REMOVAL OF NOISE FROM SHUTTLE RADAR TOPOGRAPHIC MISSION OVER VEGETATION AND BUILT UP AREA FOR LARGE SCALE TOPGRAPHIC MAPPING

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Abstract
The Shuttle Radar Topographic mission (SRTM) was carried out in the year 2000 producing a global digital elevation model (DEM). This data is useful for the production of up to date large scale topographic maps save for presence of noise which include buildings and vegetation. This research deals with the removal of this noise and involves processes such as survey field work, and comparison of the corrected SRTM with the existing topographic map of the study area. The study found out that the topographic map produced from the SRTM after the removal of noise did not completely correlate with the reference topographic map obtained from the Ministry of Lands and Survey, Awka. The study recommends that SRTM should not be used for large scale topographic mapping.
Keywords: SRTM, Noise, Topographic mapping

INTRODUCTION

Topographic maps are detailed, accurate, graphic representation of features that appear on the earth's surface. They use contour lines to represent elevation above sea level. It is important to note that a map is merely a two or three dimensional representation of the physical environment at a given time; therefore, a map will never be entirely up to date because of changes to the landscape and features. These results in the maps becoming outdate although the rate of obsolescence varies depending upon location (Geoscience Australia, 2017). Topographic maps are used by the Government and Industries among others to assist with urban planning, emergency management and the establishment of legal boundaries and land ownership, as such the importance of up to date topographic maps cannot be over emphasized. One of the methods of obtaining a topographic map is through the use of the Shuttle Radar Topographic Mission (SRTM) which was carried out in the year 2000 producing a global digital elevation model (DEM). The use of the SRTM in producing topographic maps is efficient save for the presence of noise in the SRTM data which when removed can be used to produce an accurate up to date large scale topographic map.

The SRTM DEM has been used by numerous scientists for a variety of science studies. However, all these studies have encountered the same issue: how to correct the vegetation bias in the SRTM DEM (O'Loughlin et al 2015). Similarly, tall buildings bias has also raised issues in several relating studies. Baugh et al 2013 noted that correcting the vegetation error in the SRTM DEM for a region of the Amazon Basin increased the accuracy of modelled inundation extents from 25% to 94%. This simply reaffirms the fact that vegetation and tall buildings significantly affect the accuracy of any obtained SRTM data, and as such should not be neglected. This study seeks to eliminate artifacts from SRTM DEM over vegetation and built up areas for large scale mapping.

The area selected for this study is Nnamdi Azikiwe University Awka, Anambra State Nigeria. Awka is the capital of Anambra State, Nigeria with an estimated population of 301,657 as of 2006 Nigerian Population census 9NPC, 2006). Awka is in the tropical rainforest zone of Nigeria and experiences two distinct seasons brought about by the two predominant winds that rule the area: the southwestern monsoon winds from the Atlantic Ocean and the northeastern dry

winds from across the Sahara desert. The monsoon winds from the Atlantic creates six months of heavy tropical rains, which occur between April and July, followed by a short dry period in August lasting two to three weeks with the rain resuming in September and October. This is followed by five months of dryness (November - March) marked by a Harmattan wind, also known as Ugulu in Igbo, which is a particularly dry and dusty wind which enters Nigeria in late December or in the early part of January and is characterized by a grey haze limiting visibility and blocking the sun's rays before dissipating and leading to extreme dry heat in the latter months of February and March. The temperature in Awka is generally 27-30 degrees Celsius between June and December but rises to 32-34 degrees between January and April, with the last few months of the dry season marked by intense heat. it is located at 6˚ 12′ 25″N , 7˚ 04′ 04″E.′

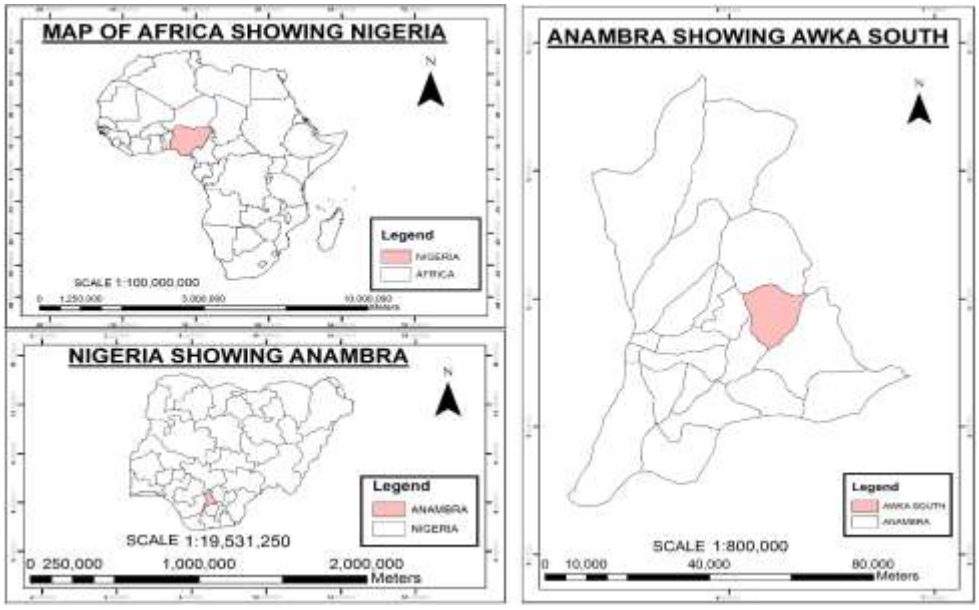


Figure 1.1: map showing the study area.

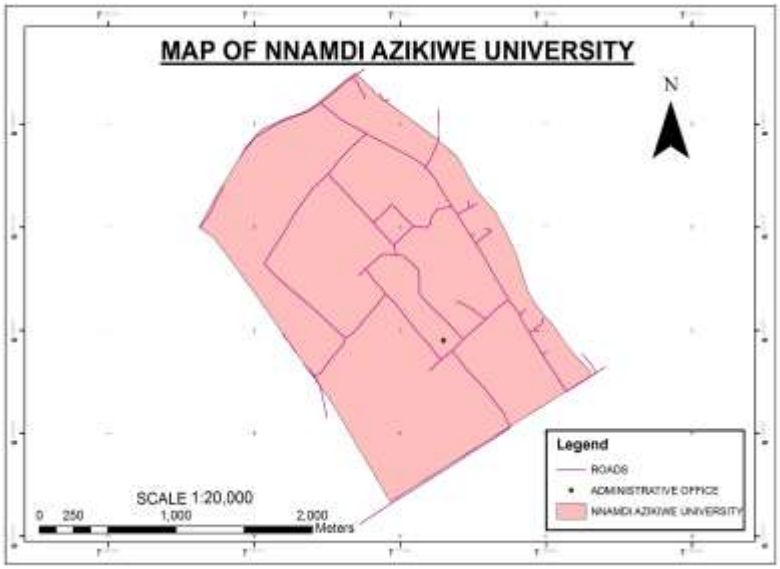


Figure 1.2: Map of Nnamdi Azikiwe University, Awka.

Methodology

The methodology adopted in this study is graphically represented in a flow chart as shown in figure 2.1.

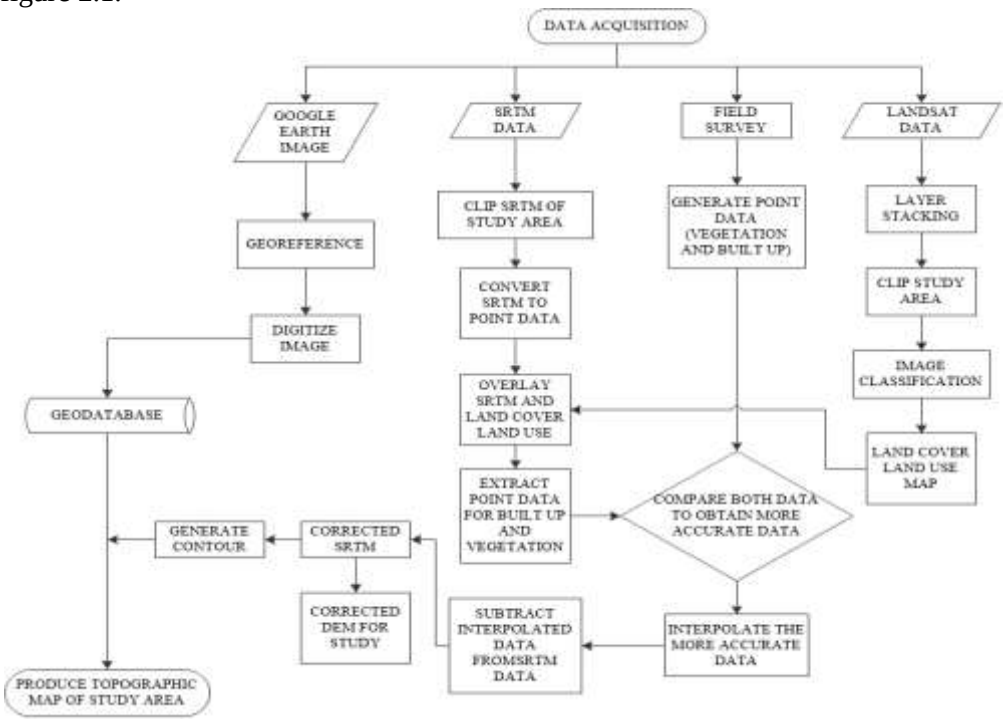


Figure 2.1: flow chart of the methodology adopted

The LandSat-8, SRTM and Google Earth Imageries were projected to the same coordinate system-WGS 84. The Landsat image was classified into built up, vegetation and bare surfaces using ERDAS Imagine software. The classified image was imported into ArcGIS environment for conversion from raster to vector format to obtain a land cover land use map. The clipped SRTM image of the study area was converted to point data using the raster to point tool in arc tool box. The landuse/landcover map obtained from the LandSat imagery was overlaid with the SRTM image.

To obtain height of features such as built up and vegetation within the study area, a field survey was carried out using trigonometric survey method. During the field survey, heights of buildings and several forms of vegetation were measured. These height data were used to determine the artifacts to be removed from the SRTM data.

The field data was entered on an excel worksheet for both built up and vegetation and then imported into ArcGIS software as separate point data. The point data were compared with the SRTM, built up and vegetation point data to determine the accuracy of the field data. These field point data were interpolated to produce a raster image for vegetation height and built up height. The point data interpolation process was done using the IDW tool (inverse weighted distance technique) as this method produces a raster data limited to the range of the values used to interpolate (Watson and Philip 1985). The raster image was subtracted from the SRTM image using raster calculator to eliminate built up and vegetation artifacts. The corrected SRTM image was used to generate a DEM and a contour map at 1m contour interval. The Google earth image was downloaded using the S.A.S planet software, and imported into ArcGIS. The main purpose of using the Google earth image is to assist in feature extraction (digitizing) and to create a geo database of features that will be used to produce the topographic map of the study area. This image was digitized in ArcGIS and a geo database was created for features such as buildings and roads. The features digitized from the Google earth image were overlaid on the corrected contour map to produce a topographic map of the study area.

Results and analysis

The landuse/landcover map of the study area is shown in figure 3.1.

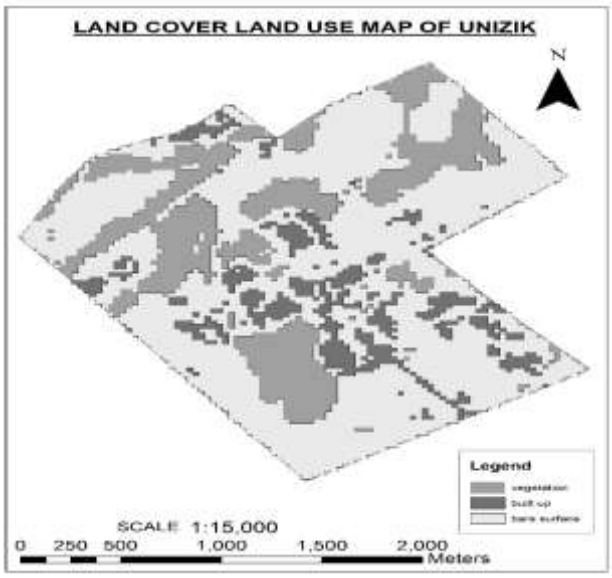


Figure 3.1: Landuse/landcover map of the study area

Two contour maps were created, one using the corrected SRTM data and the other using the original SRTM data. Both contour maps were analyzed and are shown in figure 3.2. The contours generated using the original SRTM data was observed to have a lot of high range of elevation values (36 – 61 meters), that is to say most areas of the study area have a very high elevation, which when compared to data obtained from the field work depict a false representation of the terrain. Whereas the contours generated using the corrected SRTM data has an even distribution of elevation, with an elevation value of range lower than that of the original SRTM contour (26 – 51 meters).

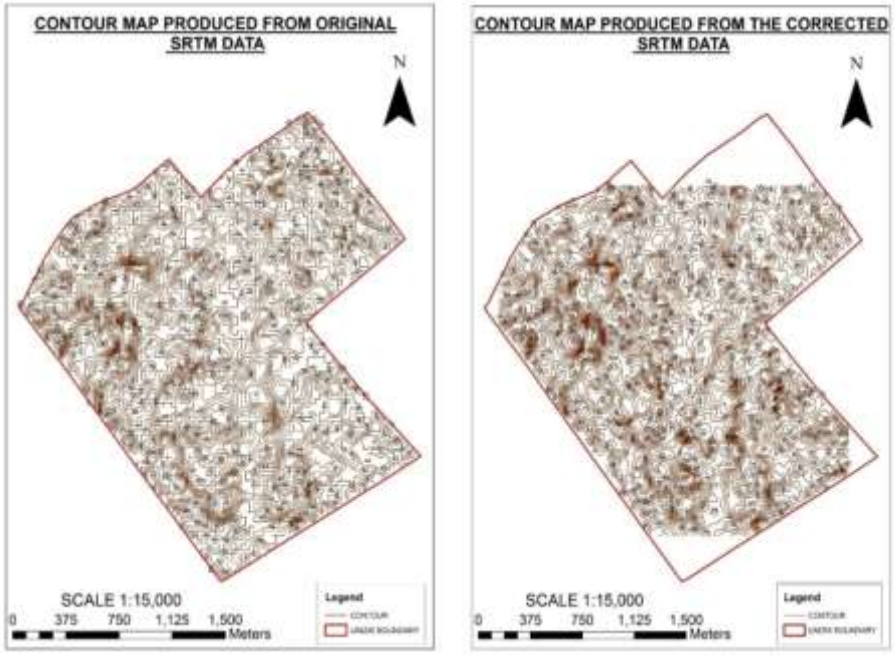


Figure 3.2: Contour map produced from original SRTM and corrected SRTM data.

A contour map produced from the original (uncorrected) SRTM image. The elevation in information on the map includes the height of features such as buildings and trees, and as such is not a true representation of the elevation of the study area. The contours generated from the

corrected SRTM image has been corrected by subtracting the built up and vegetation raster from it.

The corrected SRTM raster image was compared with the original SRTM image, and it was observed that there is a reduction in the maximum elevation value of the corrected SRTM data (see figure3.3).

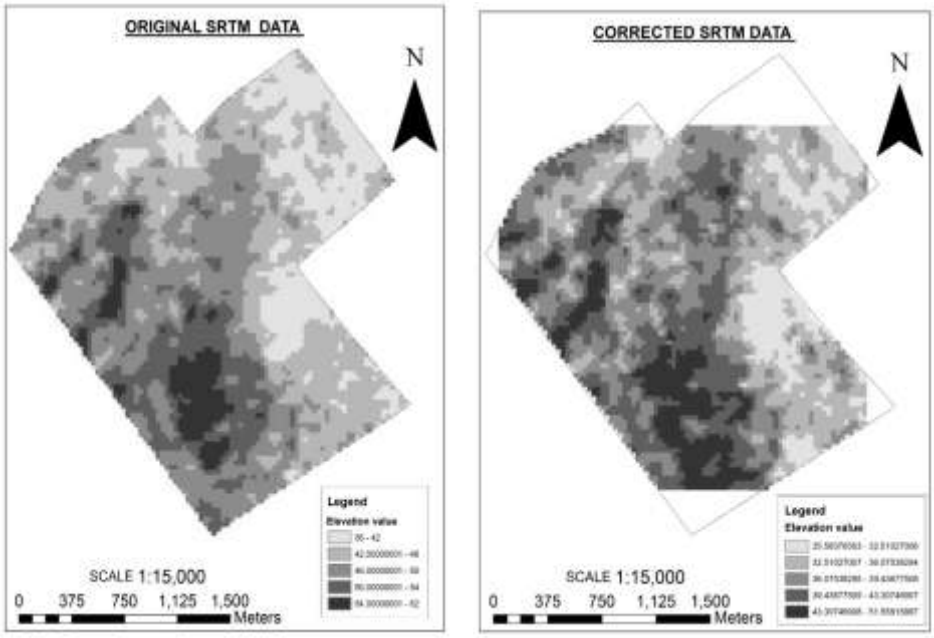


Figure 3.3: Comparison of the original and corrected SRTM data

As can be seen from the two maps shown above, the elevation values for the original SRTM data has a maximum range of 54 – 62 meters, and a minimum of 36 – 42 meters. While that of the corrected SRTM data has a maximum value of 43 – 51 meters, and a minimum value of 25 – 32 meters. This shows an obvious decrease in the elevation of the corrected SRTM image as a result of subtraction of artifacts such as buildings and vegetation.

The topographic map of the study area was produced using contour generated from the corrected SRTM data and features digitized from the Google earth image. The existing topographic map of the study area was compared with the corrected SRTM topographic map. Visual inspection of the contour lines (see figure 3.4 and 3.5) shows that there are differences, which can be attributed to the differences in their scale.

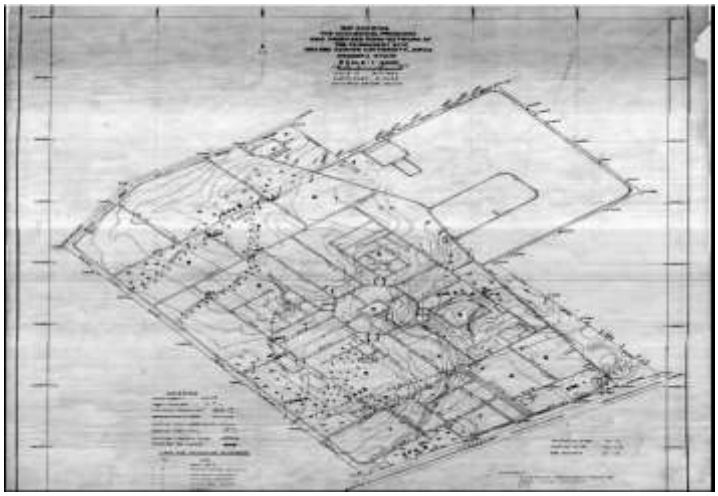


Figure 3.4: Existing Topographic map of the study area (Source: Ministry of Lands and Survey, Awka)

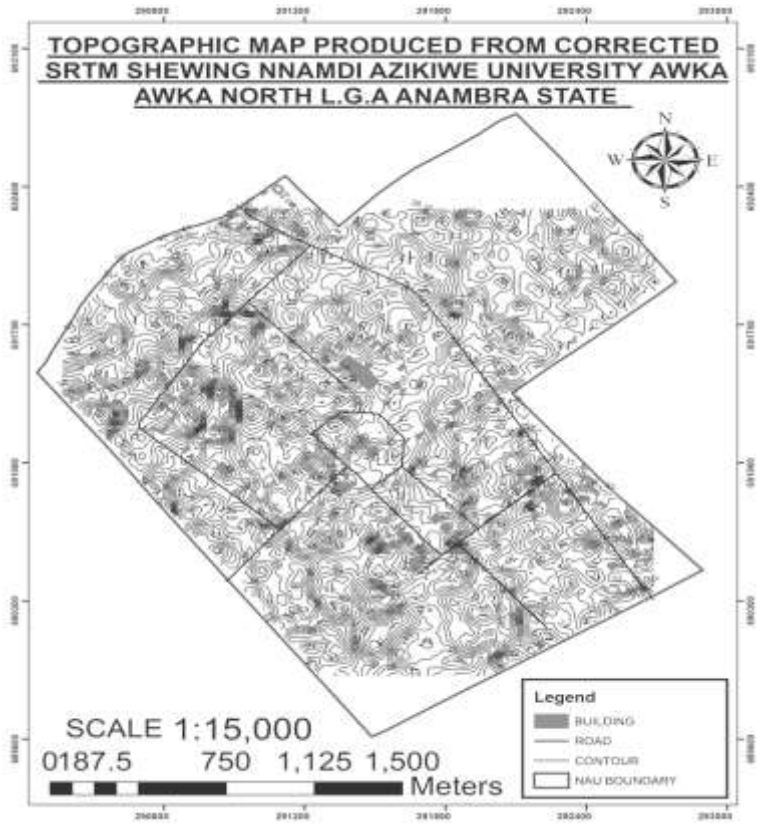


Figure 3.5: Topographic map of study area

For a better understanding and appreciation of the results obtained, both the corrected and original SRTM data sets were used to generate a 3D digital elevation model of the study area using the Surfer 10 software. The corrected SRTM raster data was converted to point data using the raster to point tool in the conversion toolbox of the arc toolbox and exported to Surfer10 software. Figure 3.6 and 3.7 shows the 3D model of the corrected SRTM and the original SRTM.

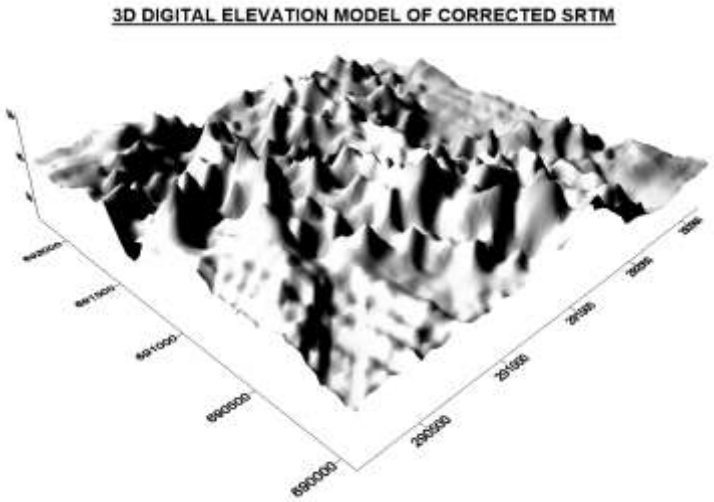


Figure 3.6: 3D digital elevation model of corrected SRTM

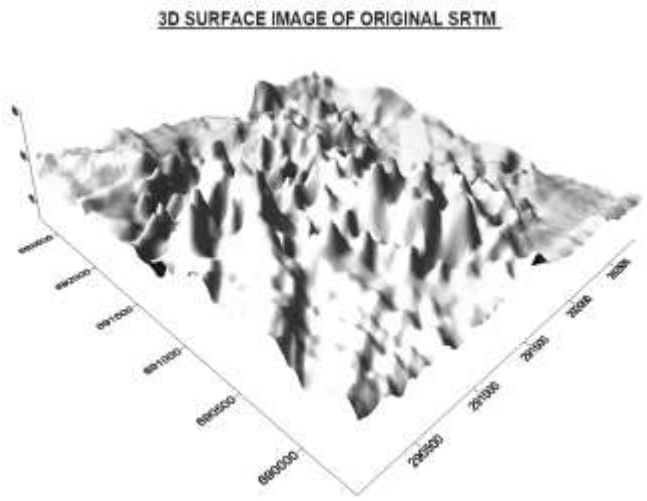


Figure 3.7: 3D surface image of original

From the maps displayed above it can clearly be seen that the corrected SRTM data did not produce a good topographic representation of the study area. The elevations shown in the maps are not exactly what is seen on ground in the study area, thus it clear that the corrected SRTM data did not produce an accurate 3D digital elevation model of the study area despite after removing the artifacts.

Conclusion and Recommendation

This study had been able to assess the effectiveness of SRTM in large scale topographic mapping. Elevation data obtained from SRTM and conventional survey techniques were compared. The topographic map developed was compared to that produced using field data in order to ascertain if it had accuracy which will make it possible to be used large scale topographic mapping. Certain challenges which make the use of SRTM in topographic mapping were discovered. For instance, The SRTM mission was carried out when some building has not been raised, trees that were existing at the time of the mission has been cut down and some have been raised. This brings about the problem of temporal resolution. The SRTM interval between spot heights is 30m which is too large as compared to the criteria for survey field work.

The research carried out shows that there are several methods of producing topographic map and the use of SRTM has not been found to be completely accurate in the production of large scale topographic map.

Based on the findings of this research, the following are recommended:

1. Only field surveys should be adopted for large scale topographical mapping.
2. Further research should be carried out on SRTM to determine and remove other sources of noise such as electric poles and moving vehicles.

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