EPSC Abstracts
Vol. 5, EPSC2010-325, 2010
European Planetary Science Congress 2010

PlanetaryGIS: a distributed system for landing-site characterization and selection for space exploration missions

T.E. Zegers (1), and R. Koenders (2)
(1) Faculty of Geosciences, Utrecht University, Budapestlaan 17, 3508 TA Utrecht, The Netherlands, tanja@geo.uu.nl.
(2) Faculty of Aerospace Engineering, Delft University of Technology, Kluyverweg 1, 2629 HS Delft, The Netherlands, R.Koenders@tudelft.nl

Abstract

With planned ESA exploration missions to Mars and the Moon there is a need for a landing-site characterization and selection process for those missions. We analyzed this process in the European context, its potential participants, and their role in landing-site characterization and selection. Potential participants are located in different countries, work at academia, industry, and technology institutes, and are moreover funded by different national agencies and institutes. The knowledge and expertise relevant to landing-site characterization and selection is therefore dispersed. To streamline and support landing site selection for ESA missions we propose a web-based, interactive system with three components: data exchange, a wiki, and a forum. A prototype system called PlanetaryGIS is under development in the framework of the Europlanet FP7 program.

1. Introduction

Solar system exploration is one of the prime goals of European countries represented in ESA. In the next decades lander missions to the Moon, Mars (demonstration lander in 2016, ExoMars in 2018), and possibly asteroids are planned. Preparations are ongoing for Mars Sample Return missions and for human exploration missions. The ability to characterize and select suitable landing sites for those missions will be key to the success of the European exploration programs.

Landing safely on the planetary surface is a goal that all planetary and lunar lander exploration missions have in common. Since the action radius of rovers is limited (typically tens of kilometers), and planetary terrains can be highly variable in terms of topography and rock/soil composition, the landing site is one of the most deterministic elements of such exploration missions. The landing site largely determines the risk during landing, and the potential to fulfill the exploration goals. Therefore the success of a lander mission is largely dependent on the process of landing-site characterization and selection

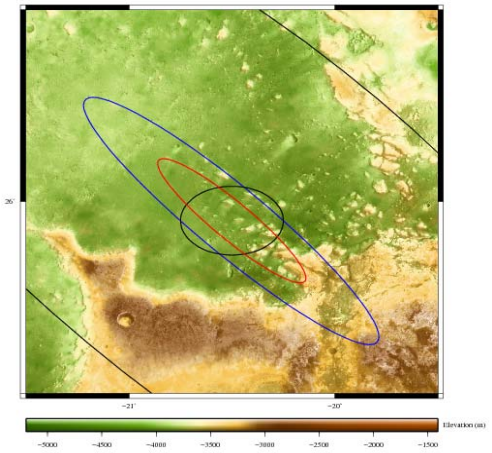

Fig.1 Landing ellipses in the Mawrth Vallis area on Mars. The image is based on combined HRSC DEM data (orbit 1564) with a maximum resolution of 150 meters per pixel and the HRSC nadir image. The landing ellipses are for MER (blue), MSL (black), a potential ellipse for ExoMars 2016 lander (red). This illustrates how smaller ellipses lead to a dramatic increase of surface area where a landing can potentially take place.

Landing-site characterization and selection (LSCS) is a process in which diverse, geographically distributed experts need to find an optimum subset of terrain attributes which minimize the risk of failure during landing, and simultaneously optimize the probability of fulfilling the exploration or science goals. This process is hampered by 1) incomplete coverage of relevant parts of the surface, 2) inconveniently large errors and/or low resolution of surface data, 3) uncertainties in the engineering risk assessment, and 4) uncertainties in the quality of observable proxies to predict the occurrence of targeted attributes. Because none of the stake-holders (scientists, engineers, project management, agencies) are knowledgeable for the entire process, it is imperative that the diverse experts collaborate to find an optimum set of attributes to define a landing site.

NASA developed a community based approach for the selection and characterization of potential landing sites, starting with the Pathfinder mission [1] and refined for the Mars Exploration Rovers [2]. The entire process for the MER took more than 2 years, during which at different stages the community could propose specific landing sites.

3. PlanetaryGIS.org

The critical challenge in developing a LSCS process for European missions lies in the need to integrate knowledge, expertise and resources which are dispersed in different communities: the science community, space industry, national space agencies, and ESA. In addition, the community, mission goals and engineering requirement, data and data products evolve continuously during the course of mission preparation, which can typically take 10 years.

We analyzed the various elements relevant to LSCS in the European context and on the basis of this analysis we propose a system, for which the prototype is called PlanetaryGIS, which has the following characteristics:

- Interactive, community-based system on the World-Wide-Web
- User interactions with the system are grouped in data and tools exchange, a wiki for knowledge exchange, and a forum for discussions.
- User generated content.

The prototype consists of three major components: 1) a forum where community interaction can take place, 2) a wiki where users can read and contribute knowledge specifically geared towards the selection of landing sites and analysis of the underlying data, and 3) a data exchange where users can download derived data products not available on the PDS and/or PSA, and where users can exchange user-generated data-sets such as geological maps of potential landing sites. Each of these components will be enhanced in the coming development cycles to fit more tightly with relevant ongoing LSCS processes such as ExoMars, but also landing sites that need to be selected for the Google Lunar X-prize missions, with anticipated landing in 2012.

Acknowledgements

The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013), under Grant Agreement n°228319.

References

[1] Golombek, M.P. Cook, R.A. Economou, T. Folkner, W.M. Haldemann, A.F. Kallemeyn, P.H. Knudsen, J.M. Manning, R.M. Moore, H.J. Parker, T.J. Rieder, R. Schofield, J.T. Smith, P.H. and Vaughan, R.M. Overview of the Mars Pathfinder Mission and Assessment of Landing Site Predictions, Science, vol. 278, 1997, 1743-1748.

[2] Grant, J.A. Golombek, M.P. Parker, T.J. Crisp, J.A. Squyres, S.W. and Weitz, C.M. Selecting landing sites for the 2003 Mars Exploration Rovers, Planetary and Space Science, vol. 52, 2004, 11-21.