Geographic Information Systems: An Enabling Tool for Lunar Exploration. K.G. Thaisen[1], A. Losiak[2], T. Kohout[3], K. O'Sullivan[4], S. Weider[5], and D. Kring[6]. [1]University of Tennessee, 306 Earth & Planetary Sciences, 1412 Circle Dr., Knoxville TN 37996 (kthaisen@utk.edu),[2]Michigan State Univ. [3]Dept. of Physics, Univ. of Helsinki [4]Dept. of Civil Eng. & Geo. Sci., Univ. Notre Dame [5]UCL/Birkbeck School of Earth Sci., [6]Lunar & Planetary Institute.

Introduction: The Moon is rapidly becoming a hotbed of activity and the Japanese Kaguya [1] and Chinese Chang`e-1 [2] spacecraft will soon be joined by India's Chandrayaan [3] and the American Lunar Reconnaissance Orbiter [4]. Each of these missions will provide datasets with improved resolution which will be incorporated into the evaluation and planning of future landing sites for both robotic and human missions. These missions will provide volumes of data that will need to be correlated quickly and accurately. This can be performed within a Geographic Information System (GIS) platform. The ability to bring together and recognize the spatial relationships between multiple datasets provide mission planners and lunar scientists a powerful tool to understand the surface conditions seen on the Moon. Within a GIS, Apollo era data can be combined with current and future datasets in order to address the questions related to landing site assessment and lunar science.

A powerful attribute of a GIS is the ability to manipulate a digital elevation model (DEM). DEM's can be used to determine slope angles, aspects, and changes in elevation. Imagery draped over a DEM can provide a three-dimensional representation of the surface which may assist in early planning of possible landing sites and/or traverses across the lunar surface. Surface elevation information can then be combined with multi-spectral imagery, high-resolution surface imagery, surface roughness, and other datasets to quickly identify sites of interest for potential exploration or to rule out sites due to surface hazards. Topographic and lateral relationships can also be explored between the different datasets.

GIS and the past: It is important to remember that it has been nearly 40 years since NASA first went to the Moon. That is not to suggest that the Apollo-era data is obsolete; Lunar Orbiter and the Apollo metric and panoramic cameras images are frequently better than anything currently available and topographic and geological maps have already been generated for many parts of the Moon. However, many of these datasets are still in analog format and not quickly incorporated into the digital formats which are used by GIS. These datasets can be incorporated into a GIS, it just takes the time to digitize them and/or reference them properly to lunar coordinates and is often well worth the effort. Fig. 1 illustrates some of the basic features which can be done with an Apollo-era topographic map and imagery.

GIS and the Present: Geographic Information Systems are quickly becoming the tool of choice for mapping due to the ability to associate additional information with features on a map and to be able to query that information. Some of the information that was collected from recent missions like Clementine and Lunar Prospector is available in GIS formats and ready to be used. As new data becomes available from lunar orbiters, it can quickly be incorporated into existing maps or to generate new maps. This rapid incorporation of new datasets will help to focus attention to particular locations of interest and provide valuable insights for future landing site selections.

Serious consideration should be given to assigning an institute, or other organization, to be responsible for the cataloging and maintenance of all Lunar datasets. This would help ensure standardize products and reduce or eliminate errors caused by different groups using different datums, projections, or coordinate systems.

GIS and the future: When robotic and human missions return to the Moon and start doing detailed field work on the lunar surface, ground truth data will undoubtedly affect current maps and can be incorporated quickly to enable better decisions for future exploration. Once a location for a permanent outpost has been selected, extremely detailed maps will be produced of the immediate area to facilitate in construction, possible in-situ resource utilization, and logistics. A GIS can incorporate all this information and be updated quickly as things change on the ground and will be essential for continuity as multiple crews rotate in and out of the outpost.

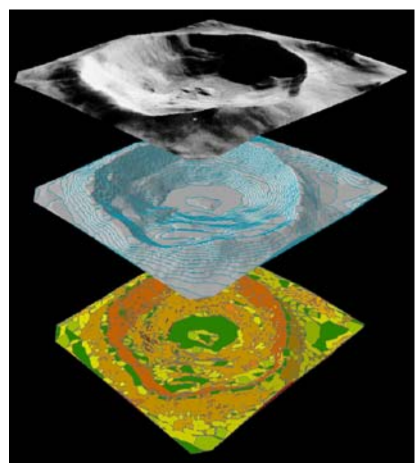

Figure 1. Lalande Crater (~22 km dia.), Top-Sub image of Lunar Orbiter IV 113-H3 draped on DEM generated from the NASA Lunar Topophotomap 77A4S1(50) Laland in ArcGIS, mid.- DEM with 100m contours, bot.-slopes (green<6°, yellow 6°-12°, orange 12°-25°, everything else >25°.

References: [1] Kato M. et al. (2008) *LPS XXXIX* Abs. #1232. [2] Zheng Y. et al. (2008) *Planetary & Space Sci., 56,* 881-886. [3] Goswami M. et al. (2008) *Acta Astronautica,* doi:10.1016/j.actaastro.2008.05.013. [4] Chin G. et al. (2007) *LPS XXXVII,* Abs. #1764.