International Cartographic Association
Association Cartographique Internationale

Analysis of heights of mountain interesting peaks and other characteristic points in Slovenia

Nina Črnigoj [a], Dušan Petrovič [a]

[a] *University of Ljubljana, Faculty of Civil and Geodetic Engineering, Ljubljana, Slovenia, nc3180@student.uni-lj.si, dusan.petrovic@fgg.uni-lj.si*

Keywords: PlanGIS, DEM, topographic bases, GNSS, altitudes

Abstract:

Slovenia is a popular turistic attraction thanks to its position and its diversity of the surface. More than 10,000 kilometers of marked mountain trails are known, which include peaks, saddles and starting points. To correctly record all the characteristic points is a big challenge for the Mountaineering Association of Slovenia (PZS). That is why PlanGIS, the Mountain Geographic Information System was established and where the spatial data of Mountaineering Association of Slovenia is kept. In PlanGIS, data of two heights are kept for each characteristic point. The source of the first height is not known, but it is probably taken from topographic and mountain maps, whereas the second height is determined from the data of the Digital Elevation Models (DEM) with a resolution of 1x1 meters, from National Lidar Survey data. Since the heights differ in many cases, even up to more than 10 meters, we determined the reasons for such differences within our research. The purpose of the task was to give PZS guidelines on which source of heights is the most suitable. We considered fourteen peaks, three parking lots, and two saddles, which represent a sample of characteristic points for research. These points were divided into 5 groups: peaks that are not overgrown or do not have a trigonometric point, peaks with trigonometric points, overgrown peaks, saddle and parking/starting point.

By measuring the heights, the ellipsoidal height is determined directly by GNSS. An ellipsoidal height is the geometric distance between a point on the surface and a reference ellipsoid, which is a mathematically determined smooth surface of the Earth's approximation. In Slovenia, the official vertical altitude system is marked SVS2010 (date Koper) and is based on the system of normal altitudes. The system uses the height reference plate SLO_VRP2016/Koper, which was established in 2016. SLOVPR2016/Koper is a quasi-geoid model that was included in the altitude system SVS2010 with GNSS/levelling points. In Slovenia, the national coordinate system is connected to the reference ellipsoid GRS80, which was adopted by the International Union of Geodesy and Geophysics (IUGG) in 1979. To compare the latest data, the ellipsoidal height had to be converted into altitude height. We did this with the Leica Infinity program, where we previously defined the coordinate system, ellipsoid (GRS80) and geoid (SLO_VRP2016/Koper).

Using static GNSS measurement, we determined the altitude of the selected points and used this data as a reference. In addition, we obtained the height from the terrain point cloud. In the group of peaks that are not overgrown and do not have a trigonometric point at the top, the largest difference between the heights in the PlanGIS is 29.1 m, which is due to an error in transcription from a topographic map or other used source. Of the nine peaks with trigonometric points, only two are those where the trigonometric point determines the highest point of the peak. The largest difference between the heights in this group was 15 m and is due to incorrect determination of the position of the point on the DEM.

Figure 1: Steep slope on the southern side of Borovlje, which affects the determination of altitude from the DEM.

Abstracts of the International Cartographic Association, 5, 2022.
European Cartographic Conference – EuroCarto 2022, 19–21 September 2022, TU Wien, Vienna, Austria.
https://doi.org/10.5194/ica-abs-5-47-2022 |

(a) 

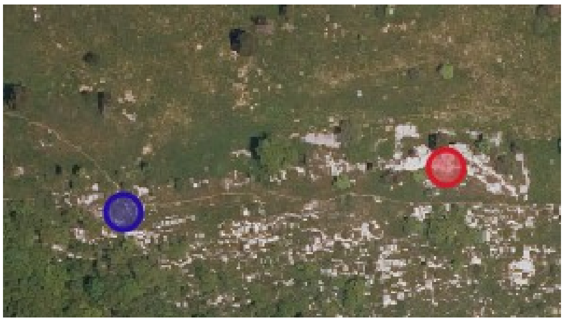
(b) 

Figure 2: (a) shows the top of Mala gora on the DTK. In PlanGIS, the highest peak point is defined by a trigonometric point located on the west side. In Figure (b) the position of the trigonometer is marked with a blue circle to the right of which is the highest point of the peak that is marked with a red circle.

In the analysis of overgrown peaks, we were most interested in the discrepancy between the measured height and the height from terrain point cloud, as their reliability of determination in the overgrown area is poorer. We found that overgrowth in our case affects the results of photogrammetric capture, but not the result of laser scanning. In the case of saddles, we found that the differences were due to an error on the topographic basis and due to the incorrectly determined position of the saddle. In the last group of parking and starting point, we considered three characteristic points and found that discrepancies are due to incorrect determination of location.

In reviewing the results of all analyzes, terrain point cloud proved to be the most reliable source in selected study cases. In all cases, whether in overgrown or steep terrain, values close to the measured height were obtained. If the height of all selected points were taken from the terrain point cloud, the error with the appropriate positioning would not exceed 0.5 m. A topographic basis is also a suitable source of data, but there are frequent cases of transcription errors in the data. DEM proved to be a suitable source in only two cases, where we considered predominantly flat starting points. In all classes, most of the time, the large difference in height was simply due to incorrect determination of the horizontal position.

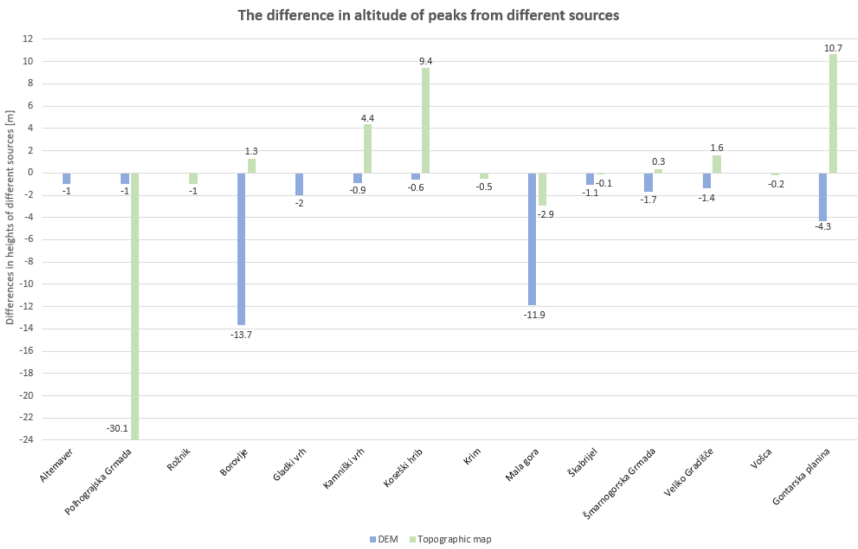


Figure 3: The difference between the measured height and the height of the remaining two sources for the selected peaks.

https://doi.org/10.5194/ica-abs-5-47-2022 |