EDITING OF LIDAR DEM TO INCORPORATE THE EFFECT OF DRAINAGE SYSTEMS IN CATCHMENT DELINEATION IN URBAN AREAS: A TEST CASE IN THE UNIVERSITY OF SAN CARLOS – TALAMBAN CAMPUS, CEBU CITY

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ABSTRACT: A catchment area represents a region which drains its surface water to a common outlet. In a natural catchment, where the path of the water follows the steepest slope of the natural terrain, the delineation of this region can be done by using LIDAR Digital Elevation Model (DEM). In developed areas where drainage systems are put in place, the draining of the water is altered by the elements of these systems and since these elements are usually placed under the ground surface the LIDAR DEM cannot capture the information needed to describe the influence of these elements in the draining process. As a consequence using the LIDAR DEM alone in delineating catchment area in regions undergoing development may not provide reliable result. In this study, catchment area of the University of San Carlos-Talamban Campus (USCTC) was delineated using HEC-GeoHMS 10.2 in ArcGIS 10.2. The delineation makes use of a LiDAR DEM with a 1 meter resolution. The location and elevation of different elements of the drainage system in the campus were gathered in the field and the data were incorporated in the DEM using the trend interpolation tool in ARCGIS 10.2. The result was a LIDAR DEM with channels to represent the drainage system. Simulation results of HEC-GeoHMS have shown that channelized LIDAR DEM yielded better representation of the actual flow of water than the unedited LIDAR DEM.

1. INTRODUCTION

In describing the terrain of the study area, an elevation model was used. HEC-GeoHMS makes use of a Digital Elevation Model or also known as DEM. In this study, a LiDAR generated DEM was utilized.

In the Philippines, the LiDAR technology is used in the PhilLiDAR Project of the Department of Science and Technology which is funded by the Philippine Council for Industry, Energy, and Emerging Technology Research and Development. The project aims to produce high-resolution flood hazard maps for the river basins in the Philippines. The project is spearheaded by the University of the Philippines – Diliman. The University of San Carlos is one of the participating Higher Education Institutions and is in charge of the river basins in Region 7.

The digital elevation model or DEM used in this study was acquired from the Phil LIDAR 1 Project. The DEM however does not take into consideration the drainage systems as they are not captured during the acquisition of the data since they are located beneath the surface of the earth. The flow of water in the catchment is affected by these drainage systems especially in urban areas. To represent their effect, the LiDAR DEM was edited using surveyed points along the drainage line.

The study was conducted in the University of San Carlos – Talamban Campus, Cebu City. There are seven buildings in the campus and most of the area is already paved and concreted. The university also constructed a retention pond out from its old soccer field to collect rainfall runoff and lessen flooding in the area.

2. METHODS

In this section, the procedure of editing the LiDAR DEM is discussed as well as the delineation of catchment using HEC-GeoHMS 10.2 in ArcGIS 10.2.

2.1 Editing of LiDAR DEM

Drainage lines of the study area have been incorporated to the DEM. Several points were surveyed to represent the elevation of the drainage system in USC - TC. The file was in shapefile format and was imported in ArcMap. Figure 1 shows the shapefile format of the drainage system overlain in USC-TC LiDAR DEM while Figure 2 shows validation points acquired during the survey. In the attribute table of the point shapefile, Northing, Easting and Elevation of the point can be viewed.

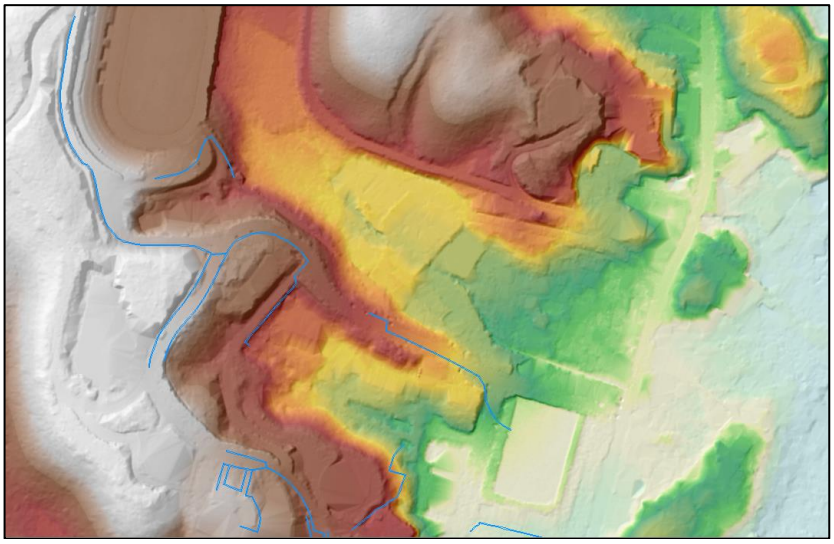

Figure 1 Drainage system in USC-TC DEM

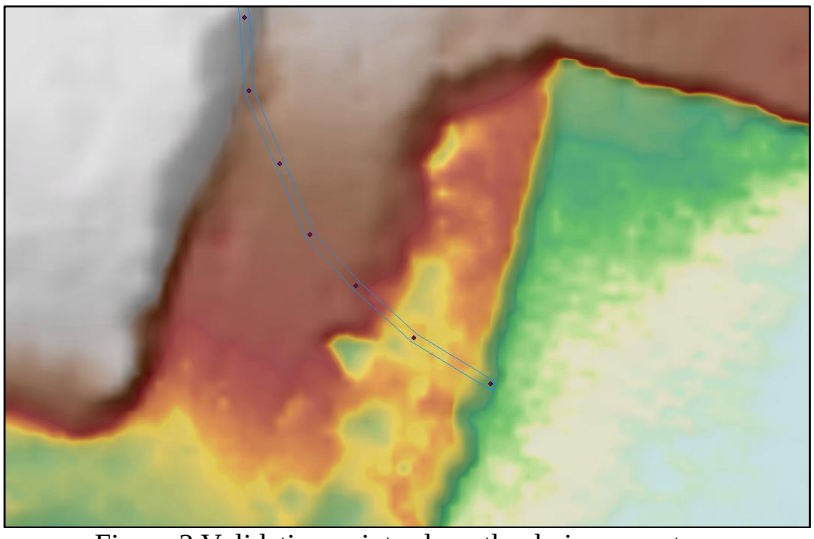

Figure 2 Validation points along the drainage system

The grids along the drainage lines are then removed from the DEM. This was done by using the raster calculator tool. The output DEM without data along the drainage system is presented in Figure 3.

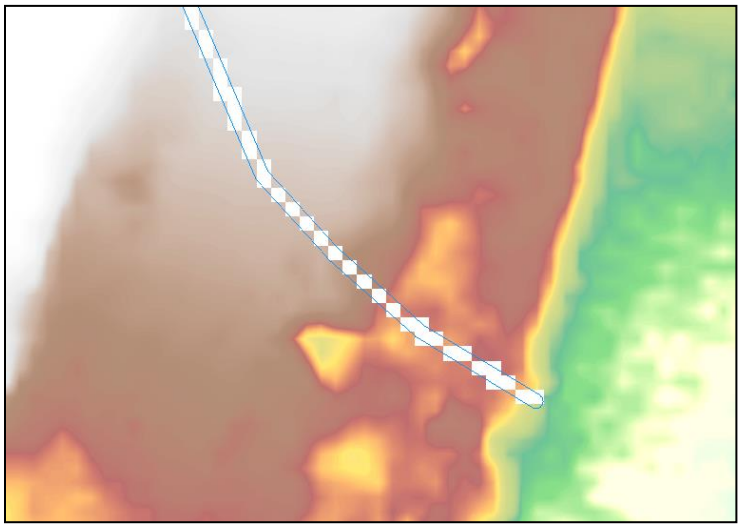

Figure 3 USC-TC DEM without drainange system

A raster of the drainage line was created representing the surveyed elevation along the drainage system. The data was interpolated by using the trend interpolation tool. This can be observed in Figure 4. The drainage system raster however does not display smooth edges because it is in grid format. The drainage system raster is then patched to the DEM.

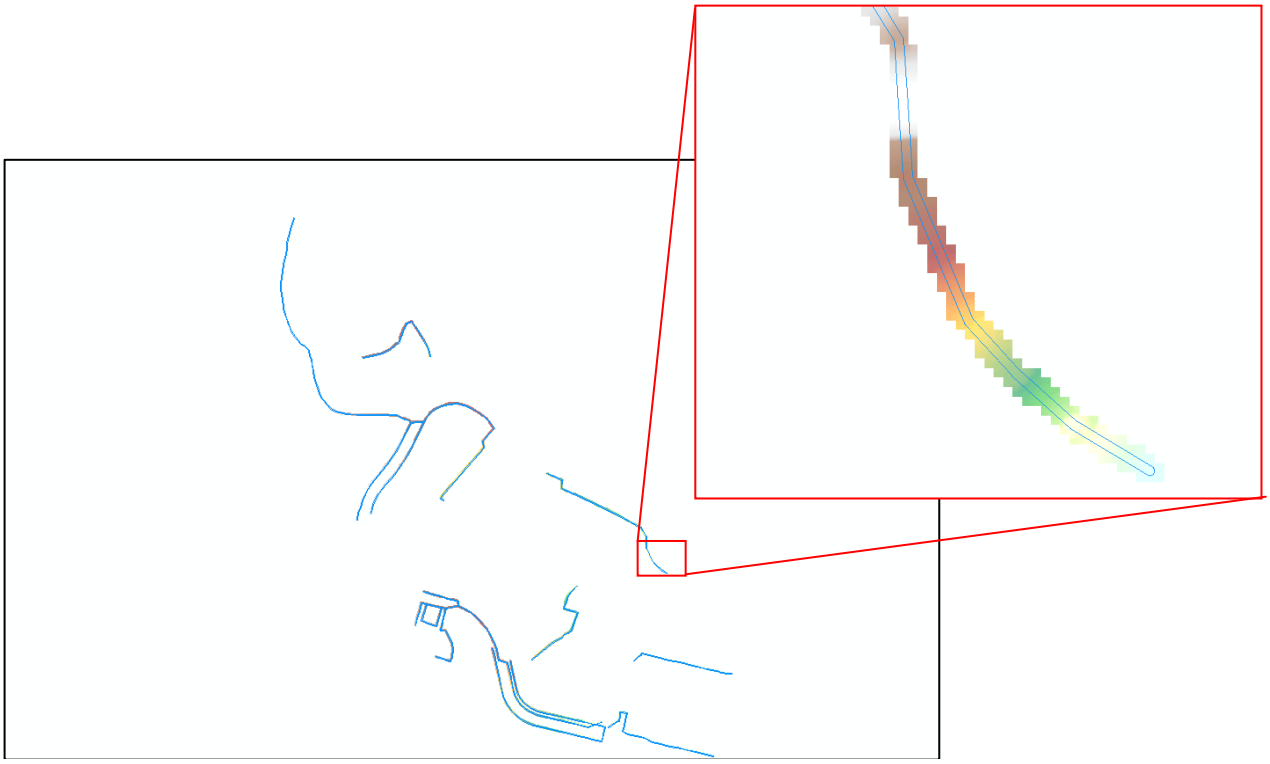

Figure 4 Raster along the drainage system

2.2 Catchment Delineation

LiDAR DEM is used as input to derive nine additional datasets which are filled DEM, flow direction, flow accumulation, stream definition, stream segmentation, watershed delineation, watersheds and streams. These are all performed using HEC-GeoHMS 10.2 in ArcGIS 10.2. In this study, two delineation of catchment was performed – one using the edited DEM while the other using the unedited DEM.

3. RESULTS AND DISCUSSIONS

After editing the LiDAR DEM to incorporate the elevation along the drainage system, the DEM will appear channelized. This can be observed in Figure 5. The unedited DEM was placed beneath the edited DEM for better comparison.

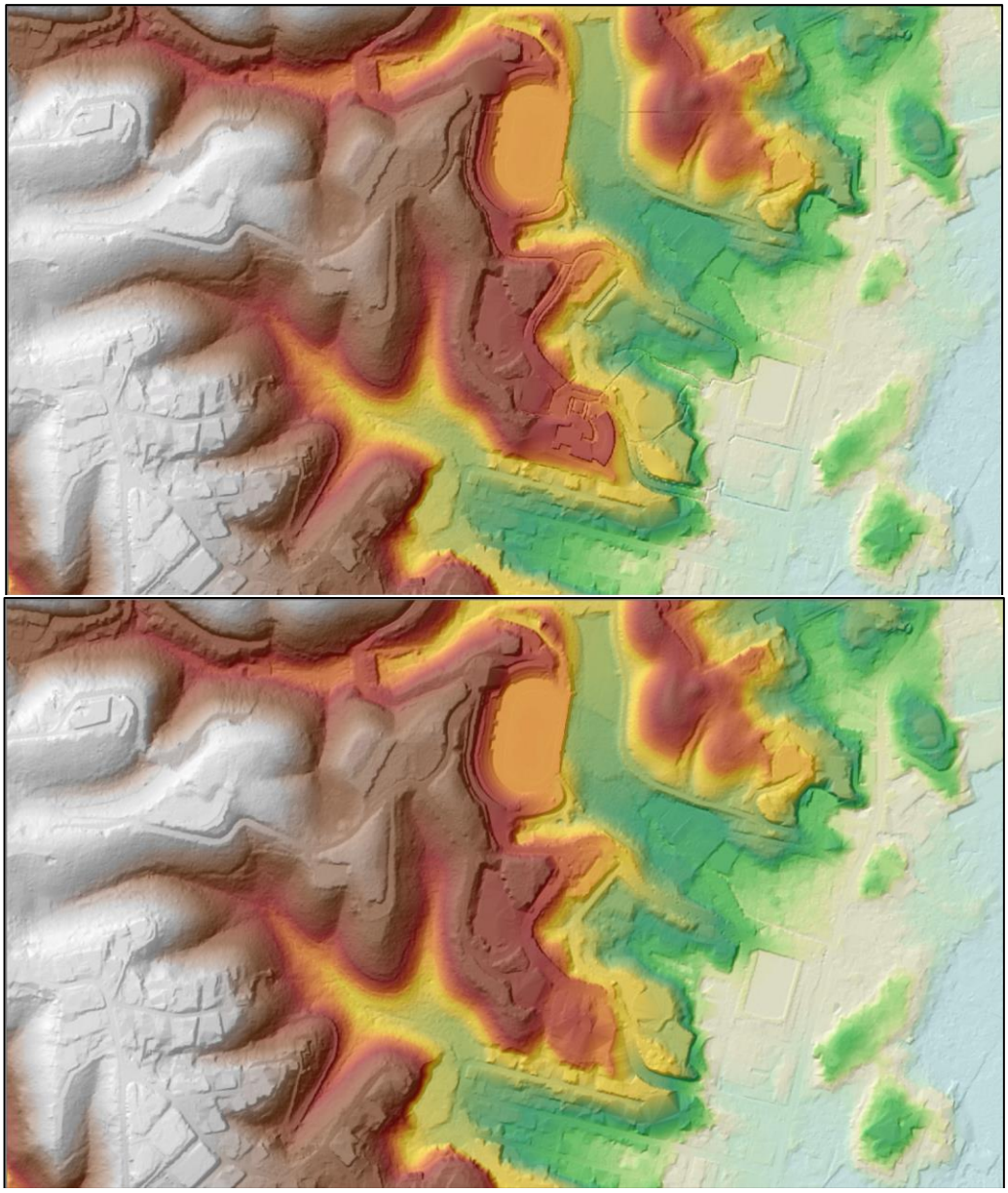

Figure 5 Top: Edited LiDAR DEM; Bottom: Unedited LiDAR DEM

The two DEMs were subjected to HEC-GeoHMS processing for watershed delineation. Both underwent the same process. In Figure 6, the two HEC-GeoHMS-generated draiangelines were overlain. It is noticeable that the drainageline of the edited DEM follows the actual drainage system in the study area.

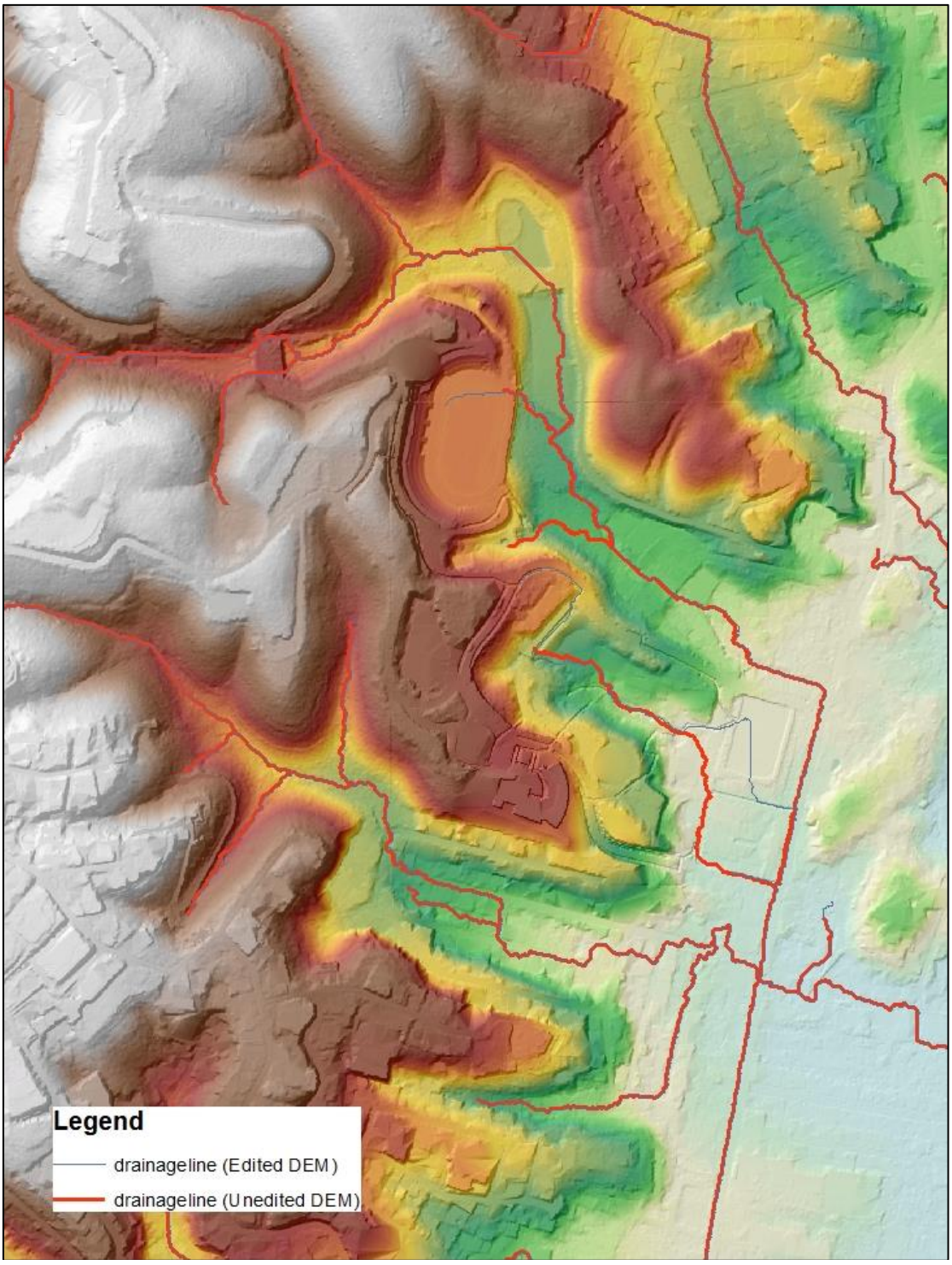

Figure 6 Drainageline processed from HEC-GeoHMS 10.2 of the two DEMs

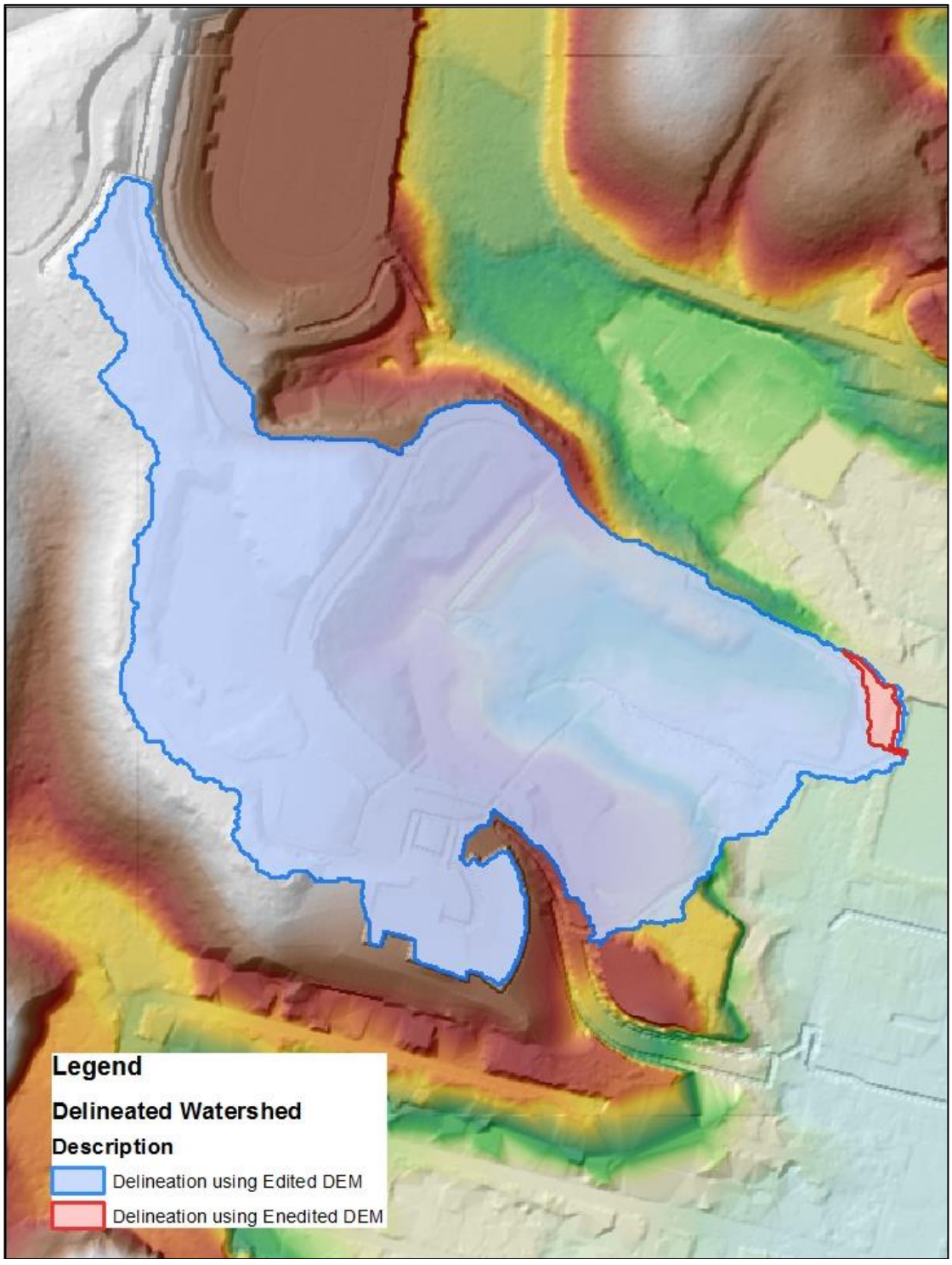

Figure 7 Delineated watershed of the 2 DEMs

After processing, the watersheds were delineated using the same point of delineation. The point of delineation was chosen to be the inlet in the USC-TC retention pond described in Section 1. The delineated area using the edited DEM is 11.1932 hectares while that of the unedited DEM is 0.0773 hectares. A huge difference in the delineated area was acquired making the former 145% larger than the latter. The presented delineated watershed in Figure 7 was also confirmed by observing actual rainfall events. Last September 28, 2014, a rainfall event occurred with duration of 3 hours. The total precipitation depth at the nearby rain gage station was 100 mm. The generated runoff would not be that much if the contributing watershed was as small as the one delineated using the edited DEM.

Figure 8 Runoff collected in the USC-TC retention pond during the Sept 18, 2014 rainfall event

4. CONCLUSIONS

From the above discussion and presentation of results, it can be concluded that editing the LiDAR DEM of urbanized areas to be used in HEC-GeoHMS is necessary. This is because the flow of water on the catchment was already altered due to the presence of drainage systems. In this study it was observed that a huge difference was acquired in comparing the results of the watershed delineation using the edited and unedited DEM.

5. ACKNOWLEDGEMENTS

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6. REFERENCES

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