



# COST-TIERED GPS UNIT THREE-DIMENSIONAL CAPABILITY COMPARISONS AND TESTING

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## ABSTRACT

Handheld Global Positioning System (GPS) units are thought to be less accurate than professional grade GPS units, but little research has been done to determine the three-dimensional accuracy of equipment grade in terms of cost. By collecting three-dimensional geospatial data with multiple GPS units of differing grade, digital elevation models can be created to compare and analyze the degree of accuracy of each unit. The Garmin eTrex, Garmin Montana, and Trimble XR models were taken into the field to create base data to be converted into three-dimensional elevation models. These GPS units range in value from thousands of dollars (Trimble XR) to just a couple hundred dollars (Garmin eTrex). The three created elevation models will then be compared to each other, as well as USGS elevation maps, to see which models are most accurate and consistent to the known base elevations.



TRIMBLE PROXR  
COST: \$10,995



GARMIN MONTANA 600  
COST: \$489



GARMIN ETREX LEGEND  
COST: \$179

## CONCLUSIONS

It is clear that cost plays a large role in GPS accuracy. The data collected from the Trimble ProXR is clearly the most accurate, the Garmin Montana 600 as the second most accurate, and the Garmin Etrex Legend the least accurate. This is especially profound in Table 1 when the standard deviations and range are examined.

It is quite possible that the data collected with the Trimble ProXR is more accurate than the base dataset; over 700 elevation values were recorded, where the USGS dataset only had 46.

Both the Garmin Montana 600 and Garmin eTrex are not differentially corrected and have barometric altimeters (elevation is measured by air pressure relatively - as air pressure decreases, elevation increases). This may play a large role in three-dimensional modeling, but less so in two-dimensional position acquisition.

Overall, the Garmin eTrex is a great value, even though it is the least accurate. If the barometric altimeter were calibrated more carefully, the accuracy would likely increase. However, for serious three-dimensional mapping, the Trimble ProXR is the obvious choice. The Garmin Montana 600 was had moderate accuracy, but it was found to be very user-friendly, with a touch screen and a good display of basemaps.

## METHODS

- The study area (Figure 1) was first chosen because of its relatively forest-free nature and distinct elevation change.
- USGS data was chosen as baseline data, as it is not collected with GPS units, but usually collected by remote means.
- The data were collected in the field with the three GPS units in a consistent 5 horizontal line by 5 vertical line fashion (Figure 1). In other words, the study area was divided into a 5x5 grid. The Trimble ProXR data was collected Wednesday, April 11th and the Garmin Montana 600 and the Etrex were both collected on Wednesday, April 18th.
- The data were downloaded into shapefiles, imported into ArcMap 10.0, and preprocessed. The elevations were converted from meters to feet and the points were kept to a consistent study area.
- Triangulated Area Networks, or terrain models, were created in ArcMap (Figure 2), then converted into a raster format (cell grid) (Figure 3).
- The rasters were reclassified into 32 categories (1-32) so data analysis could proceed. Raster math needs integer values as opposed to elevation values.
- The reclassified rasters were subtracted from the USGS raster (Figure 4); the difference between each cell of the reclassified rasters from the USGS reclassified raster was found.
- Summary statistics were run in ArcMap (Table 1) to create quantitative comparisons between GPS units.

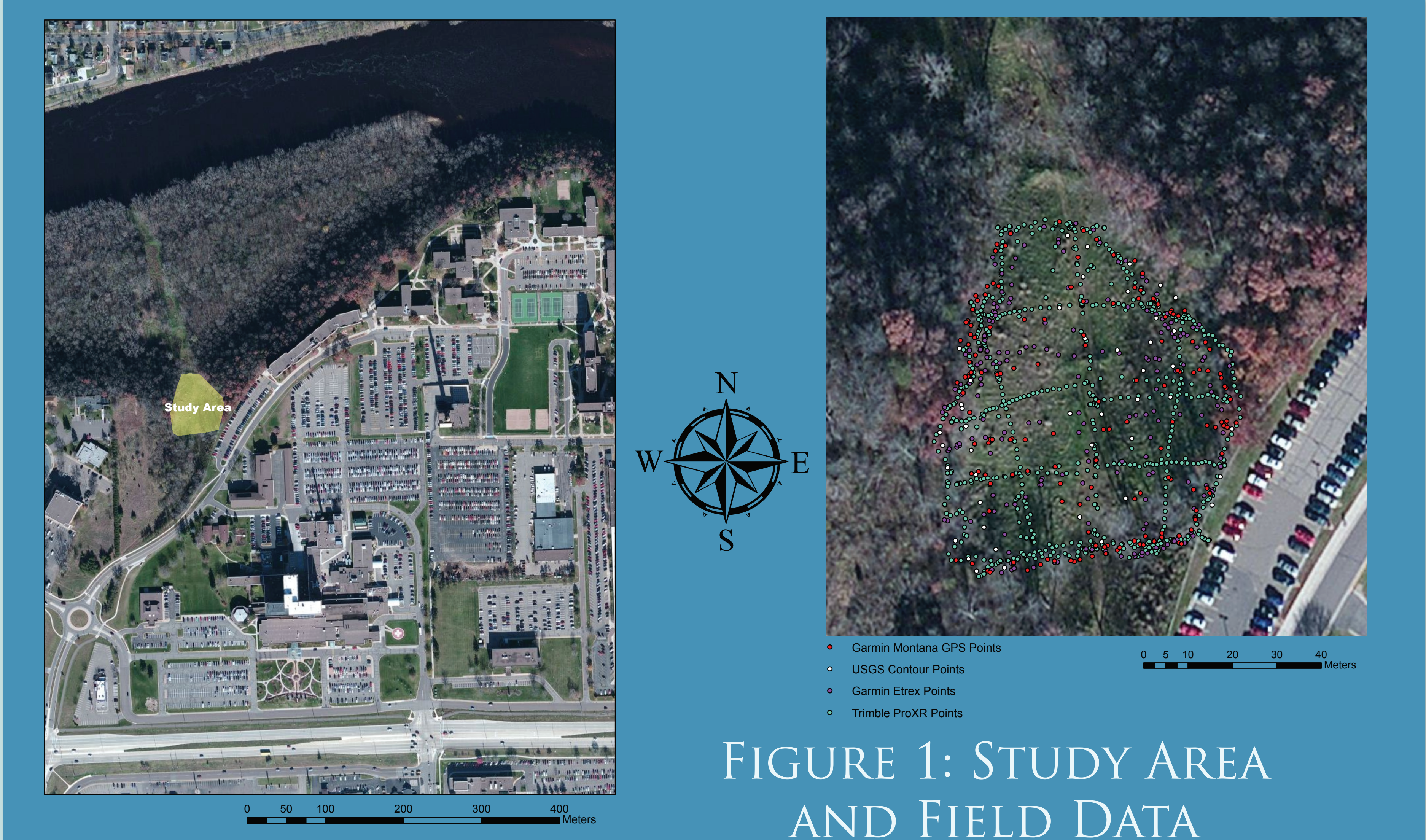
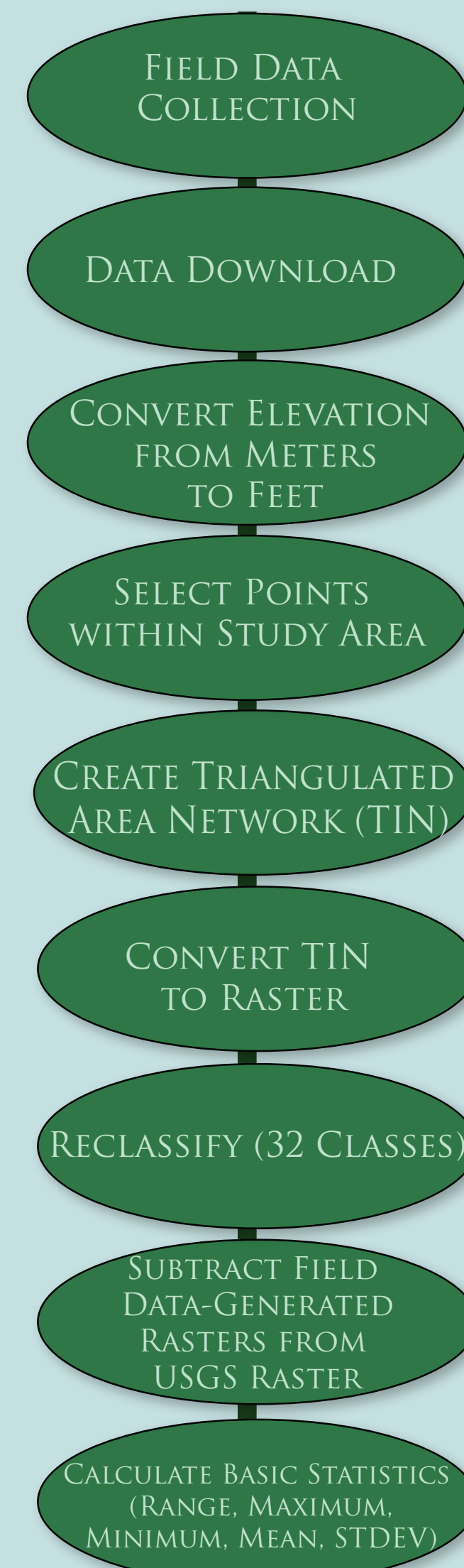
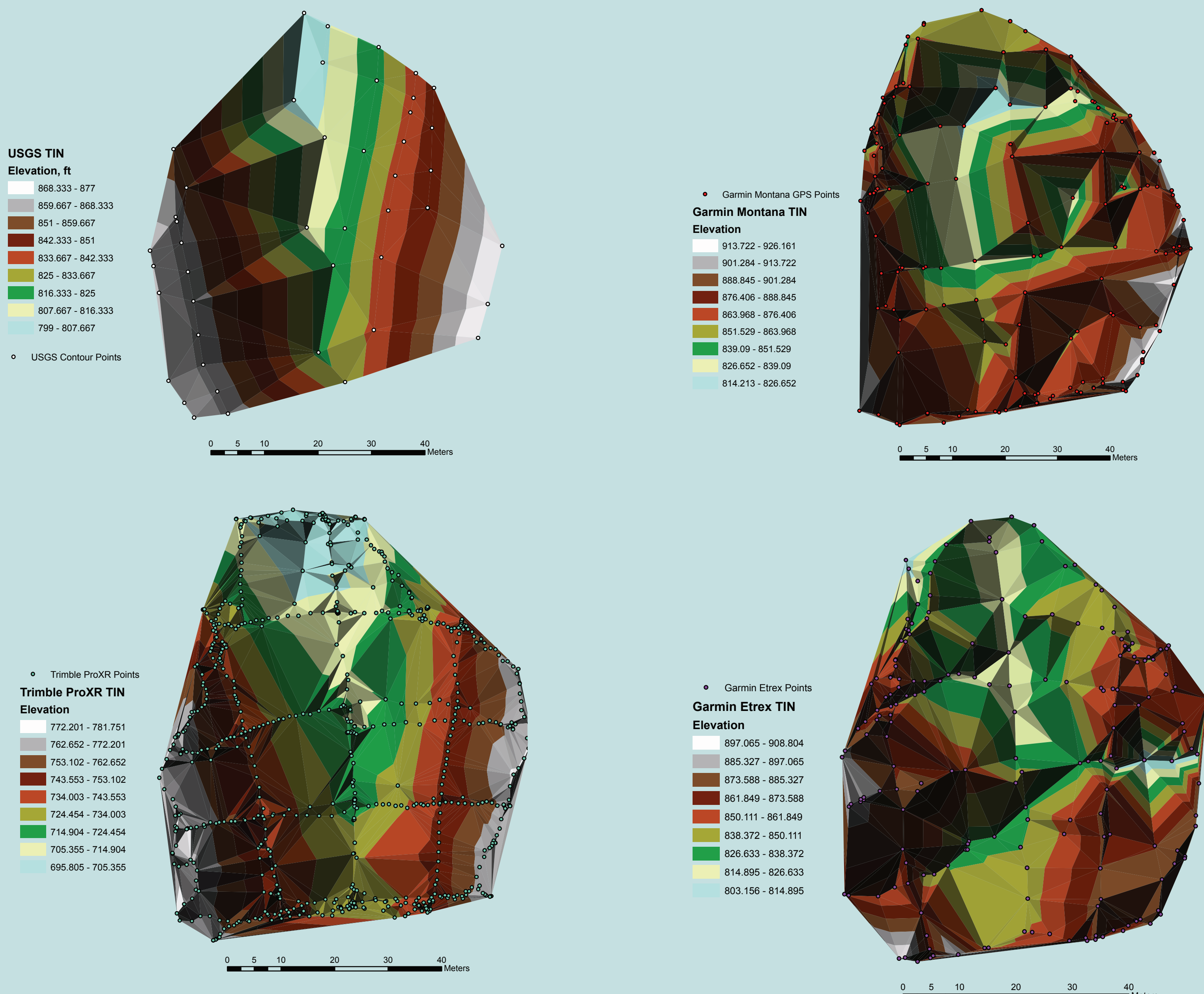


FIGURE 1: STUDY AREA AND FIELD DATA

FIGURE 2: TRIANGULATED AREA NETWORKS



## RESULTS

FIGURE 3: RASTERS

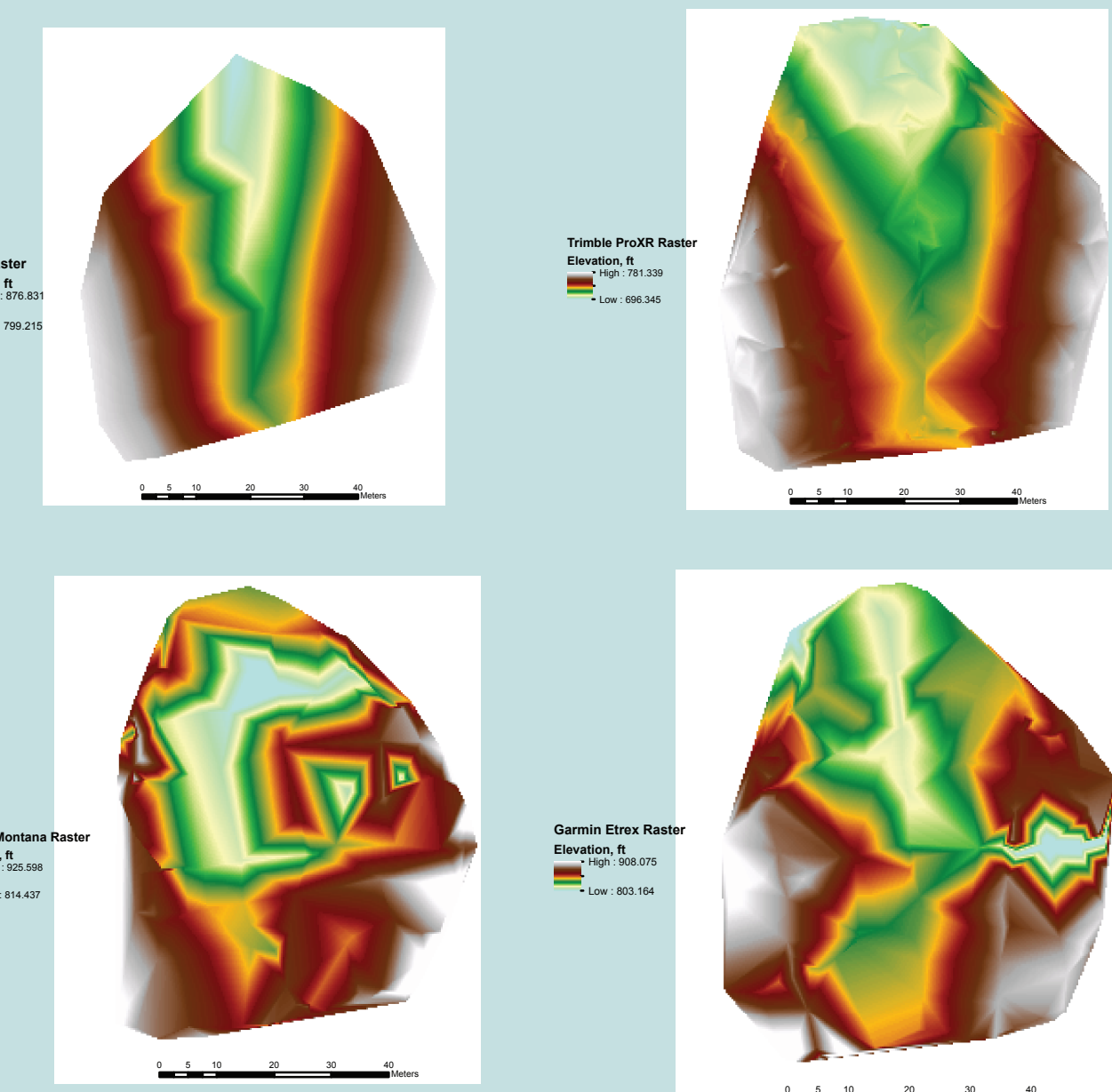


TABLE 1: COMPARISON SUMMARY

	Trimble ProXR	Garmin Montana	Garmin Etrex
Minimum	-6	-15	-29
Maximum	5	13	8
Mean			
Difference	-0.5	-1	-10.5
Standard Deviation	3.605551	8.514693	11.113055

FIGURE 4: COMPARISON RASTERS

