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Using Satellite Imagery to Map Agricultural Land Use at Lake Titicaca Peru Bolivia

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RCEU Summer 2015 Project Proposal

Title: Using Satellite Imagery to Map Agricultural Land Use at Lake Titicaca, Peru-Bolivia

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Project Summary:

At around 13,000 feet in elevation, Lake Titicaca is an impressive landscape feature that spans the border between Peru and Bolivia and is considered the largest lake in South America. Ancient human populations, including the Inca in the 15th century and the earlier Tiwanaku culture (200-1000CE) flourished in this harsh, arid region by using the lake banks for irrigated agriculture and terracing the adjacent hillsides. Today, populations still live in the area and continue to farm the lakeside and hillslopes, growing primarily wheat and potatoes; however agricultural livelihoods are at risk from decreased glacial runoff (a climatic effect) and water pollution as a result of increasing local populations. These increases in population and climate variations have occurred in the past, and have often been considered part of the reason that civilizations (including the local Inca and Tiwanaku) have collapsed around the lake. In order to understand how contemporary agricultural livelihoods fare in the face of these recurring changes, it is imperative to understand 1) the pattern of agriculture distribution across the landscape and 2) the identification of fields as currently active versus historical and unused. As is highlighted in the image below, the area around Lake Titicaca is covered in the remains of agricultural field walls, some actively managed and some relicts of ancient agriculture. Given relatively low levels of rainfall (averaging around half of our annual precipitation here in Huntsville) and a high elevation (meaning little tree cover), it is possible to use automated processing of satellite remotely sensed imagery to identify the extant remains of agricultural practice in the region.

This project will leverage existing commercial satellite datasets (obtained through a cooperative data sharing agreement with NASA) and Geographic Information System - GIS - computer software to develop ways to quantify ancient and modern agriculture in this region. Satellite imagery will be used geometrically to identify the extents of the field boundary walls as well as spectrally to estimate the amount of vegetation present in the fields, a proxy for whether or not they should be considered actively managed. We will aim to publish the results of this analysis in a leading archaeology journal and leverage the results here for other research initiatives.

Figure 1) Lake Titicaca location in South America and the visual identification of current and historical agricultural terraces.

Student Duties:

To ensure that the student has the appropriate background to conduct the research, the 12-week summer term will be divided into three phases that will scale up from basic literature survey to advanced geospatial techniques.

First phase: the student will work with Dr. Griffin to survey the current literature in archaeology, ecology, agriculture, and public policy journals to get a full understanding of the scope of the problem. The student will get experience writing up a ***literature review*** and will learn how to employ ***bibliographic management software***. This research period will last approximately 4 weeks, culminating in a report on what we know about agriculture in this region, and focusing on how we might identify ancient agriculture using satellite remote sensing.

Second phase: the student will learn ***basic GIS techniques and satellite remote sensing***, focusing on aggregating publicly available data for the Lake Titicaca Basin. This portion of the research will involve interacting with Dr. Griffin's current graduate students and research team, and leveraging desktop and online tutorial materials to learn the basics of the ArcGIS and ENVI software. The student will also learn how to atmospherically correct satellite imagery and why that is important. This phase will again last approximately 4 weeks and will result in an mid-stage GIS database of available data ready for visualization and analysis.

Third phase: this final portion of the research will focus on an advanced geospatial analysis technique known as ***feature extraction***. The student will again be working under the supervision of Dr. Griffin and his current graduate students to learn the basics of feature extraction and how it can be used to identify individual agricultural fields from the satellite imagery. The student will design (with the help of the research team) a workflow proposal to analyze the satellite imagery and quantify the types of agricultural areas both geometrically and spectrally. This final phase will last 3-4 weeks and result in an analysis of agricultural fields for the study region.

Finally, the student will put together the results from each phase into a final report that will be submitted to Dr. Griffin and the RCEU committee. In addition to the RCEU poster session, the student will also be encouraged to reach out via other poster and presentation venues, including the annual UAH Von Braun Symposium and GEOHuntsville Conference. The expectation is that this final report will form the core of a short research publication in the field of archaeology, on which the student will have the opportunity to be a co-author.

Benefit to the Student: The student will get exposure and training on a wide range of datasets and software packages, including ArcGIS, ENVI (+FX), and Zotero; the student will have the opportunity to work as part of a research team, interacting and getting ideas from other undergraduate and graduate Earth science students; the student will also learn how to structure a research question and design to address a question in the Earth sciences; finally, past students who have worked on these projects with Dr. Griffin have gone on to get GRAs through UAH, NASA, and other universities as well as follow-on internships at NASA and elsewhere.

Student Contribution: The student will be a key contributor to this research, getting to do the bulk of the data analysis for this portion of the project in addition to structuring and documenting the methodology.

Faculty Supervision and Interaction:

The student will be supervised throughout the duration of the project by Dr. Robert Griffin. Dr. Griffin has a PhD in environmental archaeology and has worked in the vein of applied GIS and remote sensing in archaeology for over a decade. The student will be assigned a fully-equipped computer in the department's geospatial analysis lab with which to conduct his/her research. Supervision by Dr. Griffin will take place at the NSSTC facility where he and the student will establish best methodologies and review progress in weekly team meetings. The student will also benefit from the presence of Dr. Tom Sever, an environmental archaeologist within the Atmospheric Science Department, who will also be present in the facility throughout the summer. Finally, Dr. Griffin's graduate assistants located in the NSSTC's Human Dimensions, Discovery, and Decision-Making Lab (HD3) will be present throughout the summer and will be available to assist the student as he/she moves through the phases of the proposed analysis.