



Data Collection and Processing Report for the NAPA River Watershed

Funding Agency: Napa County, CA

Disclaimer: This report was generated on Jan 25, 2013 almost 10 years after project data was collected and processed and for that reason this report is unusual and incomplete. This project was not funded by NSF and occurred prior to NCALM's establishment as an NSF center. This project was a joint venture between research groups at Earth and Planetary Science Department at University of California at Berkeley and the Civil and Coastal Engineering Department at the University of Florida.

1. LiDAR System Description and Specifications

This survey was performed with an Optech 2033 Airborne Laser Terrain Mapper (ALTM) serial number 98b110 mounted in a twin-engine Cessna Skymaster aircraft (Tail Number N337P). The instrument nominal specifications are listed in table 1.

Operating Altitude	300-2000 m, Nominal
Horizontal Accuracy	1/5,500 x altitude (m AGL); 1 sigma
Elevation Accuracy	5 - 35 cm; 1 sigma
Range Capture	2 range measurements per pulse: first and last returns
Intensity Capture	12-bit dynamic range for first and last returns
Scan FOV	0 - 40 degrees; Programmable in increments of ± 1 degree
Scan Frequency	0 - 40 Hz
Spot size	0.18 m at 600 m AGL
Pulse Rate Frequency	33 kHz
Position Orientation System	Applanix POS/AV
Laser Wavelength/Class	1054 nanometers / Class IV (FDA 21 CFR)
Beam Divergence nominal (full angle)	Divergence 0.3 mrad (1/e)

Table 1 – Optech ALTM 2033 specifications

See <http://www.optech.ca> for more information from the manufacturer.

2. Area of Interest.

The survey area is defined by a polygon enclosing the Napa River Watershed from Calistoga, CA to San Pedro Bay. It contains approximately 1130 square kilometers. Approximate dimensions of the polygon are 70 km northwest to southeast and 19 km southwest to northeast. The location and extent of the polygon is shown below in Figure 1.

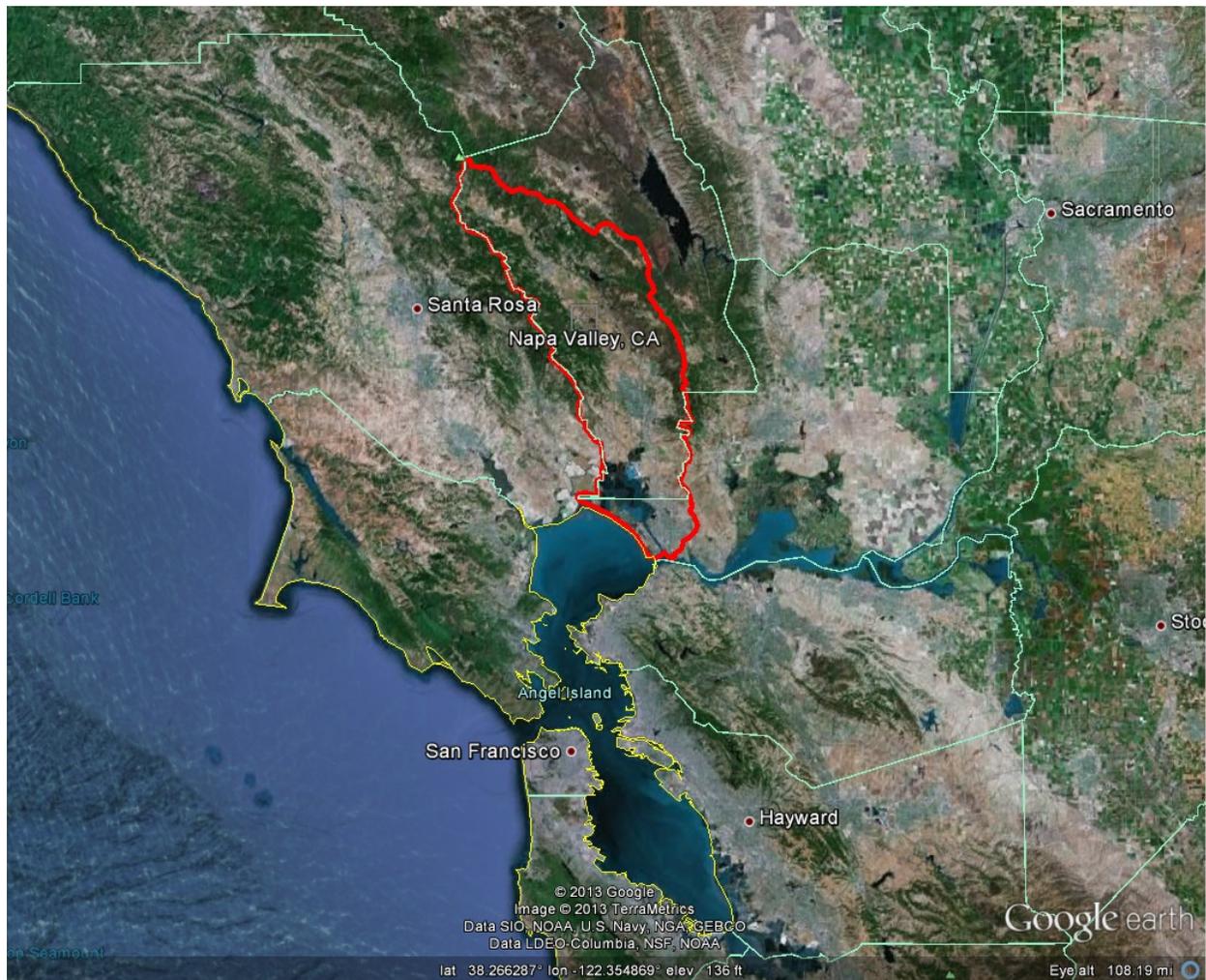


Figure 1 – Shape and location of survey polygon (Google Earth).

3. Data Collection

- a) **Survey Dates:** The survey took place from May 15, 2003 – June 1, 2003 and required 14 survey missions. The plan consisted of 129 project flight lines and about 30 addition densification lines added in the northwest mountainous section and along the major drainages. Figure 2 (below) shows the project polygon in green, the flight lines in red, and the densification lines in black. Cross lines in the northwest corner are also shown in red.

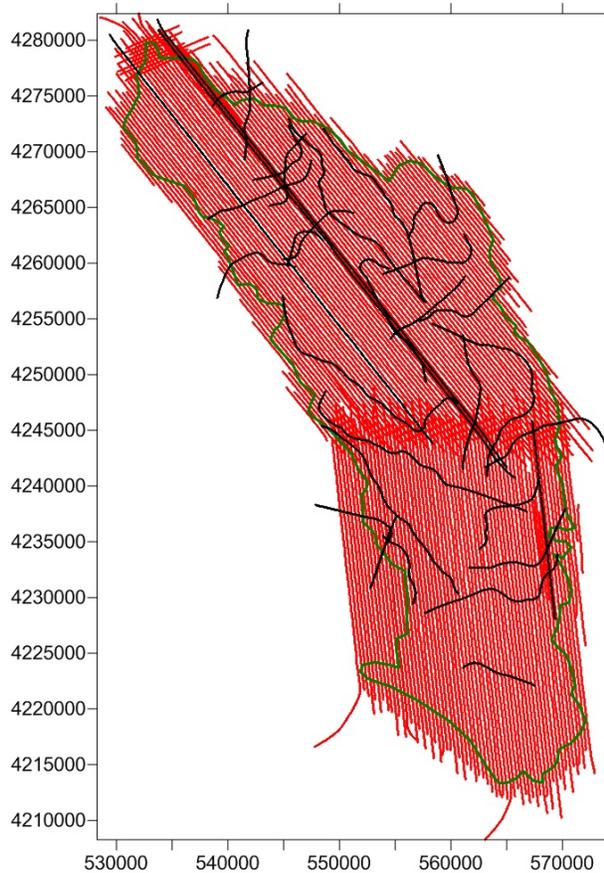


Figure 2 – Flight lines for Napa River Watershed project plotted from processed trajectories and trimmed to show laser-on positions only. Flight line spacing was 325 m (UTM Zone 10 meters).

b) Airborne Survey Parameters: The survey parameters are provided in Table 2 below

Nominal Flight Parameters		Equipment Settings		Survey Totals	
Flight Altitude	700m AGL	Laser PRF	33 kHz	Total Flight Time	42.8 hrs
Flight Speed	60 m/s	Beam Divergence	0.3 mrad	Total Laser Time	27.5 hrs
Swath Width	470 m	Scan Frequency	28 Hz	Total Swath Area	1350 km ²
Swath Overlap	33%	Scan Angle	± 20°	Total AOI Area	1130 km ²
Point Density	~1.3 p/m ²	Scan Cutoff	0.5°		

Table 2 – Survey Parameters and Totals.

c) Ground GPS: Three GPS reference station locations were used during the survey. All ground GPS observations were logged at 1 Hz. Table 3 gives the coordinates of the stations, and Figure 3 shows the location of the GPS stations with respect to the project area.

GPS station	NAPA	GAMB	SPOT
Operating agency	UF	UF	UF
Latitude	38.2161255048	38.4267249285	38.4977696082
Longitude	-122.2722878967	-122.3737808690	-122.4785483084
Ellipsoid Height (m)	-22.247	2.611	56.766

Table 3 – GPS Coordinates of ground reference stations

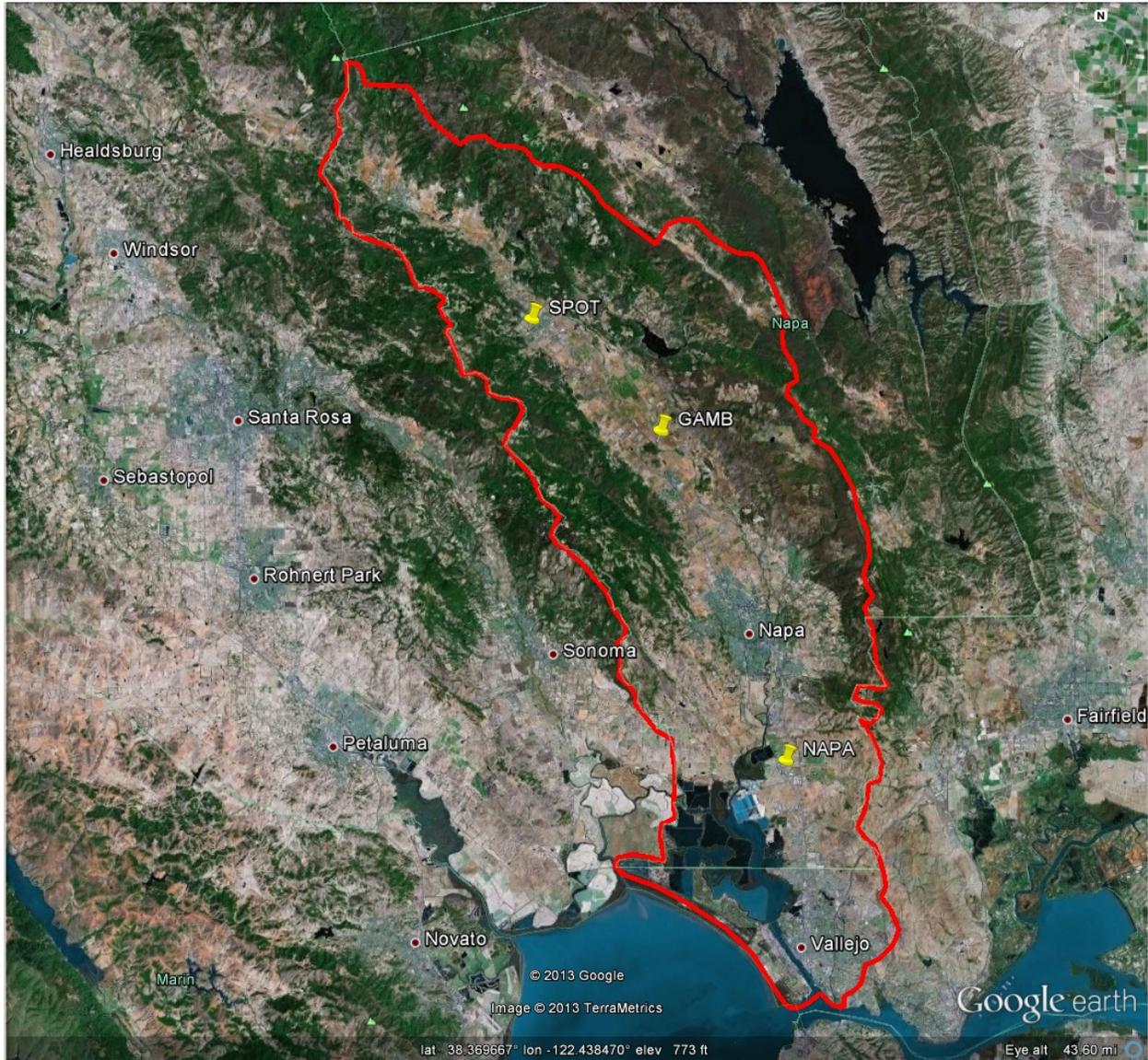


Figure 3 – Locations for the three GPS Reference Stations used in the survey (Google Earth).

4. GPS/IMU Data Processing

Reference coordinates for all NCALM stations are derived from observation sessions taken over the project duration and submitted to the NGS on-line processor OPUS which processes static

differential baselines tied to the international CORS network. For further information on OPUS see <http://www.ngs.noaa.gov/OPUS/> and for more information on the CORS network see <http://www.ngs.noaa.gov/CORS/>

Airplane trajectories for this survey were processed by Dr. Gerald Mader himself of the NGS Research Laboratory using his own creation: KARS (Kinematic and Rapid Static) software. KARS kinematic GPS processing uses the dual-frequency phase history files of the reference and airborne receivers to determine a high-accuracy fixed integer ionosphere-free differential solution at 1 Hz. All final aircraft trajectories for this project are blended solutions from the three stations.

After GPS processing, the trajectory solution and the raw inertial measurement unit (IMU) data collected during the flights are combined in APPLANIX software POSpac which implements a Kalman Filter algorithm to produce a final, smoothed, and complete navigation solution including both aircraft position and orientation at 50 Hz. This final navigation solution is known as an SBET (Smoothed Best Estimated Trajectory).

5. LiDAR Data Processing Overview and Accuracy Assessment

The point cloud was produced by REALM software (Optech) in flight strips ASCII 9-column format.

Calibration for systematic biases in the two boresight angles of roll and pitch was done by graphical means using profiles cut from project lines and perpendicular cross lines. The scanner mirror scale factor was calibrated using profiles of flight strips over water surfaces.

An accuracy assessment was performed by using check points collected by kinematic GPS with a roof-mounted GPS antenna on a car driven on paved roads near the Napa airport. Heights of nearest neighbor LiDAR points from 2 different mission flights were differenced with heights from these check points using 16 separate flight strips: two strips from DOY 137 and 14 strips from DOY 138. LiDAR neighbors were constrained inside a 0.50 m x 0.50 m search square surrounding each check point. Three statistics were computed from 1506 height differences (Laser point height– Check point height). The average difference was -0.012 m. The standard deviation of these differences was 0.074 m and the RMS was 0.075 m.

Classification of ground points was performed by a variety of algorithms developed at both the University of Florida and the University of California at Berkeley.

A LiDAR point cloud and derived DEM will have visible artifacts if it is examined at a sufficiently fine level. Examples of such artifacts include visible swath edges, corduroy (visible scan lines), and data gaps.

A detailed discussion on the causes of data artifacts and how to recognize them can be found here:

http://ncalm.berkeley.edu/reports/GEM_Rep_2005_01_002.pdf .

A discussion of the procedures NCALM uses to ensure data quality can be found here:

http://ncalm.berkeley.edu/reports/NCALM_WhitePaper_v1.2.pdf

6. Data Deliverables

All deliverables share common datums as follows:

- a) **Horizontal Datum:** NAD83
- b) **Vertical Datum:** NAVD88 (GEOID 99)
- c) **Projection:** UTM Zone 10N
- d) **Units:** Meters
- e) **File Format:**
 - Point cloud in ASCII format.
 - A classified last return dataset (no first return, i.e. canopy top, data included)