THE HIGH LAKES PROJECT/SHAGAN INITIATIVE: BRIDGING PLANETS - FROM MARS TO EARTH AND BACK N. A. Cabrol[1], E. A. Grin[1], G. Chong-Diaz[2], C. Demergasso[2], and the HLP Team, [1] NASA Ames/SETI CSC, Space Science Division, MS 245-3, Moffett Field, CA 94035-1000. Emails: Nathalie.A.Cabrol@nasa.gov and Edmond.A.Grin@nasa.gov; Email; [2] Universidad Católica del Norte, Antofagasta, Chile. Emails: gchong@ucn.cl and cdemerga@ucn.cl.

Overview: Funded by the NASA Astrobiology Institute (NAI) between 2003-2008, the High Lakes Project's (HLP) focused on the impact of high UV radiation and climate change on lake habitats as an analog to early Mars [1-3]. Objectives included the identification and characterization of resulting physical, chemical, and biogeosignatures as clues to assess Mars habitability and life potential with current and future missions. HLP explored high altitude lakes (4,500 m-6,000 m asl) in the Central Andes of Bolivia and Chile where environmental conditions are analogous to early Mars [4]. In the process, data showed the impact of a staggeringly rapid climate change *here and now* on our own planet. Bridging planets and going beyond its initial objectives, HLP has added to the body of evidence gathered through atmospheric modeling and studies of glaciers [5] that shows that (a) the Central Andes is one of the regions most affected by climate change with (i) the rapid loss of water reservoirs forecasted to generate massive displacement of populations within 50 years [6-7], and (ii) the modification of biogeochemical cycles and loss of biodiversity yet to be quantified; (b) the tropical latitude and altitude result in some of the most challenging geophysical environments on the planet. Solar irradiance is 170% that of sea level and averaged maximum UV-B reaches $4 W/m^2$. The maximum erythemally-weighted daily dose recorded is ~7 times that of Antarctica during ozone hole events. The atmosphere is permanently depleted in ozone, which falls below ozone hole definition (40% depletion) 33-36 days/year and is between 30-35% depletion the rest of the time. The impact of strong UVB and UV erythemally-weighted daily dose on life is compounded by the broad daily temperature variations with sudden and sharp fluctuations, and an enhanced yearly negative water balance (-1,200 mm/yr average). This year-round combination of variables defines this region as an end-member extreme environment where a substantial fraction of the Andean population lives and works up to 5,000 m asl and is exposed with minimal warning systems; and finally, (c) HLP showed the existence of abundant new species requiring archival before they disappear [8-9].

Current Status: Since 2002, HLP has generated interest beyond the planetary science community. The abundance of new species discovered broadened the range of the primarily physical investigation to include at least an initial inventory before the end of the project. US and foreign limnologists, ecologists, microbiologists including biotechnology, physiologists have joined HLP along with scientists affiliated to NOAA to help assess the impact of climate change, water loss, rapid interannual fluctuations, and facilitate comparison with other regions of the world.

The NAI funding ended in 2008. The HLP team has now submitted two (pending) proposals at the Earth Science Division addressing the carbon and ecosystem responses to environmental changes and the impact of melting ice on lakes in the Central Andes. Both proposal are 3-year studies and are, as a result, limited in scope and areal extent when long-term monitoring is the only method to gain the high-resolution predictive capacity necessary to assess trends, magnitude of changes, and their physical, biological, and societal impact at adequate scales. As environmental changes are affecting the atmosphere, hydrosphere, and biosphere, an interdisciplinary approach is critical to holistically quantify the evolution of climate, water resources, and ecosystems and generate data to critically assess the potential magnitude of the foreseeable crisis and to propose mitigation. This stands true for both Earth and Planetary science missions.

The Southern High Altitude Geosciences and Astrobiology Network (SHAGAN): As a result, we propose to develop SHAGAN, an interdisciplinary project that will cover the Central Andes, Altiplano, and the Atacama. It will use orbital, field, and laboratory methods to generate long-term, interdisciplinary datasets on the impact of climate and environmental change on aquatic habitats and biodiversity, and to develop and maintain a data center that will benefit both NASA's Earth and Planetary Science communities. Because of the multifold analogy of the surveyed area with planetary surfaces, SHAGAN, with one database will support both NASA Space Science Division's effort to understand and model planetary environments, their habitability, evolution, and potential for life, and the Earth Sciences in its effort to quantify the magnitude and impact of climate change. Our objectives are to: (1) *Characterize and quantify the interannual evolution and impact of low ozone and high solar irradiance in Andean aquatic environments*. The high-resolution data collected by a network of UV dosimeter will support NASA's Earth Science Division's global effort to map, understand, and model the rapid evolution of key atmospheric parameters in a sensitive area of the world where a large-scale, high-resolution survey is lacking. In the process, data will provide critical information about the evolution of similar environments on other planets (e.g., the early and present Earth and Mars) and their impact on habitability; (2) *Characterize and quantify the interannual evolution and impact of climate change on aquatic habitats, their chemistry, and water balance*. SHAGAN will monitor the weather, the atmosphere/water interface, and will provide data on how interannual variability affect optical properties and UV penetration in the water column. This will give an insight into the stress experienced by ecosystems exposed to rapid temporal changes in their habitat and their ability to adapt (or lack thereof). These questions are all relevant to planetary exploration, in particular in the context of the decline of aquatic habitats on Mars 3.5 billion years ago as climate changed, and to ozone-free early Earth; (3) *Characterize and quantify biodiversity, life cycles and adaptation strategies in rapidly evolving aquatic habitats*. While obtaining data about the composition, survival abilities, and modification rates of ecosystems, we will catalog known and new species. The results will expand knowledge of the terrestrial biosphere, identify endangered species, and will provide clues to plausible adaptation strategies and shelters used by life on other planets in similar conditions and their biogeosignatures; (4) *Develop and maintain a data center* into a structured website accessible to the science community and public through separate portals.

While stemming from HLP, SHAGAN is far from being a mere continuation. HLP was fundamentally a planetary analog project. SHAGAN will be an integrated, large-scale, high-resolution, interdisciplinary project addressing questions through field and laboratory analytical techniques and methods, top-to-bottom (satellite mission data) and bottom-up (in-situ instruments) approaches across scientific disciplines and NASA's Divisions. It will provide a network of sites for field deployments and remote stations. Expected domains of collaborations include: *Satellite data interpretation* using GFSC and NOOA's archives for atmosphere and climate data context and long-term survey; Shuttle photo archives, ASTER, Hyperion, and IKONOS data for the geological context and long-term evolution of lakes and watersheds; and planetary missions data; *Geophysics*: An array of ground UV-dosimeters will provide transects characterizing solar irradiance and ozone at the atmosphere/water interface, and UV penetration in water; *Terrestrial and Planetary Geology* through sample analysis and analog work; *Limnology and Ecology* through in situ and laboratory sample analysis; *Biodiversity* will be sampled yearly from identical points and characterized using in situ and laboratory inventories, surveys, and molecular genetic markers. Data is expected to provide information on biodiversity, life cycles, its temporal and spatial changes, and its physical and chemical signatures. The identification of these biosignatures will also serve planetary exploration in the search for past and/or present life on other planets; *Planetary Exploration*: The multifold planetary analogy of the investigated areas makes SHAGAN an exceptional training ground for planetary mission instruments, investigation techniques, and for the development of instrument concepts. Data, through the data center, will be also available to external investigators developing analog research in any of the surveyed areas and/or requesting background data for terrestrial and planetary science projects. SHAGAN will require fieldwork at high altitude and remote areas. Like in planetary missions, scientific payload volume and mass are critical and will provide guidelines to develop mission-grade concept payloads. SHAGAN will rely on a network of UV and meteorological stations that can be accessed remotely year-round. The main remote data collection center will be located in the United States. With regular downlinks, issues will be detected rapidly and SHAGAN will benefit from one back-up data center in Chile with a trained technician that can be sent on site and resolve potential issues quickly, thus minimizing potential data loss. *Education & Public Outreach*: Our website will have a public access presenting our goals and objectives. It will have special sections on planetary analogs, current planetary missions, and climate change, with links to critical websites dealing with the subject. As for HLP's students and young researchers will be involved at all levels of the project.

Conclusion: SHAGAN's goals might be reached through the funding of focused, medium-budget proposals responding to several NRAs in both the NASA's Earth and Planetary Science Divisions. However, for scientific continuity and cost effectiveness, this option is less desirable than envisioning the possibility of larger cross-divisions funding that could support such projects benefiting both divisions and fostering greater interdisciplinary collaborations.

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