PLANETARY GEOGRAPHIC INFORMATION SYSTEMS (GIS) ON THE WEB.

T. M. Hare and K. L. Tanaka, U.S. Geological Survey, Flagstaff, AZ, 86001; thare@usgs.gov

Introduction. We are producing a Web-based, user-friendly interface that will integrate powerful Geographic Information Systems (GIS) and Planetary Data System (PDS) graphical, statistical, and spatial relational tools for analyses of planetary datasets. The interface, known as "Planetary Interactive GIS-on-the-Web Analyzable Database" (PIGWAD), will provide database support for the research and academic planetary science communities, particularly for geologic mapping and other surface-related investigations.

Background. GIS is an organized collection of computer hardware, software, and geographic data whose operations can be tailored to efficiently capture, store, update, manipulate, analyze, and display all forms of geographically referenced information [1]. Application of GIS in the planetary sciences has grown dramatically over the past few years, as scientists have been able to prepare thematic maps and determine spatial relations among multiple datasets [2-10]. However, the creation of a GIS can be an expensive and daunting task for an organization that does not have the necessary hardware, software, and technical expertise. Such investment is not justifiable for most planetary projects.

Thus, NASA's Planetary Geology and Geophysics Program, under the auspices of the Planetary Cartography and Geologic Mapping Working Group (PCGMWG), has chosen to support a planetary, Web-based GIS that the entire science community may utilize. The USGS in Flagstaff will provide this service, given our expertise in both terrestrial and planetary GIS [7]. Datasets that will be incorporated must be approved under the scientific oversight of the Geologic Mapping Subcommittee (GEMS) of PCGMWG. In addition, specialized interfaces to support the distinct needs of particular spacecraft missions or science projects may also be constructed.

Approach. Planetary datasets incorporated into PIGWAD will preserve the quality and resolution of the original data to the extent possible. A key element to the utility of a planetary database will be the spatial coregistration of the datasets. This requirement will necessitate the adjustment of datasets into a common geodetic framework. In addition, as geodesy is updated for a planetary body, the GIS datasets will also require modification.

Several software companies have released GIS network-oriented solutions. Each company has been trying to meet the demand of rapid data delivery over an already strained World Wide Web. Environmental Systems Research Institute, Inc. (ESRI), which has been in the GIS business for more than 25 years, has recently released two web-based GIS solutions. The solution we have chosen is Internet Map Server (IMS), an extension to ArcView. ArcView, ESRI's most popular desktop GIS application, when combined with IMS, optimizes network flow by using small compressed images. Some other advantages for choosing ArcView include: (1) many of the tools needed are already built into ArcView, (2) it has already proven capable of handling planetary data [7], and (3) it permits great flexibility by making it possible to customize the user interface and the tools that accompany it. Thus users do not need to learn the intricacies of ArcView; instead, they just need to become familiarized with an easy-to-learn graphical user interface. For the planetary GIS, we plan to construct three different user levels—beginner, intermediate, and advanced.

The first time a user connects to the Web-site interface via Netscape or Internet Explorer, a small JAVA applet will be loaded into their machine. Each time the user submits a request with the JAVA applet, the Web server will process the request and return either a compressed image or tabular information. This approach allows the user to browse the data as if it were on the user's computer. Subsequent requests will result in a refresh of the map, guaranteeing the most up-to-date version of the database. The user also has the option of downloading the data to use on their own machine.

The beginner interface will allow one to view a base image and any number of GIS layers in different, commonly used projections. From this interface, one can zoom, query, add text, and draw simple graphical additions like arrows or boxes. Then the user can create a layout that automatically adds a key, scale bar, title and north arrow.

The intermediate interface will incorporate all the above and add some easy-to-use analysis and spatial relationship tools. This functionality will allow users, for example, to select a geologic feature and find the nearest volcano in ground units, or calculate the sum area of rock outcrops for a particular geologic period. This interface also will allow one to set up multiple selection routines. For example, one may ask the system to highlight and select all the outcrops of geologic units from Mars' Amazonian Period with an area greater than 60 km^2 and then print out a list of results.

The advanced interface will give the user hundreds of options from user-defined parameters for map projections to complicated buffering and layer-intersection functions. Possible future advance additions include 3D virtual reality capabilities, video simulations, and anaglyph creation.

Schedule. PIGWAD is currently on schedule to have the hardware, software, and a select set of datasets running by March of 1999. The first database to be incorporated will be for Mars and will include the Viking digital image mosaic, geologic unit and feature maps, topography, and other remote-sensing datasets. Other databases of Venus, Mercury, the Moon, and outer planet satellites will be future additions. Check the Planetary Geologic Mapping Web page via wwwflag.wr.usgs.gov/USGSFlag/Space for updates.

Summary. GIS gives one the tools not only to view several different types of data together but also to perform various data analyses including advanced spatial intersections, unions, and robust conditionals. By incorporating this functionality into a user-friendly Web environment, a wide array of investigators and educators can easily implement the analytical power of a planetary GIS.

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