Accurate Mapping of Ground Control Points for Image Rectification and Holistic Planned Grazing Preparation

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ABSTRACT

Managing livestock grazing for improving or maintaining rangeland condition is controversial and difficult. It has been suggested that holistic planned grazing will not only maintain rangeland condition, but improve it. A study will be conducted by Idaho State University's GIS Center to test this hypothesis. In order to prepare a study area for this experiment some initial ground work was needed. Five centimeter resolution aerial imagery was to be taken of the entire study area to provide visual documentation of the condition of the study area prior to onset of the experiment. Before the imagery was flown Ground Control Points were established and mapped to +/- 2 cm accuracy using survey grade GPS. Fences that split the study area into two separate pastures were mapped using GIS and marked in the field using GPS for navigation. Pre-study ground truth data was taken at 100 different locations throughout the study area. At the conclusion of this project, the study area was ready for the holistic planned grazing experiment.

KEYWORDS: Planned grazing, GIS, Ground control points

INTRODUCTION

Range management is the manipulation of rangelands to produce goods and services for society. There are two basic components of range management. They are "(1) protection and enhancement of the soil and vegetation complex, and (2) maintaining or improving the output of consumable range products, such as red meat, fiber, wood, water, and wildlife" (Holecheck et al., 2001). Managing livestock grazing for improving or maintaining rangeland condition is controversial and difficult. There are differing theories as to what biological processes are affected by grazing and which grazing systems have the least affect on these processes (Walker, 1995).

One grazing technique that has been suggested to recoup natural vegetation is holistic planned grazing (Savory and Butterfield, 1999). This method for managing rangelands requires high intensity grazing for short durations. The high intensity grazing breaks up crusted soil and standing senesced vegetation through trampling. The trampled vegetation becomes litter which covers the bare land. Litter conserves soil moisture by reducing evaporation, protects soil from heat and adds nutrients to soil through decay (Williams et al., 1993). The protected soil is then more suitable for growing new vegetation.

A study implementing planned grazing will be conducted by ISU's GIS Training and Research center to test the effectiveness of planned grazing in restoring natural vegetation. Before implementing the planned grazing study some preparation work needed to be performed.

The purpose of this project was to prepare an area for a holistic planned grazing study where the effects of the grazing could be monitored and analyzed using geotechnologies. Pre-study five centimeter resolution aerial imagery was taken to establish visual documentation of the condition of the land prior to the study. To accomplish the purpose of the project and to ensure accurate georectification of the imagery ground control points (GCP)s had to be established and their exact spatial location recorded; fences needed to be planned, mapped, and erected within the study area and initial ground truth data had to be collected. The preparation work was completed during the summer months (July and August) of 2005.

METHODS

Aerial imagery was flown over the entire study area. Ten GCPs were setup strategically throughout the flight path in a pattern recommended by the vendor, 3Di Corporation. The location of the GCPs and the boundary of the O'Neal study area are shown below (figure 1). The GCPs were setup using two strips of reinforced plastic, six inches wide and six feet long, laid across each other in the shape of a cross (+). All GCPs were oriented with each arm of the cross pointing in one of the four cardinal directions (north, south, east, west). Each GCP was covered with chicken wire and staked down with eight inch spikes to ensure it would remain in place. After placement of each GCP a GPS location was recorded at the center of the cross using a Trimble GeoXT GPS unit.

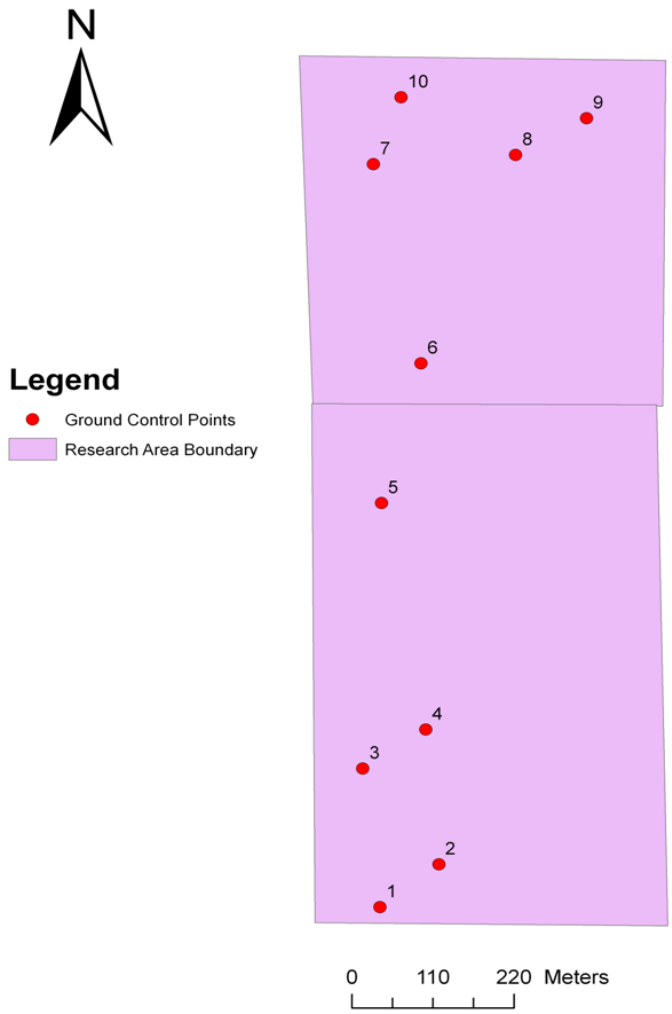

Figure 1. O'Neal study area ground control point locations

The Trimble GeoXT GPS receiver is capable of (+/-0.7m with a 95% CI) using native latitude-longitude (WGS 84)(Serr et al., 2005). In order to georeference an image with five centimeter resolution, GCP's with +/- 3.4 cm accuracy was required. To collect GCP locations to satisfy this requirement, survey grade GPS units were needed. The units chosen for this were Leica SR530 units capable of (+/- 0.1m @ 95% CI) (Serr et al., 2005). Two units were needed; one to be used as a base station and one to be used as a rover. Note: the total station was required as real-time correction signals were not available in the somewhat remote study area.

The Base station occupied a previously surveyed BLM survey monument (Township 8, Range 36 E NW 1/16 section 26 E, year 2002), so future work could be executed using location information collected from this project. The base station was started and allowed to collect static observations (positions) for at least two hours. Multiple positions were recorded so averaging could be performed to obtain the precise location of the base station.

Using the Trimble GeoXT unit each of the previously installed ground control points was located from records taken at the time of installation. The Leica SR530 rover GPS unit was connected to a two meter tall antenna. The base of the antenna was set in the center of each GCP using the spike or re-bar as the reference. The rover collected locational information from satellites and from the base station. At least 40 positions were recorded at each GCP location so they could be averaged for an accurate (+/- 3.4 cm) determination of the center of the GCP.

Location data collected by the base station and rover was downloaded in the lab by technicians using Leica Ski_Pro software. Each Leica SR530 was connected to the desktop computer in the lab and data was transferred from the storage card in the unit to the hard drive of the desktop. The positions were then viewed as points on a map and as a table with their coordinates and other information listed.

The downloaded raw data was sent to the Online Positioning User Service (OPUS) to be corrected based on the positions recorded by the base station, the known location of the survey marker and three Continuously Operating Reference Stations (CORS) sites (http://www.ngs.noaa.gov/OPUS/What_is_OPUS.html). The corrected data was accurate to +/- 2 cm which was better than the 3.4 cm accuracy required. These data were used for georeferencing the aerial imagery by 3Di Corporation.

Fencing of the study area to ensure that only holistic planned grazing would take place was the next step. Fence lines were drawn inside the boundary of the property using ArcGIS software. The study area was split into two pastures, one to be grazed holistically (north pasture) and one to be rested (south pasture). The fence lines were flagged every 50 feet within the study area by using a Trimble GeoXT for navigation. The fencing was then completed by an independent contractor, Pro-tech fence of Blackfoot, Idaho.

One-hundred sample points were randomly generated across the study area; twenty five points were generated within the south pasture; fifty points were generated within the north pasture; and 25 points were generated outside the pastures within a BLM grazing allotment that implements traditional rest-rotation grazing. Each point met the following criteria; 1) >70 meters from an edge (road, trail, or fence line) 2) <750 meters from a road. Ground truth data was collected according to methodology used by ISU's GIS TReC (Sander and Weber, 2004).

RESULTS

Upon completion of this project the aerial imagery (figure 2) was successfully co-registered and delivered. Pre-grazing ground truth data is available, and the study area is fenced, ready for grazers.

Figure 2. Aerial imagery of the O'Neal study area

DISCUSSION

Establishing easily visible GCPs whose location information is accurate to +/- 2 cm allows for very accurate georeferencing of the five centimeter resolution aerial imagery. The accurate imagery can now be used to create a vegetation census of the O'Neal study area. The high resolution imagery will also provide a good visual documentation of the condition of the land prior to the planned grazing study and can serve as a reference in future years.

The next step of the project is to erect GCPs that can be detected within the 2.4 m resolution of Quickbird satellite imagery. A very accurate rangeland health model has been created using Quickbird imagery. One problem with this imagery, however, is that exact co-registration of Quickbird imagery with patchy targets (e.g., new weed infestations) was difficult due to its high spatial resolution. Highly visible, large ground control points (GCP) would enable the imagery to be accurately georeferenced and co-registered with field observations located using GPS. Accurate georeferencing will result in a more accurate model which will result in more conclusive evidence of changes within the O'Neal study area due to planned grazing.

The GCPs erected for the Quickbird imagery will need to be much larger than the ones created for the aerial imagery. The techniques used for establishing the accurate location of the GCPs this year, however, can be used for mapping the new GCPs that will be erected in the future.

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