MARS GIS LANDING SITE SUITABILITY MODELS. D. Curkendall[1], T. Hare[2], R. Anderson[1], E. Dobinson[1] and L. Plesea[1], [1]Jet Propulsion Laboratory, Caltech, 4800 Oak Grove Drive, Pasadena, CA, 91109-8099, dcw@jpl.nasa.gov, [2]U.S. Geological Survey, 2255 N. Gemini Dr., Flagstaff, AZ, 86001.

Introduction: We have explored the use of GIS suitability models for the screening and analyzing of potential sites for Mars landers using engineering and scientific constraints in an iterative manner. While initially performed on locally held data sets, these analyses have now been extended to use widely distributed data from standardized Web Mapping Servers (WMS) [1]. The ability to exploit a wide variety of data within a single analysis tool offers the opportunity for community wide participation in landing site selection. We have created several preliminary models within the Geographic Information System (GIS) software package ArcMap by the Environmental Systems Research Institute (ESRI). We have extended the capability of ArcMap to use Internet streamed data sets within the models as well as hosting a user-controlled model entirely from a web interface.

Motivation: Selection of landing sites for martian rovers can be a very tricky balance between landing safely and choosing scientifically interesting areas. Spacecraft safety is always the primary concern, but within all of the possible "safe" sites, those that are of greater scientific interest are the ones to be considered. Bringing in a wealth of available data sets to help with this choice requires that all data are co-registered and in the same coordinate and projection system. GIS technology provides a common substrate for the analysis of these disparate data sets, and for the application of both engineering and scientific constraints to select out the most promising and suitable areas.

Method: For the purposes of testing the GIS approach, we chose several of the engineering constraints used in the selection of landing sites for the Mars Exploration Rovers as described in Golombek et al [3]. Our simplest model includes MOLA topography [4] (to access elevation and slope), MOLA roughness, and TES thermal inertia [5], but we have also tested other parameters like proximity to hematite (Figure 1). A sample model run reclassifies each layer and ascertains landing site suitability based on weighted results for each constraint. The weights for each layer are user-definable and interactive which allows the user to easily test many different scenarios. An example of an absolute constraint would be using the MOLA topography to determine if the elevation were low enough, which is necessary to allow the descent vehicle to slow down. An example parameter that could be weighted from "optimal" to "questionable" to "unacceptable" would be thermal inertia. Thermal inertia is used as a proxy for rock abundance and dust coverage. A value that is too low indicates very dusty conditions; a value that is too high indicates an area too rocky for a safe landing and/or for rover trafficability. Thus, because the interactivity of the model, real-time trade-offs can relax the criteria and hopefully yield a greater solution space. The last step in the model further constrains the targetable areas based on the landing site error ellipse. The algorithm essentially "walks" the suitable areas and determines if there is enough contiguous space to house the ellipse (Figure 2).

Another goal that was successfully implemented included using data sets that were not local to the application but streamed from the Internet. We also created an interactive web version of the model to enable scientists to run it without having the GIS software on their host machine.

Future: The preliminary engineering constraints for the Mars Science Laboratory (MSL) have been recently released by JPL [2]. And even though MSL does not launch until 2009, the process of selecting the landing site has already begun. We hope to use the methods tested here to help the community better select safe but interesting sites.

References: [1] Dobinson, E., et. al., (2006), Adaptation & Use of Open Geospatial© Web Technologies for Multi-Disciplinary Access to Planetary Data, LPSC XXXVII, abs. 1463. [2] Grant, J. and M. Golombek, (2006), Announcement for the First Landing Site Workshop for the 2009 Mars Laboratory, URL: http://webgis.wr.usgs.gov/msl/. [3] Golombek, M. et al., (2003), Selection of the Mars Exploration Rover landing sites, JGR 108(E12) doi:10.1029/2003JE002074. [4] Smith, D., et. al., (1999), Mars Global Surveyor Laser Altimeter Precision Experiment Data Record, NASA Planetary Data System, MGS-M-MOLA-3-PEDR-L1A-V1.0. [5] Mellon, M. T., et. al., (2002), A global map of thermal inertia from Mars Global Surveyor mapping-mission, LPSC XXXIII, abs. 1416.

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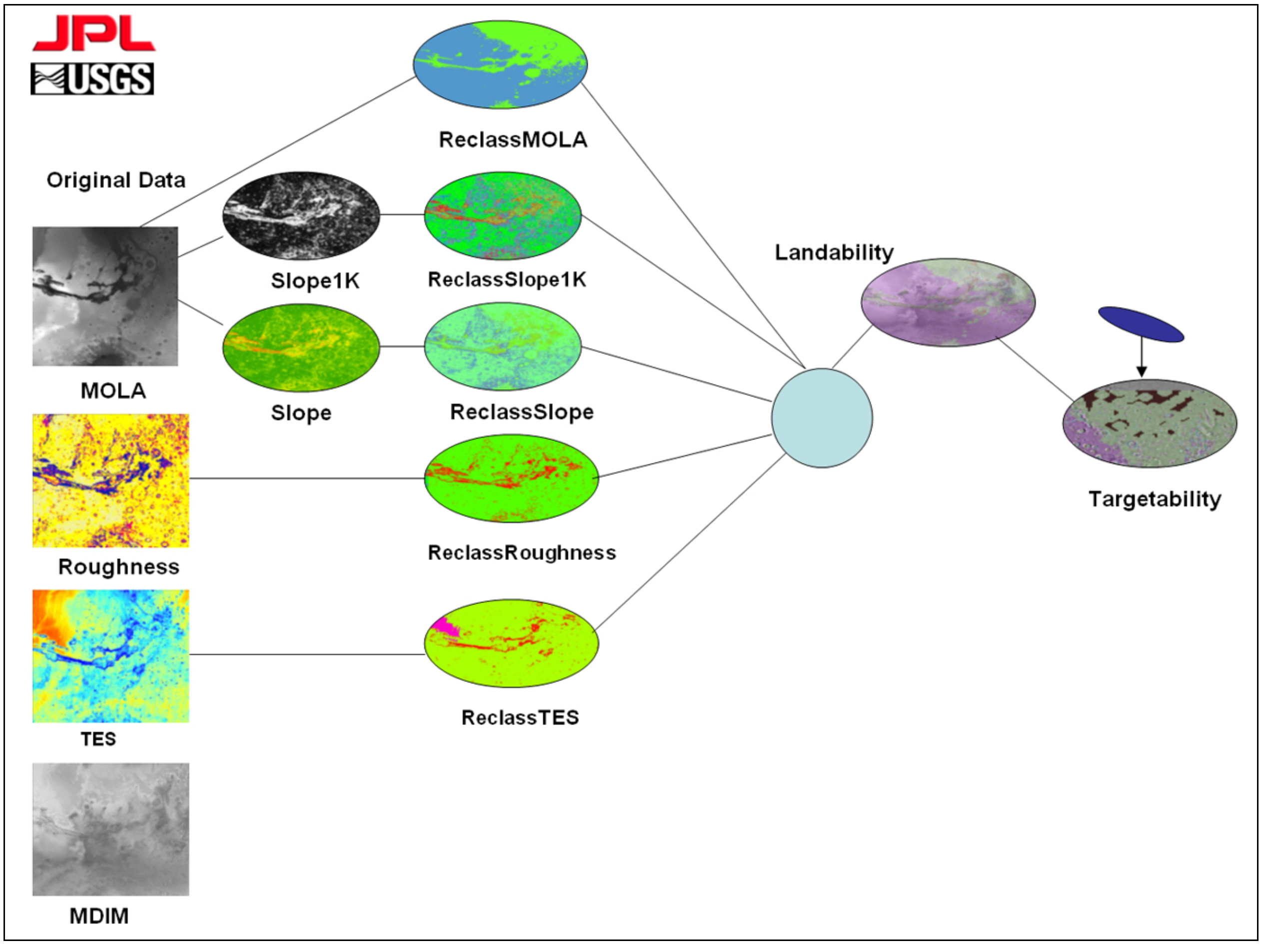

Figure 1 (above). An sample flow diagram for a simple MER landing site suitability model. Landability results display areas that are safe, questionable and too hazardous based only on the input layer constraints. Targetability filters out regions that cannot be selected because they are too small of a area to fit the landing ellipse.

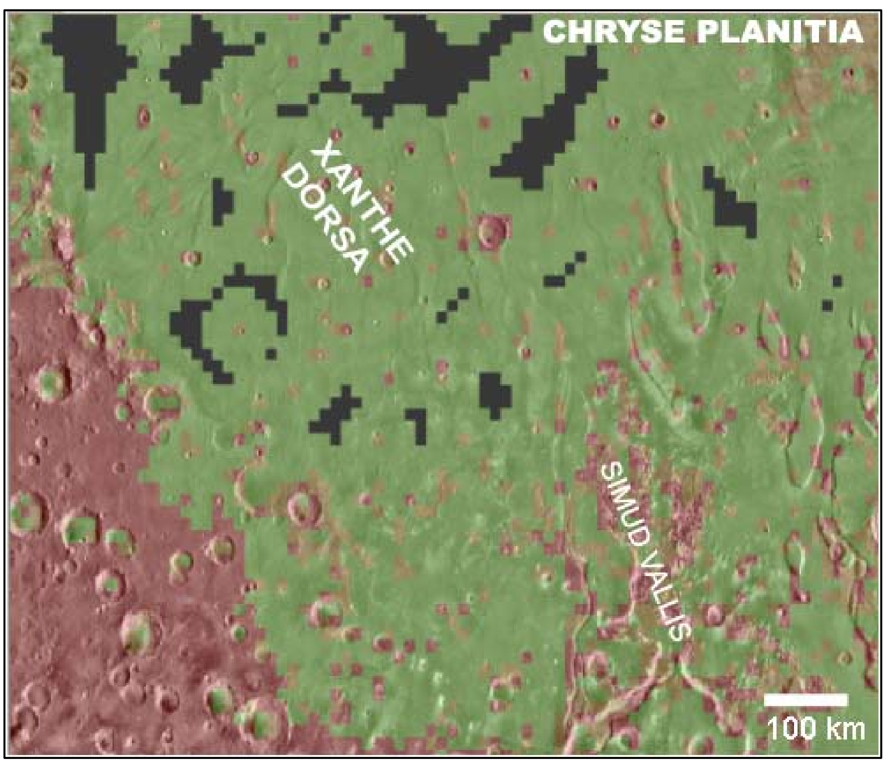

Figure 2 (left). A sample targetable area showing southern Chryse Planitia. The classified colors show that green areas are safe, whereas the red areas violate one or more safety criteria. The black pixels were reclassified during the targetability step and are both safe and contain enough contiguous safe areas (i.e. green) to fit the 50 km landing site error ellipse. Thus, the black regions are 'targetable'.