Mapping of Earth Flow Displacements

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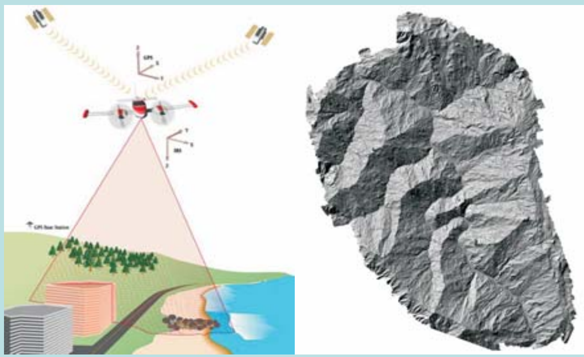
INTRODUCTION

The objective of this project is to determine how far the earth flows on the North fork of the Eel River, CA (right) have moved since the early 1990s. To accomplish this, we've compared aerial photos of the area taken on July 26, 1991 by WAC Corporation of Eugene, Oregon to LIDAR data collected on September 24-26, 2006. By measuring the displacement of trees and large boulders on the flow, we can determine not only the distance traveled, but also the approximate speed of the flow.

LIDAR

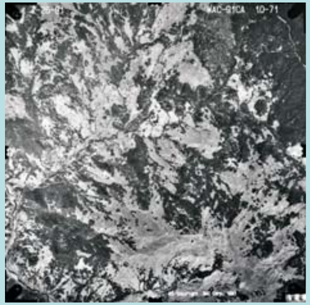
The technology that makes this approach possible is the relatively new Light Detection And Ranging (LIDAR) systems. With the help of GPS satellites, base stations and high-speed computers, an airplane can fly over the desired area at relatively low altitude while swiping a laser over the ground in a side to side motion, collecting elevation data in rapid succession. This technique is sometimes known as Airborne Laser Swath Mapping (ALSM).

LIDAR was chosen for this project because of its extremely high accuracy and detail. The data that we were working with had one meter resolution, meaning that the laser gave an elevation reading once every square meter. At this resolution and covering approximately 250 square kilometers, our LIDAR map (below-right) and all of its accompanying files required about 9GB of space. An interesting thing about LIDAR is that sometimes the laser beam penetrates the canopy, therefore you can use sophisticated algorithms to remove the trees and just see the bare landscape underneath, which is ideal for identifying earth flows.

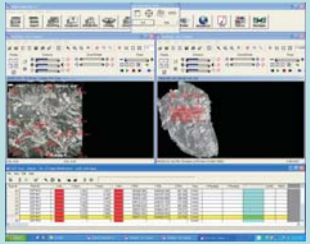


PROCESS

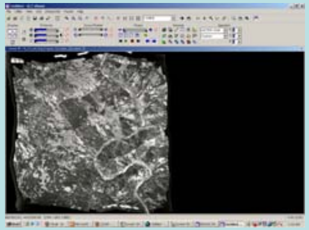
In order to compare the aerial photos to the LIDAR, first the photos must be orthorectified to remove any distortion. For this task we used a program from Leica Geosystems called ERDAS IMAGINE 9.1



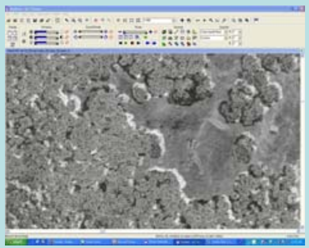
First, both the LIDAR data and the photo are opened in separate viewers in IMAGINE. Then we collected at least fifty Ground Control Points (GCPs) from all over the photo, while also locating them on the LIDAR. This tells the computer how to stretch or compress the photo in order to make it match the LIDAR.



After all of the GCPs are in place, the resample button is clicked and the photo begins to rectify. Because the photo was scanned at 2400 dpi, rectification can take up to 5 minutes.

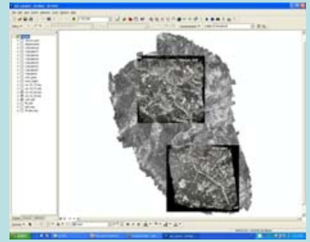


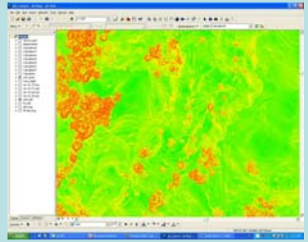
Finally, we can open both the photo and the LIDAR in the same viewer to compare them and see if the photo rectified properly. By changing the transparency of one or the other, we can see how well they match up and determine if the photo must be rectified again.

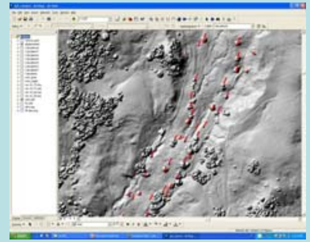


RESULTS

After the photos were rectified and inspected, it was time to load them, along with the LIDAR data, into another GIS program called ArcMap. Because the photos are automatically positioned over the correct spot on the LIDAR (right), we could immediately start making vector maps of the earth flow displacements (below-right). With the help of a slope map derived from the LIDAR to identify trees (below), we collected as many displacement vectors as possible.







FUTURE WORK

As this project continues, we will analyze soil samples taken from the two main earth flows on July 29 – August 2, 2007 (right). The large chunks of soil (below-right) will be coated and weighed under water to measure density, and the bags of loose soil from various depths (below) will be subjected to a series of chemical tests to measure the concentration of certain elements. The hypothesis here is that specific elements are more abundant near the toe of the earth flow due to gradual buildup over time.