Integration of Airborne Lidar and Ground Survey Data within the CHaMP Monitoring Program

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Why?

Knowledge of integration of Airborne Lidar and ground based surveys will become necessary as the Champ program progress's and the data sets become available. The broad expanse of Airborne Lidar provides data far beyond the typical Champ ground based survey. Often the Lidar data includes the entire floodplain up to some distance onto the adjacent hill slope and in some cases the entire watershed.

The typical Champ topographic extents is limited by time constraints. Crews generally survey in channel attributes to the top of bank and then a limited distance onto the floodplain. This strategy leaves the possibility that the stream may alter course into an area that was not previously ground surveyed. The presence of Airborne Lidar data in area outside the extend of the ground based survey offers the opportunity to quantify geomorphic change outside the extents of the previous ground surveys.

The advantages of ground based survey techniques are the ability to survey the wetted portion of wadeable streams, cost, accuracy and the control of timing. Collection of Lidar is dependent on the weather and the schedule of the contractor hired to collect the data, while collection of ground based data is much less dependent on weather and can be timed to coincide with other Champ data collection efforts. The cost to hire a ground based crew, cost of the equipment and logistical cost are much less then that of Lidar. The accuracy of ground based data is about twice as good as Airborne Lidar data outside the wetted channel. The use of Lidar data in the wetted channel is dependent on the type Lidar being used, the wetted depth, and water clarity. While blue-green lidar will function in wetted areas the accuracy is less then that of ground based surveys in wadeable streams. Red lidar does not have water penetrating capabilities therefor it will not return any data for bedform under water.

When stream location relative to other attributes is important Lidar provides valuable geomorphic context that is not available from the Champ ground based survey. Bigger "picture" attributes like valley form, alluvial fans, terraces, adjacent slopes, vegetation height, can all be gained from lidar data.

The chicken or the egg, which is first and does it matter?

The ground based data or the Airborne Lidar data can be collected first.. It is more efficient if the Lidar is completed first because the Lidar coordinate system is established in a manner that is more accurate then the coordinate systems developed with CHaMP protocol. Therefore all Champ ground based survey data will need to be surveyed in or moved to the Lidar coordinate system. Moving the ground based data can be completed using tools available in Arc GIS, but it is a time consuming proposition to move a validated database and associated rasters, and tins. Champ has not developed a tool for this purpose. Any watersheds initiating the CHaMP protocol that already have Lidar data are encouraged to utilize the Lidar coordinate system upon commencing ground surveys.

Data Review

A thorough review of all survey data available for the watershed should be conducted to determine a refined strategy. The time required to integrate data will be dependent on: Watershed size, geomorphic configuration, location of Lidar control within the watershed, tree canopy, vehicle access, and amount of data to integrate.

Utilizing lidar Control

Within the Champ Program the Lidar control will always take precedence over any Champ Coordinates derived from a handheld GPS device. The Lidar coordinate system is developed using dual frequency receivers collecting static data and the static data is processed using triangulation with the CORS system This type of data processing creates UTM coordinates that are much more accurate relative to the world than the UTM coordinates from Champ supplied handheld devices.

Extending Coordinate System/Control

The Lidar control will be used as the basis for future surveys. Extending the Lidar control to Champ reaches can be accomplished using rtk-GPS. The rtk base is set on a control point established during the Lidar flight. The coordinates for the Lidar control will be in the Lidar report. If the champ reaches are not within radio reception of the rtk base, more control will need to be set which allows the extension of the Lidar control system into additional parts of the watershed. The setting of additional control should be done in a manner that allows for the best radio reception over long distances. Usually this can be accomplished by setting control on ridges (that intersect the valley).

Surveying Existing Champ Control

The Champ benchmarks for each reach will need to be surveyed in the Lidar coordinate system. Wherever possible, depending on satellite visibility, using the rtk rover to survey the benchmarks will be the most efficient option. Satellite visibility will be a function of tree canopy and valley confinement. Alternatively, using the rtk, control can be set as close as possible to Champ reaches and then a TS can be used to survey the benchmarks. Every benchmark set at a site since 2011 should be staked out and searched for with a magnetic locator. Missing benchmarks can be found by noting the northing and easting deltas of found benchmarks and applying similar deltas to missing benchmarks. Missing benchmarks can often be found using this method. Locating all the benchmarks at a site will aid in resolving data problems during site transformations.

Future Topo Surveys

All surveys conducted after the Lidar coordinate system is established should be conducted in the lidar coordinate system or transformed to the lidar coordinates system.

Ground Truthing

Ground truthing is the process of checking ground survey data relative to air-borne data. For Champ this can be accomplished during the survey of the benchmarks. Collection of topographic or ground data should be conducted in locations where it is expected that Lidar data and rtk-GPS data will have the best chance to agree. This would be areas with good visibility to satellites

which will also have good visibility to the laser on the aircraft. when red lidar data is being checked the ground truthing should be done out of the channel in the flood plain and on terraces. When Green Lidar is being checked in channel areas with good sky visibility as well as on the floodplain and terraces. The ground truthing data should be collected through-out the study area.

Previously Collected Topo Data

Ground Survey data that was collected before the Lidar data must be transformed to the lidar coordinate system for utilization of the Lidar data. This means all champ data for each reach within the study area will need to be transformed to the lidar coordinate system. The exact same rotation and translation should be applied to each years survey of a champ site if the same benchmark coordinates were used for every years survey.

Here are two of the many possible transformation scenarios.

1) It is possible to move the validated gdb, rasters and regenerate tins in GIS. I found this to be very time consuming and the potential for mistakes is not acceptable.

2) I typically revert to a coordinate file and dxf breakline file and perform the transformation in Foresight, Magnet tools or LGO. Then reprocess the data in the champ tool bar.

If a site has previous benchmark problems the problems are likely to remain after rotation and translation and may be exacerbated unless additional steps are taken to resolve benchmark problems.

The parameters for each site will be different.

The Champ transformation tool does not allow the user to control the rotation or translation values and therefore should not be used.

Lidar data variability

- Champ watersheds may not be in same coordinate system as the lidar data. 10 vs 11 vs 12.
- Multiple flights in the same area may not be in same coordinate system. 10 vs 11 vs 12.
- Multiple flights in the same area with same coordinate system may use a different coordinate for the same base point.
- Each flight (lidar data set) may require different transformation parameters for the same Champ visit.

Warning:

Utilization of lidar from a flight requires utilization of the coordinates from the Lidar flight report for that particular flight.

Using any other coordinates will introduce additional error.