Digital Elevation Profile: A Complex Tool for the Spatial Analysis of Hiking Trails

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Abstract: One of the current attributions of mountain geomorphology is to provide information for tourism purposes, such as the spatial analysis of hiking trails. Therefore, geomorphic tools are indispensable for terrain analyses. Elevation profile is one of the most adequate tools for assessing the morphometric patterns of the hiking trails. In this study we tested several applications in order to manage raw data, create profile graphs and obtain the morphometric parameters of five hiking trails in the Căpățâni Mountains (South Carpathians, Romania). Different data complexity was explored: distance, elevation, cumulative gain or loss, slope etc. Furthermore, a comparative morphometric analysis was performed in order to emphasize the multiple possibilities provided by the elevation profile. Results show that GPS Visualizer, Geocontext and in some manner Google Earth are the most adequate applications that provide high-quality elevation profiles and detailed data, with multiple additional functions, according to user's needs. The applied tools and techniques are very useful for mountain route planning, elaborating mountain guides, enhancing knowledge about specific trails or routes, or assessing the landscape and tourism value of a mountain area.

Key words: geomorphic tool, mountain route, morphometric parameter, mountaineering, Carpathians.

1. Introduction

Broadly speaking, preparing a good quality mountain trip requires special knowledge of topography, landforms, tourist skills and behaviour. Yet, the practical side was largely neglected for a long period of time, or at least not made available to public use of mountain trekkers or hikers. The technical approach has been usually an attribute of mountain guides, sports coaches, experienced hikers, etc. Therefore, the data are available in trekking or hiking manuals, mountain guidelines or legislative papers (Cartotrekking, 2001; Kogayon, 2011; H.G. 77/2003).

Selecting the most appropriate route inside a mountain area often depends on the ground accessibility and tourism purpose (i.e. scientific, recreation, photography, education). Hence the importance of geomorphological mapping in outlining the

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landform patterns is crucial (Evans, 2012; Smith et al., 2011). The analysis of landform accessibility has been a constant concern in recent years (Chiou et al., 2010; Kwan et al., 2003; Mihai & Șandric, 2004; Tóth & Dávid, 2010), including the particular hiking trails. For example, (Clius et al., 2012) analyzed the landform accessibility for hiking trails in the Ceahlău National Park (Eastern Carpathians, Romania). Other studies concerned the assessment of time-scale erosion processes developed along hiking trails (Tomczyk & Ewertowski, 2013). Recent efforts to involve the geomorphological tools in tourism activities have resulted in the elaboration of geotourism map for several tourist areas in Italy and Romania (Baias et al., 2010; Castaldini, 2008; Castaldini et al., 2009; Comănescu & Dobre, 2012; Comănescu et al., 2013; Ilieş et al., 2011).

Besides all these, elevation profile is a often applied geomorphological tool which emphasizes the topographic features of any given terrain (Giles, 1998). It is widely applied in tectonic geomorphology (Bishop & Shroder, 2004; Bull, 2007; Burbank & Anderson, 2012), glacial geomorphology and glaciology (Hubbard & Glasser, 2005), limnology (Avouac et al., 1996), fluvial geomorphology (Hergarten et al., 2014; Whipple et al., 2007), or teaching geomorphology and regional geography (Allen, 2008). It is also useful in elaborating detailed mountain guidelines by describing the parameters of hiking trails. The elevation profile provides precise information and data on trail’s morphometry, which further serves to group them into difficulty levels. In mountain areas, hiking routes are primarily under the control of topography. Topography is defined by several morphometric parameters: elevation, slope, curvature, configuration of stream and river valley network, depth of valley incision, etc. (Huggett & Cheesman, 2002).

In the current informational society, investigation of tourism offers is directly linked to the use of multimedia sources. Modern techniques provide automatically-generated elevation profiles, widely available from several free online or installed applications. The present study aims to provide (in the context of several case studies) highlighting models of the hiking trails features, from the perspective of the relationship between morphometric parameters. We revealed the appropriate digital means and tools for the spatial analysis of mountain (hiking) trails in order to identify the most suitable route according to purpose (e.g. tourism, scientific research, medical). We focused on creating the digital elevation profiles of several hiking trails and analysing the morphometric data availability for each application we used. Detailed information about distance, time, slope, elevation, etc. was considered in order to classify the available applications in terms of data complexity. The resulted database could serve to plan mountain routes by extracting the related topographic features.
2. The Tested Hiking Trails

The hiking trails we selected are located in the eastern part of Căpățânii Mountains (South Carpathians, Romania), which cover an area of 766.14 km². Geological diversity is a typical feature of this mountain range which broadly influences the topography. Metamorphic rocks (paragneiss and schist of the Sebeș-Lotru series) prevail on the central Căpățânii Ridge (Lupu et al., 1978; Mutihac et al., 2004; Oncescu, 1965). The Jurassic reef limestone is present on the NE-SW monoclinal ridge, highly faulted and dissected by narrow steep valleys, named the Vânturarîța-Buila Massif (Ardelean, 2010; Badea et al., 1998). Massive, long and rounded ridges were sculpted on metamorphic rocks, (Posea, 2005), whereas the limestone ridge consists in alternative sharp and plateau-like sectors. Maximum elevations reach around 1900-2000 m on the peaks that rise above the Paleogene erosion surface named Borăscu at 1800-1900 m (Velcea & Roșu, 1982; Posea et al., 1974). The cross profile is asymmetric. The northern major slope is very steep because it rims an important tectonic line (the Lotru fault); therefore, the accessibility degree is very low (Badea et al., 1987). The southern slope is much smoother and accessible, and hosts several important head basins. In the subalpine level, the morpho-dynamic processes intensively developed on a thick weathered layer (Onaca, 2005), resulting in numerous active montane gullies (Tîrlă, 2012).

The main five trails cross through areas of high morphometrical and geomorphological diversity: rounded metamorphic ridges, sharp limestone ridge, low-elevated saddle, etc. River and stream downcutting is strong enough to provide a highly-elevated environment, suitable for such an analysis. Detailed information about these hiking trails are provided by (Kogayon, 2011).

3. Data, Software and Methods

3.1. Data

The elevation profiles are created on the basis of digital tracks which are being recorded on a hand GPS device during the trip. In this case we used an eTrex Vista HCx model with a maximum resolution of 3.5 m. The recorded tracks run along the trails numbered 1-5 on the map in Figure 1. The corresponding hiking trails were labeled during the 1960s and drawn on the tourist map of Căpățânii Mountains (Popescu, 1968). The raw data consists in a series of .gpx files which can be imported in the online

\(^2\) Also available at www.buila.ro (Retrieved 07-09-2009).
or installed applications in the required fields in order to generate the profile. Their main features are briefly exposed in Table 1.

**Figure 1.** Location map of the hiking trails.

**Table 1.** The tested trails in the Căpățânii Mountains.

<table>
<thead>
<tr>
<th>No.</th>
<th>Trail</th>
<th>Symbol</th>
<th>Mark</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Şasa Valley – Gera Chalet</td>
<td>T1</td>
<td><img src="image" alt="T1 Symbol" /></td>
<td>Mostly along the forest road, marked only on the ridge trail section</td>
</tr>
<tr>
<td>2</td>
<td>Olănești Valley – Mt Folea – Gera Chalet</td>
<td>T2</td>
<td><img src="image" alt="T2 Symbol" /></td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Mt Stogu – Hădărău Saddle – Gera Chalet</td>
<td>T3</td>
<td><img src="image" alt="T3 Symbol" /></td>
<td>Along the interfluve (it crosses the saddle)</td>
</tr>
<tr>
<td>4</td>
<td>Costești Valley – Peak Buila</td>
<td>T4</td>
<td><img src="image" alt="T4 Symbol" /></td>
<td>Mostly along the forest road; marked only on the ridge trail section</td>
</tr>
<tr>
<td>5</td>
<td>Pahomie Hermitage – Peak Buila</td>
<td>T5</td>
<td><img src="image" alt="T5 Symbol" /></td>
<td>Very steep, runs uphill the SE face</td>
</tr>
</tbody>
</table>
3.2. Software

A number of available applications were used in order to transfer and manage the track data, and generate the elevation profiles afterwards:

a) Data transfer and management. Raw data can be initially obtained by using the applications to transfer GPS elements (i.e. waypoints, tracks, or routes) from the device to computer and then to manage them. Among the most commonly used software packages there are Map Source (Garmin, 2010), DNR Garmin (DNR, 2014), EasyGPS (TopoGrafix, 2014a) and ExpertGPS (TopoGrafix, 2014b). The attribute tables' contains raw data (e.g. geographical coordinates, time) which can be used for morphometric analyses.

b) Elevation profile. Several online or installed applications were tested in order to assess the provided elevation profile and supplementary data depending on the intended purpose: Google Earth™ (Google, 2014), ExpertGPS (TopoGrafix, 2014b), ArcMap™ v9.3-10.2.2 (ESRI, 2014), GPS Visualizer (Schneider, 2013), and Geocontext (Pietruszka, 2010). Other applications or software packages also provide similar results: Google Maps™ (Pawlowicz, 2007), Manifold® (Manifold Ltd., 2014), etc. We used only the T3 trail for testing, and the results are shown in Figures 5-7.

3.3. Methods

We proposed a workflow chart which could be applied for graphical displaying and morphometric analyses of hiking trails using the digital elevation profile (Figure 3). One major data source is the attribute tables of the .gpx files, which are displayed either on free (EasyGPS, DNR Garmin) or licensed applications (MapSource, ExpertGPS). Each waypoint on the track is defined by two geographical coordinates (latitude and longitude). Another important parameter provided by the attribute table is the proceeding time (the time at which each waypoint was recorded) or elapsed time (total time). Geographical coordinates and elapsed time are two parameters which are usually not shown on the elevation profile, but they are available in the attribute tables. We extracted the elapsed time for each track by using the already mentioned applications. The data for T3 trail are shown in Figure 2, and for all trails in Table 4.
Figure 2. Raw data (trail length, time, and coordinates) provided by GPS software.
4. Results and Discussion

4.1. Displayed Modes of Graphs and Data

The various software packages provide either simple or complex data on the elevation profile. The simplest results (graph, distance/length and elevation) are provided by ArcGIS and GPS software (ExpertGPS and MapSource), which contain the usual tools for creating general profiles.

In order to test the multiple functions and information provided by the analyzed applications, we created elevation profiles for the T3 hiking trail (Vânturarîta-Buila Massif - Hădărău Saddle - Mount Gera - Gera Chalet). The results are shown in Figures 3-6 and Table 2.

Table 2. Types of data provided by the tested applications on T3 hiking trail. The differences in the same type of data result in calculation errors.

<table>
<thead>
<tr>
<th>Application</th>
<th>Distance (km)</th>
<th>Up-hill (km)</th>
<th>Down-hill (km)</th>
<th>$\Sigma$↑ (m)</th>
<th>$\Sigma$↓ (m)</th>
<th>Denivalation (m)</th>
<th>Average slope (°)</th>
<th>Median</th>
<th>Time (hh:mm:ss)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ArcMap</td>
<td>7.533</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>MapSource</td>
<td>7.5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3:47:18</td>
</tr>
<tr>
<td>Expert GPS</td>
<td>7.5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3:47:18</td>
</tr>
<tr>
<td>Google Earth</td>
<td>7.61</td>
<td>-</td>
<td>-</td>
<td>867</td>
<td>-388</td>
<td>-</td>
<td>16.0</td>
<td>1590</td>
<td>-</td>
</tr>
<tr>
<td>GPS Visualizer</td>
<td>7.5349</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>13:30:30 to 17:17:48</td>
</tr>
<tr>
<td>Geocontext</td>
<td>7.30</td>
<td>4.9</td>
<td>2.4</td>
<td>848</td>
<td>-372</td>
<td>574</td>
<td>16.0</td>
<td>1,609</td>
<td>-</td>
</tr>
</tbody>
</table>
In ArcMap, the elevation profile can be displayed after several steps followed in order to convert the .gpx file to 2D file, then to 3D file using the Interpolate Shape function of 3D Analyst extension. The usual elevation/distance range is displayed alongside the graph. Other complementary data such as geographical coordinates and waypoint-assigned times are provided by the DNR Garmin extension for ArcGIS (DNR, 2014), shown in Figure 2.

MapSource (Garmin, 2010) is a multi-function application which allows transferring and managing raw data, then creating simple, but graphically-enhanced elevation profiles (the elevation/distance type). The map is displayed only if the GPS device is connected to computer. ExpertGPS (TopoGrafix, 2014b) has similar functions except for the graph quality, having limited displaying options.

Google Earth provides complex graphical functions and data: satellite imagery with detailed aerial photographs draped on a 3D surface (DEM). Besides the commonly displayed distance and elevation, it provides cumulative gain and drop, denivelation and slope, which are also available on separate sections or at each point.

GPS Visualizer is linked to Google Earth and its particular utility lies in displaying the variations of the selected parameter (e.g. distance, elevation, time, cumulative gain, cumulative loss, slope, etc.). Moreover, the graph palette varies according to parameter data. Combining more than two parameters (e.g. time, distance, and elevation) is a more useful technique (Figure 4C). The application allows displaying the correlation between time and distance along the profile graph with color palette showing the corresponding elevation at each point. The thresholds on the time curve represent the breaks; the higher the threshold, the longer the break.

Other complete graphical and statistical information package is provided by Geocontext-Profiler (Pietruszka, 2010), as we exemplified in Table 3 for all the tested hiking trails. Its major utility lies in the linkage with Google Earth visual tools (satellite imagery, aerial photographs and DEM).

**Table 3.** Trail parameters provided by Geocontext-Profiler online application ($\sum\uparrow$ - cumulative gain; $\sum\downarrow$ - cumulative drop).

<table>
<thead>
<tr>
<th>Trail</th>
<th>Length (km)</th>
<th>Average slope (%)</th>
<th>Uphill (km)</th>
<th>Downhill (km)</th>
<th>$\sum\uparrow$ (m)</th>
<th>$\sum\downarrow$ (m)</th>
<th>Denivelation (m)</th>
<th>Median (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>5.67</td>
<td>18.8</td>
<td>4.1</td>
<td>1.3</td>
<td>862</td>
<td>-138</td>
<td>733</td>
<td>1,566</td>
</tr>
<tr>
<td>T2</td>
<td>4.22</td>
<td>10.3</td>
<td>0.72</td>
<td>3.3</td>
<td>78</td>
<td>-624</td>
<td>550</td>
<td>1,614</td>
</tr>
<tr>
<td>T3</td>
<td>7.30</td>
<td>16.0</td>
<td>4.9</td>
<td>2.4</td>
<td>848</td>
<td>-372</td>
<td>574</td>
<td>1,609</td>
</tr>
<tr>
<td>T4</td>
<td>6.97</td>
<td>16.6</td>
<td>5.47</td>
<td>1.5</td>
<td>1,001</td>
<td>-161</td>
<td>840</td>
<td>1,245</td>
</tr>
<tr>
<td>T5</td>
<td>4.00</td>
<td>29.5</td>
<td>3.11</td>
<td>0.88</td>
<td>1,103</td>
<td>-182</td>
<td>946</td>
<td>1,273</td>
</tr>
</tbody>
</table>
Figure 3. Simple graphs and basic data of trail T3 displayed in: A. ArcMap/3D Analyst extension; B. MapSource; and C. ExpertGPS.
Figure 4. Elevation and time profiles of trail T3 displayed in GPS Visualizer.
Figure 5. Elevation profiles and complex parameters of trail T3 displayed in Geocontext-Profiler (A. entire trail; B. detailed graph and slope for the red inset) and Google Earth (C).
Besides the previously discussed data, it calculates median, linear trend, uphill and downhill distance. The slope tool shares similar functions with Google Earth.

Overall, the available morphometric parameters displayed alongside the resulting graphs were centralized below in Table 4.

**Table 4.** Graph utilities and morphometric parameters of the elevation profile displayed by various online or licensed applications.

<table>
<thead>
<tr>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
<th>(9)</th>
<th>(10)</th>
<th>(11)</th>
<th>(12)</th>
<th>(13)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ArcViewer</td>
<td>●</td>
<td>●</td>
<td>-</td>
<td>●</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>ArcMap</td>
<td>●</td>
<td>●</td>
<td>-</td>
<td>●</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>MapSource</td>
<td>●</td>
<td>●</td>
<td>-</td>
<td>●</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>●</td>
<td>-</td>
</tr>
<tr>
<td>Expert GPS</td>
<td>●</td>
<td>●</td>
<td>-</td>
<td>●</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>●</td>
</tr>
<tr>
<td>Google Earth</td>
<td>●</td>
<td>●</td>
<td>-</td>
<td>●</td>
<td>-</td>
<td>-</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>GPS Visualizer</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>●</td>
<td>●</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Geocontext</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>-</td>
<td>●</td>
<td>-</td>
</tr>
</tbody>
</table>

*Numbers significance: (1) Application; (2) Map; (3) DEM; (4) Interconnections; (5) Distance, in km; (6) Uphill, in km; (7) Downhill, in km; (8) Cumulative gain, in meters; (9) Cumulative drop, in meters; (10) Denivelation, in meters; (11) Average slope, in degrees; (12) Median, in meters; (13) Elapsed time.*

According to data complexity, we grouped the resulted profiles into the following four categories:

1. Simple profiles and summary raw data: ArcMap™ (Figure 3);
2. Simple profiles and complex raw data: MapSource, ExpertGPS (Figure 3);
3. Medium complexity profiles: Google Earth (Figure 6);
4. Complex profiles and data: GPS Visualizer and Geocontext (Figures 4 and 5).

DNR Garmin and EasyGPS were excluded because the graph function is missing, and the elevation profiles cannot be created.

GPS Visualizer and Geocontext-Profiler are the two applications that we recommend for advanced hiking trail analytics. The elevation profiles displayed by GPS Visualizer assemble wide combination possibilities. One particular type of profile (time vs. distance, with additional colors for elevation) is very useful to assess the elapsed time for breaks: 10-minute breaks each hour walk (H.G. 77/2003). On the other hand, Geocontext combines its own graphs and detailed data with Google Earth tools. Other applications (e.g. MapSource and ExpertGPS) provide simple elevation profiles, but also more complementary data such as geographical coordinates waypoint-assigned time and elapsed time. The simplest overall results are provided by the ArcMap™ application. However, simple results do not mean weak data, as limitations vary broadly depending on the final purpose.
4.2. Comparative elevation profiles
The following example compares the effectiveness of two elevation profiles showing the route configuration (features) towards the same target or ending point: Peak Buila (1849 m). As one can notice, the denivelation is quite similar (970 m vs. 934 m), and there is a small difference in the travel time (only 34’) comparing to the large difference in length (2.87 km). Therefore, the slope makes the difference in this case. If reverse slope values, it results a much longer time to travel on T4 and shorter on T5 (Table 5).

Table 5. Comparative parameters of the T4 and T5 trails.

<table>
<thead>
<tr>
<th>Trail</th>
<th>Distance (km)</th>
<th>Denivelation (m)</th>
<th>Average slope vs. Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Real</td>
</tr>
<tr>
<td>T4</td>
<td>7.32</td>
<td>970</td>
<td>16.6%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5h45'</td>
</tr>
<tr>
<td>T5</td>
<td>4.45</td>
<td>934</td>
<td>29.5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5h11'</td>
</tr>
</tbody>
</table>

Figure 6. Comparative elevation profiles of the trails aiming at the same peak (Buila, 1885 m).
Thus, for a rapid ascension towards the peak, in this case T5 is recommended, although it requires increased endurance and effort. The higher slope is compensated by constancy, which determines the hiker to acquire quickly a steady rhythm. T4 is suitable for recreation purposes, with alternating higher and lower slope route segments and longer time to spend during the hike.

Comparison of two or several hiking trails is useful only if there is a possibility of choosing only one route from several options in the same mountain area. In this way, one could better use the available time, the body adapts better to terrain conditions and eventually the traveling time shortens.

4.3. Whom is it addressed to?
A great advantage of these tools and techniques is that they are available not only to specialists in mountaineering or geomorphology, but also – and this is mostly important – to usual tourists, trekkers and hikers who can better plan their route in this way. To support and promote the quality mountain tourism, access to multilateral information on the accessibility (topographic features) - duration - visibility relationship may facilitate the options for choosing a particular mountain route.

4.4. Public use and tourism education in mountain areas
The digital elevation profiles and additional morphometric data could also be included in mountain guides and maps, contributing to enhancing the knowledge about some particular routes. The information they provide (i.e. distance, elevation, slope, and time) can be used to establish the difficulty levels for hiking trails. These levels are set by the mountain law in every state - for example, the H.G. 77/2003 in Romania. The mountain guides and manuals usually contain all the complementary details (Cartotrekking, 2001). However, the information provided by the elevation profiles are not sufficient to establish the difficulty degree of hiking trails. They must complete the information about ground features additionally provided by the geomorphological maps: stability, hill slope gradient, etc. For example, a low-slope trail (below 15) might cross over a steep hill slope or even quasi-vertical walls. Under these conditions, we propose that digital elevation profiles and derived data to be used along the geotourism map (Comănescu & Dobre, 2012; Comănescu et al., 2013). Both are recent tools that we consider very useful for a high-quality, modern investigation of hiking trails.

5. Conclusions
Elevation profile is a useful geomorphic tool for the morphometric analysis of hiking trails in mountain areas. It provides the necessary data needed for an accurate, high-
quality route planning for various tourism purposes (e.g. recreation, scientific work, education).

After exploring a number of various possibilities to create elevation profiles in the digital environment, the results showed that the most suitable applications for the extraction of complex information are GPS Visualizer and Geocontext-Profiler. In some manner, Google Earth also provides advanced data. Although the statistical data is not quite consistent, GPS Visualizer provides interesting parameter combinations in order to create profile graphs (elevation or even time profiles) of the hiking trails. The Geocontext-Profiler tool combines the Google Earth facilities with its own detailed graphs and statistical data.

Comparative elevation profiles and the corresponding datasets are useful if we wish to select only one route from several available for the same mountain area. In this case, the most commonly analyzed parameters are: distance, time, cumulative gain, and slope.

The elevation profile is an important component to be investigated both numerically and graphically in the spatial analysis of hiking trails, especially to establish the difficulty degree and elaborate mountain guides and tourism maps. It would be useful to be available for public use alongside the tourism or geotourism maps.

References


