WebGIS tools applied to science traverse planning and the geospatial analysis of terrestrial analogue sites

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Introduction: The Canadian space agency (CSA) is currently developing a geospatial architecture intended for planetary and terrestrial analogue databases. The main objective of the project is to provide CSA staff and Canadian stakeholders with the opportunity to expand their knowledge of terrestrial analogues by enabling a visual and semi-quantitative comparison of Earth-based and planetary datasets [1]. A fundamental requirement of the architecture is the ability to display and manipulate terrestrial and planetary databases to support the Canadian Analogue Research Network (CARN) [2, 3] and analogue missions [4]. The choice of an Internet-based Geographic Information System (WebGIS) is well-suited to the multidisciplinary nature of CSA-supported analogue research projects and missions, and to the required interoperability between multiple systems in exploration science and engineering. The WebGIS allows the visualization, manipulation, and basic analysis of terrestrial and planetary data. Planning of traverses for extravehicular activities (EVA) at terrestrial analogue sites is also under development. Advanced analysis of data acquired during traverses will be possible. All the software and libraries used for the development of the WEBGIS consist of free and open source software (FOSS).

WebGIS Architecture: Figure 1 illustrates each component of geospatial architecture, and when they are used in the sequence. The use of FOSS is advantageous because it ensures that applications can be modified according to individual projects and no financial investment is needed to acquire software or licences.

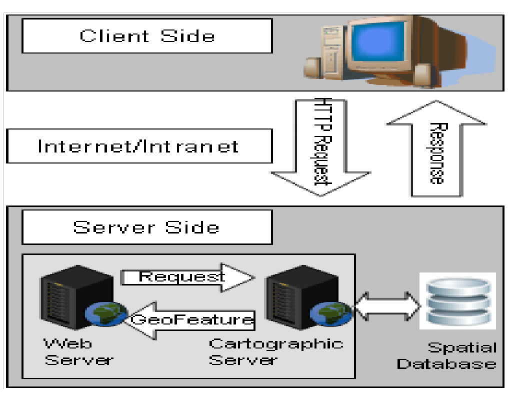

Figure 1. CSA geospatial architecture

Figure 2. CSA WebGIS components

Figure 2 illustrates the WebGIS components flow used for geoprocessing, servers, and clients. For the client side components, GeoNetwork is an interface that enables queries and searches of all the metadata. MapFish is a library composed of OpenLayers, ExtJS, GeoExt and specific toolkits. It is used to create the WebGIS interface and develop geospatial tools. The web server Apache HTTP runs on a Unix operating system. The geographic data are managed by both GeoServer and MapServer. Finally, data are stored in a PostGreSQL database, with the PostGIS geospatial extension. The Grass GIS modules are used for geoprocessing and are accessible through PyWPS. All the components are interoperable through the OpenGeospatial Consortium (OGC) standards on interoperability concerning data and processes.

Study area: Geospatial analysis and traverse planning tools are currently being tested on data from the Haughton impact crater, located on Devon Island in the Canadian High Arctic (75° 22' N, 89° 41' W). The Haughton crater is a 39 Ma impact structure (23 km in diameter) offering the advantage of 100% exposure in the polar desert environment in conditions that are analogous to those on Mars [5]. Field projects have been carried out at this site in the fields of Geology, Engineering, Biology, Space Mission Design, Astronaut Training, etc. for over a decade. High-resolution images such as shown on Figure 4 allow the creation of a Digital Elevation Model (DEM), the basis for traverse planning and least cost path analysis.

Figure 4: GeoEye-1 stereoscopic couple images (50 cm/pixel) acquired in July 2009 showing the outline of the Haughton impact crater, Devon Island, Canada. ©Canadian Space Agency.

Every data pixel on high-resolution images also enables a direct comparison of spatial and spectral resolution with the data from Mars Reconnaissance Orbiter (MRO) HiRISE camera. Space mission scenarios for the Moon and Mars [6] are used to test the traverse management tool, yielding a number of plausible, optimal scenarios for reconnaissance geological exploration and terrain characterization.

WebGIS functionalities: The WebGIS contains a set of basic tools that are widely applicable to CSA stakeholders, and allow the user to navigate throughout the study area (e.g. zoom and pan features, distance and area measurements, cursor coordinates, layertree with opacity modification, overview map, etc). Two advanced functionalities are implemented: (1) a tool that creates points, paths, and areas of interest; (2) a tool for traverse planning. The first provides vectorial data edition such as the creation, modification, and deletion of geographic features in a geospatial database. All the operations conform to the Web Feature Service Transactional (WFS-T) standards from the OGC.

The traverse planning tool allows users to create, compare, and select optimal traverses according to a predetermined set of space or analogue mission objectives. For example, a least cost path analysis can be applied to accomodate multiple coordinates provided by the user. The Grass GIS modules r.walk/r.cost and r.drain are used in combination to create the least costly path, depending on a cost matrix which is represented as the slope for functionality purposes [7]. This cost matrix used in the least cost path analysis can be modified to suit any given mission scenario. Figure 5(a) illustrates some coordinates entered by the user as point of interest, while the line pattern on figure 5(b) represents the traverse created. A DEM allows the user to compare the efficiency of several traverses, thus optimizing field work to achieve mission objectives.

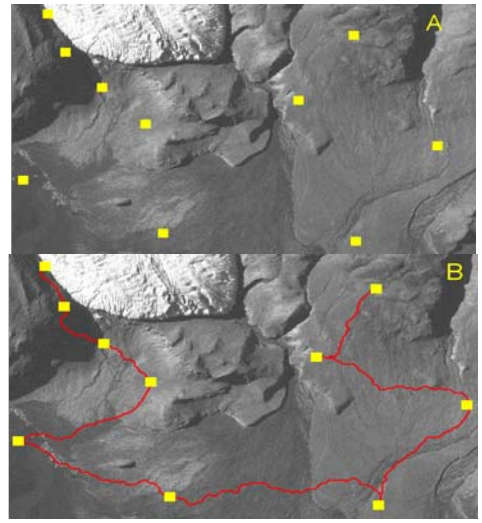

Figure 5. Application of WEBGIS traverse management tool showing point data (a) and the resulting traverse (b).

Conclusions: The Canadian Space Agency is currently developing a corporate geospatial architecture to support exploration projects and analogue research in Canada. The geomatics project, started in 2007, is the first of its kind at the CSA. Activities carried out so far have demonstrated the many advantages of GIS applications in planetary science projects and for exploration. The choice of a WebGIS is well-suited to the multidisciplinary nature of analogue research projects and missions, and to the required interoperability between multiple systems in exploration science and engineering.

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References:[1] Germain, M. and Phaneuf, M. (2009) 17th International Conference on Geoinformatics Abstract #3423. [2] Hipkin, V., et al.. (2008), *LPS XXXVIII*, Abstract #2052. [3] Osinski, G.R., et al. (2006). *Geoscience Canada*, 33 (4): 175-188. [4] Lebeuf, M., et al. (2008), J*oint Annual Meeting of LEAG-ICEUM-SRR*, Abstract #4033. [5] Osinski, G.R., et al. (2005), *Met. Planet. Sci*., 40: 1759-1776. [6] Bleacher, J.E., et al. (2008), *NLSI Lunar Science Conference* Abstract #2166. [7] Bevan, A. (2008) Computational Models for Understanding Movement and Territory. 25 p. 5th *International Symposium on Archeology*.