these applications, several difficulties arise:

- Allocation of different tasks such as modelling and visualization to the client or server side for achieving a balance between the two sides;
- Bi-directional and sustained communication between the client and server sides at each time step in the course of modelling and visualization;
- Intermediate result update on an existing map or chart instead of data reloading and redrawing;
- Synchronization between different windows for visualization of results.

The existing Internet techniques have some limitations in dealing with the above issues. Therefore how to overcome these limitations is still a desirable challenge for environmental visualization on the Internet.

We examine different scenarios for web-based visualization, which includes Common Gateway Interface (CGI) approach, Java Applet, and finally Servlet in conjunction with Java 3D techniques. It is demonstrated with our examples that different techniques can accomplish different degrees of visualization purposes, but only the Servlet technique is most suitable for mapping a complex dynamic process that is usually model based on the Internet. In other words, this technique holds potentials in supporting both data and process-oriented visualizations.

## References

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