# White Point Landslide: Analysis of Surface Change


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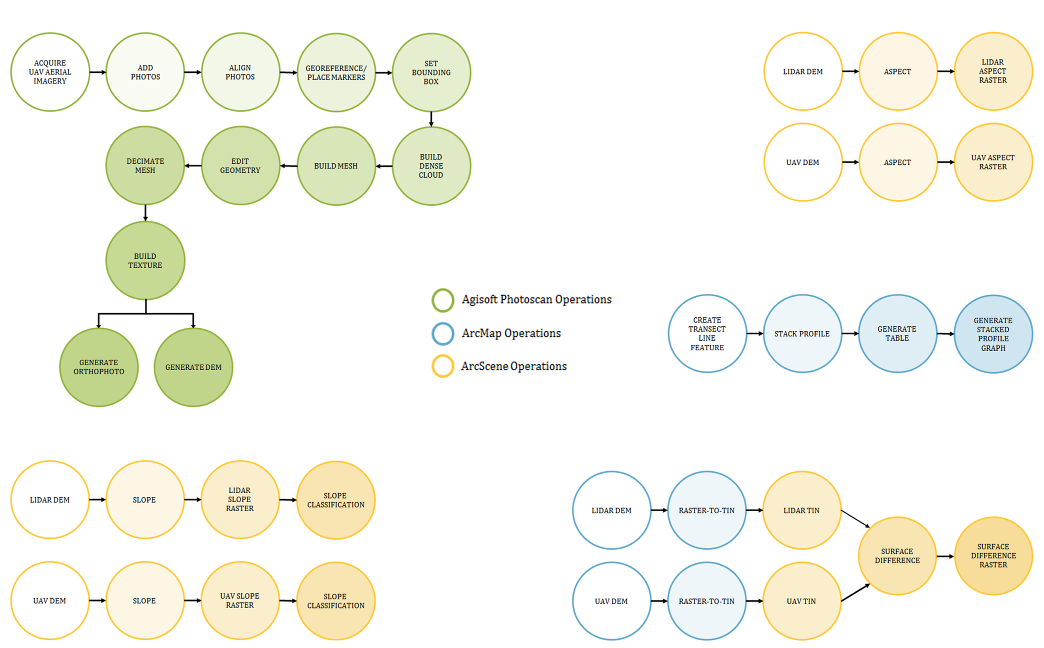
## INTRODUCTION

The White Point Landslide is located on the Palos Verdes Peninsula, in the San Pedro area of the City of Los Angeles. The recent landslide occurred on November 20, 2011, involving portions of the broad flat mesa, coastal bluff, and roughly 420 feet of the Paseo Del Mar roadway. The underlying bedrock of the Peninsula is highly susceptible to landslides and several other landslide events have taken place in recent years.


Through the use of Unmanned Aerial Vehicles (UAVs), photogrammetric processing, LiDAR, and 3D geospatial technology, the change in surface of landslide areas can be determined. Elevation surfaces of the White Point area preceding and following the 2011 landslide were generated using these methods. The surfaces were compared through a series of spatial analyses and 3D visualizations.

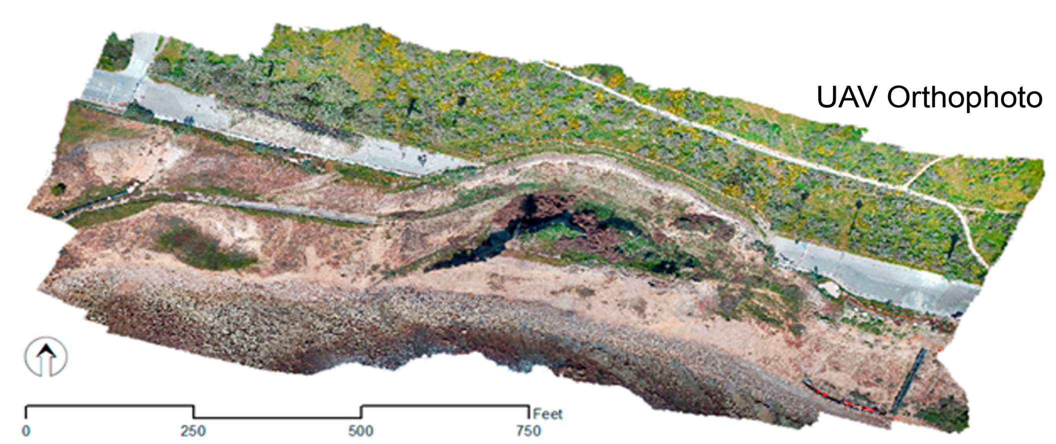
## METHODOLOGY

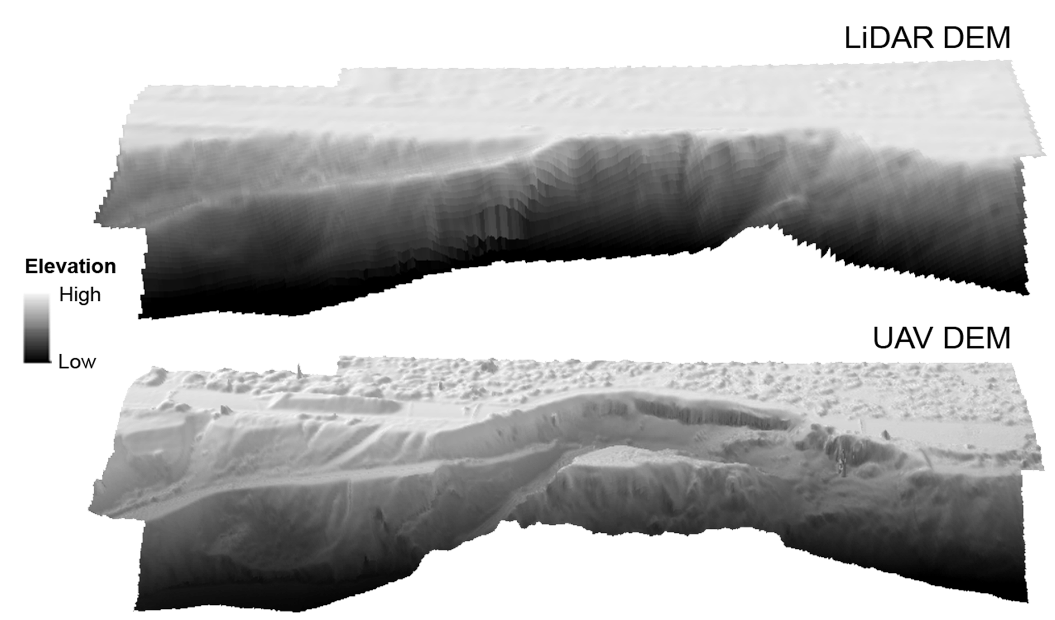


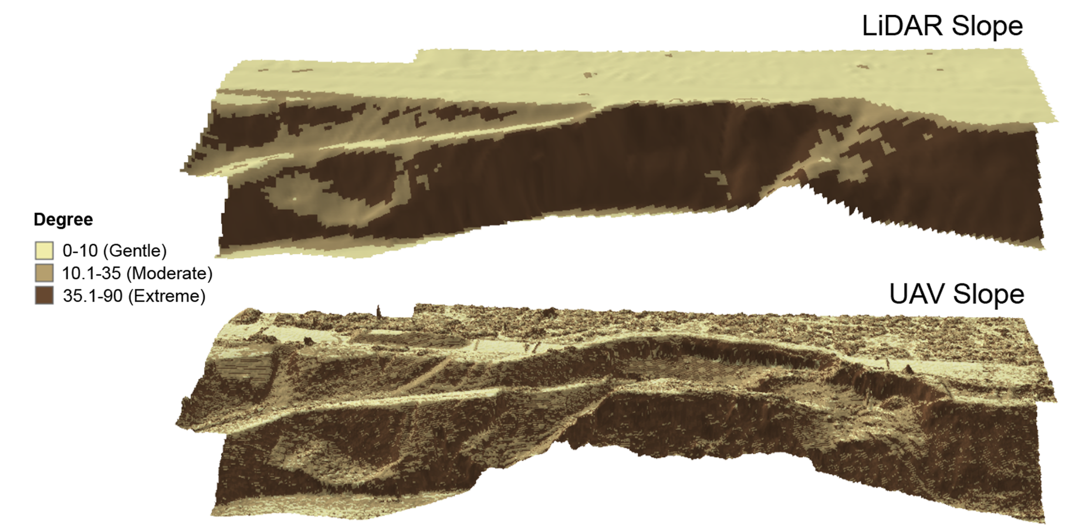
A 2006 LiDAR DEM and UAV aerial imagery from 2015 of the White Point landslide site were acquired. A DEM and orthophoto were generated from the UAV imagery, using photogrammetric processing software. The 2006 LiDAR DEM was used as the reference surface prior to the 2011 landslide and the 2015 UAV DEM was used as the target surface resulting from the 2011 landslide. The DEM surfaces were compared using a transect line and a stacked profile graph was produced. The LiDAR and UAV DEM surface slopes and aspects were also compared. The DEM surfaces were converted to TINs in order to calculate the volumetric surface difference of the White Point site, resulting from the landslide.

## RESULTS

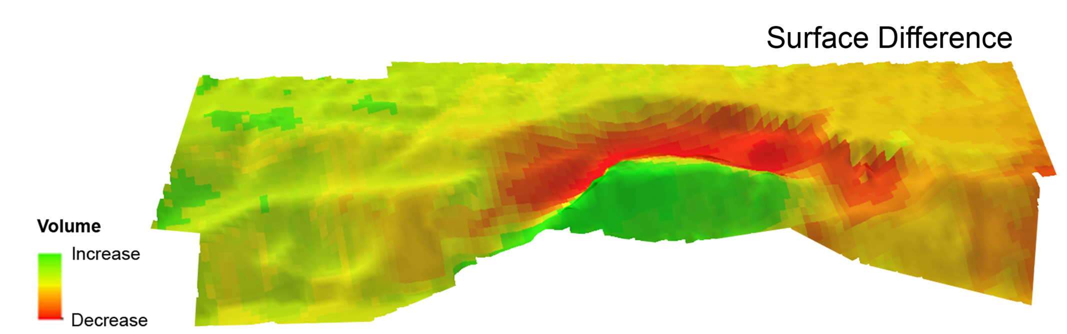
The orthophoto produced from the UAV imagery is high quality and aggressively filtered. The impact of the 2011 landslide on the Paseo Del Mar roadway is noticeably visible and the resulting slump block is shown on the DEM.

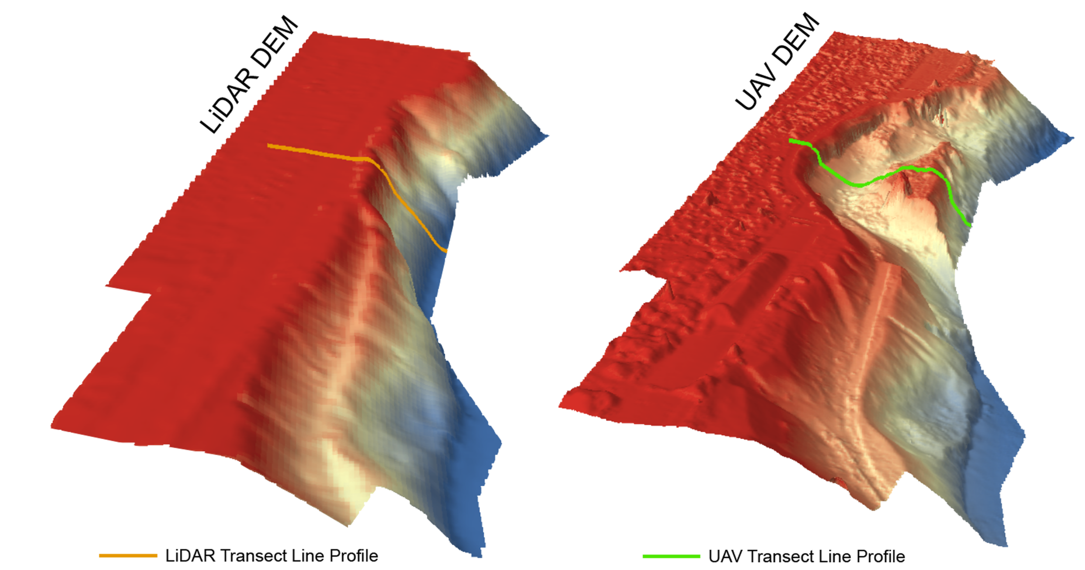


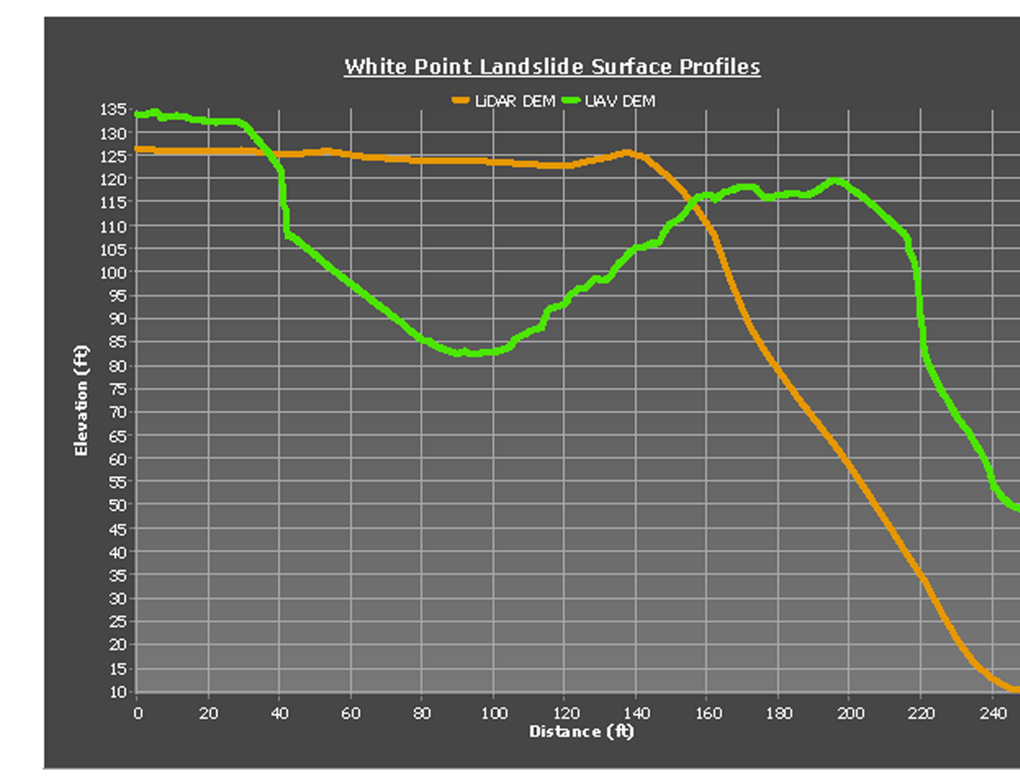




Slopes of the LiDAR DEM and UAV DEM are classified as gentle, moderate, and extreme. The landslide increased the surface area of the site, thereby exposing more moderate slopes along the coastal bluff. The results of the surface difference between the LiDAR and UAV DEMs determined that roughly 1,300,000 $ft^3$ of the surface decreased in volume, while approx. 4,000,000 $ft^3$ increased in volume due to the 2011 landslide. A stacked transect line was used to calculate the surface profile shifts in elevation and distance. The bluff moved 80 ft. toward the shoreline.



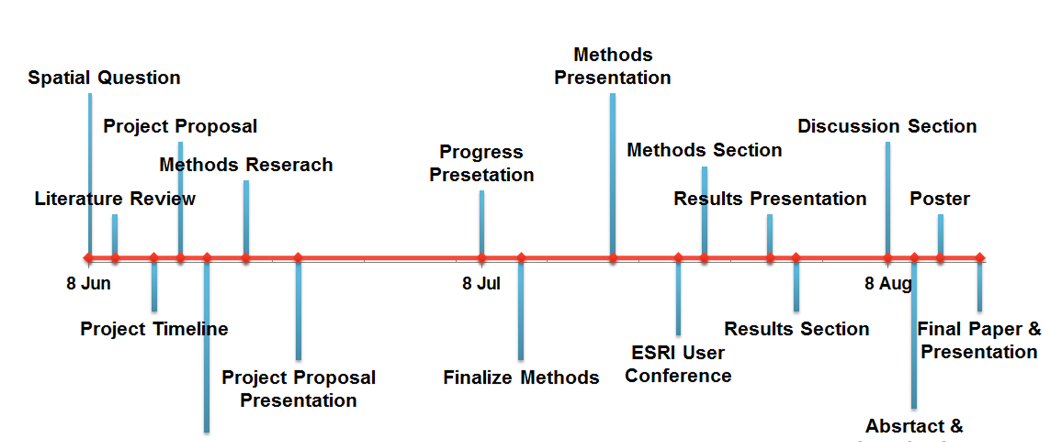




## DATA & DATA SOURCES

The LiDAR DEM and Los Angeles County orthophoto were acquired from the Los Angeles Region Imagery Acquisition Consortium. The UAV aerial imagery of the White Point Landslide area was collected using a Phantom 1 quadcopter on February 14, 2015.

| Dataset | Source |
|---|---|
| LiDAR DEM | LARIAC 1 (2006) via CSULB |
| Los Angeles County Orthophoto | LARIAC 1 (2006) via CSULB |
| UAV Imagery | Dr. Lipo, Dr. Lee, Dr. Wechsler, and CSULB |

## TIMELINE




## DISCUSSION

The presence of vegetation within the UAV surface model effected the volumetric surface comparison to the LiDAR TIN, adding volume to the overall "increased volume" statistic and contributing to uncertainty in the surface difference results. Comparing a bare earth representation of pre- and post-landslide surfaces might produce a more accurate result. Student licenses and access to CSULB acquired data and software negated all financial costs associated with this project. The UAV was operated following established AMA regulations.


Photo Credit: Tom Kantor White Point Landslide April 2, 2012; before mitigation efforts

## CONCLUSION

Methods for quantifying surface changes due to landslide events are relevant to hazard mitigation, geologic monitoring, and geospatial visualization applications. The use of UAV-derived surfaces for quantifying change was explored. Future work would include the LARIAC 2015 LiDAR DEM (expected in fall 2015). Using the 2006 LiDAR DEM and the 2015 LiDAR DEM as the pre- and post-2011 landslide surfaces for comparison, the accuracy of the UAV-derived surface could be better quantified. Additional UAV imagery of the White Point site should be collected using ground control points, with vegetation classified and masked, to produce a more accurate UAV-derived DEM. The UAV-derived DEM and the 2015 LiDAR DEM could be compared to assess the accuracy and viability of UAVs for DEM creation and landslide assessment. The methods applied can be used to assess surface change due to future landslides and geologic activity along the Palos Verdes Peninsula and in other locations.

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