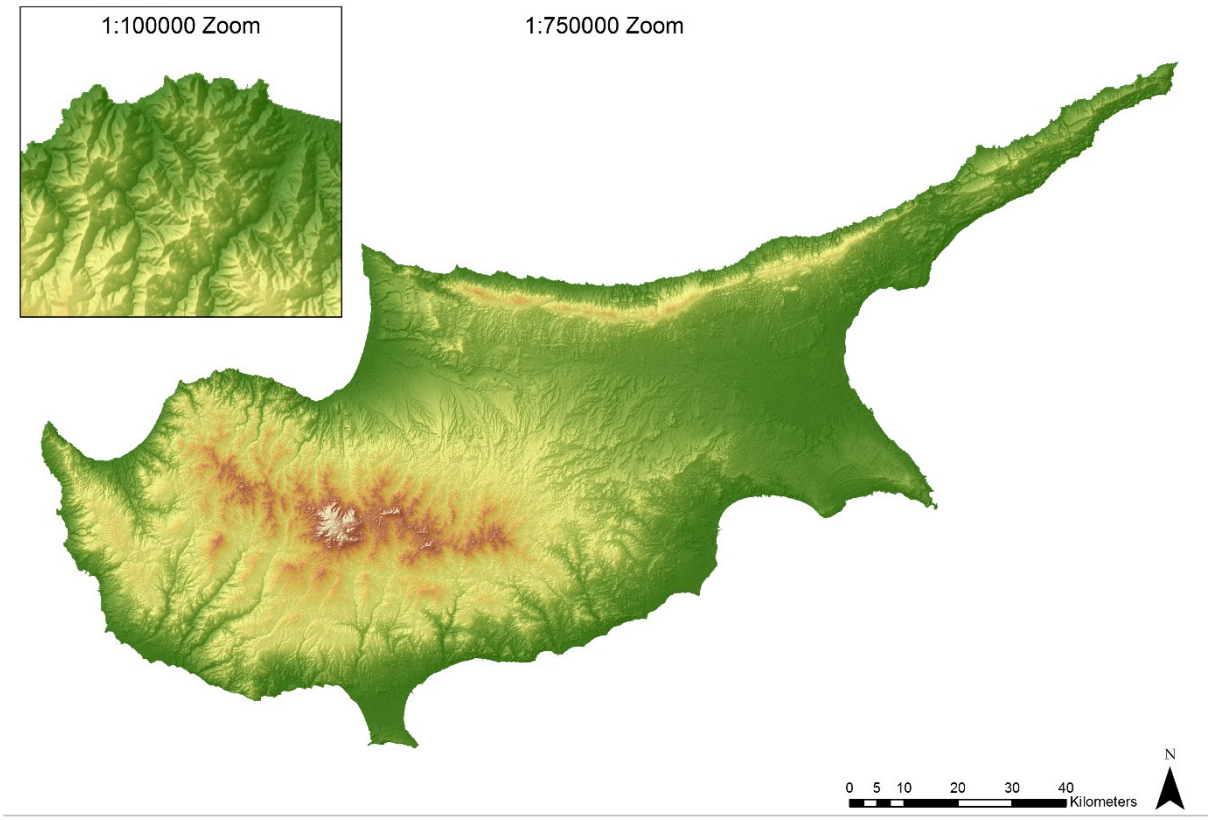
A Digital Elevation Model for Cyprus based on the Advanced Land Observing Satellite World 3D Topographic Data (ALOS 2 W3D30) Digital Surface Model

Paraskeva Charalambos, University of Edinburgh

As part of the topography chapter for my PhD, I needed to conduct spatial analyses using a Digital Elevation Model (DEM). Thus, I was seeking a suitable DEM for Cyprus that would be of good enough quality for regional spatial research and free to use for academic purposes. After testing several datasets (ASTER GDEM, ASTER GDEM V2, ALOS 1, SRTM, USGS, GTOPO, SDTS), I chose the World 3D Topographic Data (W3D) with images acquired by the Advanced Land Observing Satellite (ALOS) of the Japan Aerospace Exploration Agency (JAXA). This dataset is provided in tiles measuring 1 arcsec (c. 30m mesh) and containing 1 deg. lat/long, and has a stated height accuracy of 5 meters as standard deviation at 1 sigma. Particularly for Cyprus, I have used the Digital Surface Model (DSM) tiles (provided as signed 16bit GeoTIFF files), which represent the height above sea level with a calculated elevation value by average (AVE) and median (MED) when resampling from the 5-meter mesh version. These tiles were released on 9 October 2015, as part of the ALOS 2 W3D30 DSM dataset available by JAXA in the following link: http://www.eorc.jaxa.jp/ALOS/en/aw3d30/

For the production of the DEM, the following process was followed in ArcGIS 10.3.1. Initially the six tiles from the aforementioned DSM model, which include the entire island of Cyprus, were imported in ArcMap 10.3.1 and the Mosaic to New Raster command was executed with the following settings: Transformed to UTM WGS84 (for compatibility with other popular datasets used in Cyprus); Operator: Mean; Colormap Mode: Match; all other settings left to default ArcGIS values. This produced a unified Digital Elevation Model (DEM) for the island, but there were minor issues with the coastline (extending beyond current island coastline, errors caused due to mixing the shore with small rocks in the sea or protective wave breakers, errors caused due to the tide, etc.). This was rectified by applying a Clip command to the produced DEM with an output extent set to a 1:5000 consolidated coastline polyline. This in turn was produced based on the Department of Lands and Surveys Cyprus (DLS) freely available municipalities limits Google Earth KMZ file (available from: http://goo.gl/mPXxpl), which was imported in ArcMap, merged with the Union command and coastline extracted using the Feature to Line command. Also, the DEM was resampled to 25m, so as to provide a standard sized cell (the original ALOS 2 has a c.31x29m cell size), which is comparable to other DEMs available for the island. I've also calculated the Root Mean Square Error (RMSE) between the original and resampled DEM. It is found to be 2.8m, which is considered negligible for the purposes of regional level research. Given that the distribution of difference diagram is bell-shaped (Fig. 1), a general rule of thumb indicates that about 2/3 of all the cells will differ by less than the RMSE and about 95% of all the cells will differ by less than twice the RMSE. This indicates that there is generally good agreement between the original and resampled DEM. After this, I manually corrected a handful of cells to correct DSM errors and make the max-min values of the final DEM correspond to the officially accepted values, namely 1954m for the top peak of Troodos (c. 8 cells) and -5m for the deepest points of the Limassol and Larnaca salt lakes (c.40 cells). Finally, a Hillshade was created using the Hillshade command to accompany the DEM and a custom-colour ramp was produced to apply a realistic 3D look, as seen in Fig. 1 below.



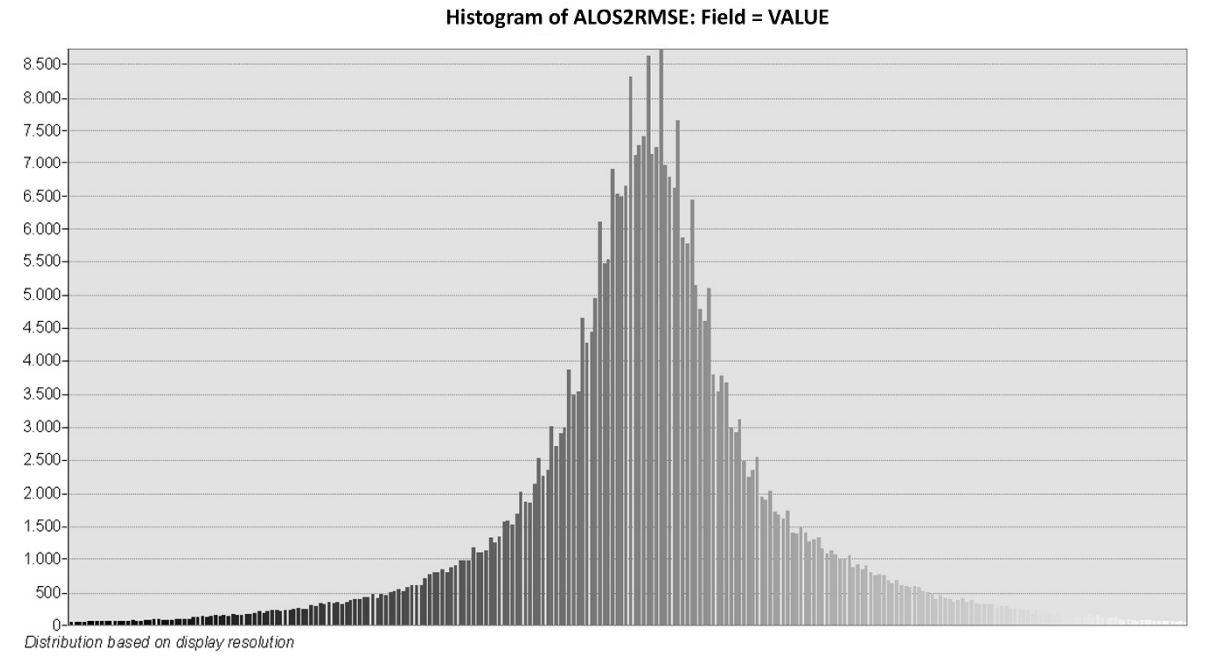


Figure 1: The combined DEM and Hillshade images (above) and the RMSE histogram (below) are provided for preview and verification purposes correspondingly. The DEM and Hillshade can be downloaded from the link provided in the abstract (this includes only the georeferenced TIFFs, not the custom-colour ramp shown in this preview).