Revealing recreational behaviour and preferences from GPS recordings

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Introduction

The mafreina project (Management Toolkit Freizeit und Natur: www.mafreina.ch) is conducted in the Biosfera Val Müstair. As part of the project a vast amount of GPS track were recorded, including 550 winter and 1100 summer trips. Automatic visitor counters and automatic sensor cameras supported the recordings. Further, additional information – including main activity during the tour and familiarity with the areas – was collected by means of questionnaires.

Beyond basic analysis of tour length and duration, average speed, etc., the main focus of the presentation is on analysis of more detailed aspects of the visitors' behaviour. The analysis' includes:

- Analysis of 'stops' (i.e. location where the subject had a break)
- Analysis of activity type (mainly distinction of hikes, mountain bikes, skiers, and snowshoers)
- Relation of slope and speed (for different activity types)
- Probabilities of selecting destinations from given entry points
- Tour distribution over land cover, elevation and gradient classes

Finally the presentation demonstrates how GPS tracking data can be analysed to provide visitors preferences and route choice behaviour. By means of logistic regression of the routes subjects actually took vs. possible alternatives (within a given max additional time/distance limit) the significants, sign and estimated influence of characteristics of the path network can be revealed.

Analysis of 50 tracks

A subset of 50 subjects for the summer of 2010 was selected for the present analysis of the relation between slope and speed. The sampled comprise 127.955 point in total. The tracks were broken up into subtracks (routes taken between locations of pauses). In total the data set comprise 243 subtracks of an average length/duration of 7.5km/98.4 minutes). On average the subtracks had an elevation difference (difference of min and max altitude along the subtrack) of 266 m. For analysis of elevations (and slope) a 25x25m Digital Elevation Model (DEM) was applied. The dataset include both hikers and mountainbikers.

In a mountainous terrain – like the present case study area- it is intuitively expected that there is a relation between a subjects' speed and the local slope of the path. That is, speed will be higher when moving downhill than uphill. Further it could be expected that mountainbikers' speed would be more influence by slope than hikers. The same would be expected for winter activities (which is not part of the present analysis) – i.e. skiers' speed would be more affected by slope than snowshoers'.

In figure 1 the resulting relation between subjects' average speed and slope is shown. The relation was analysed by means of simple linear regression. The displayed results are based on respondents' entire tracks (i.e. not subtracks between stops). The reason for this is that subtracks often goes up to a location at a higher elevation where a stop is made, and then back. Accordingly the diversity of slopes for a single subtrack would be relatively small (i.e. primarily positive or negative), which would jeopardize the explaining power of the regression analysis.

The resolution of the applied DEM – 25x25 m – was often larger than the resolution of the GPS recordings (distance between points). The revealed slope (difference in elevation divided by distance between two consecutive points) would frequently be 0. Accordingly the applied algorithm was set up to look for the distance/elevation differences of points along the track being minimum 100m apart.

In general the explaining power (R^2) ranges from 27% to 0%. As expected by inspection of the beta-values, the explaining power is generally higher for higher speeds than for lower. Further, it must be concluded that an individuals' speed in influenced by more factors that slope.

The results displayed in figure 1 support the proposed hypothesis: there seems to be a relation between slope and speed – the steeper the slops downhill, the higher the speed. Further it appears that the group of respondents at relatively low average speeds (around 4 km/h) has a lower tendency (if any) of influence of slope. Intuitively these 'slow respondents' are expected to be hikers – the faster are bikers. Yet again, this support the second hypothesis – that hikers are less vulnerable that slope than bikers. The chart (fig. 1) indicates that there are two types of bikes (high-speed respondents'. One strain at relatively low speed (average speed of 6-9 km/h), being highly influenced by slope and one slightly faster (9-11 km/h) being less influenced. This could indicate two types of bikes with different levels of shape and technical skill. In general it appears that the faster the mountainbikes are, the less slope influences their speed.

As mentioned above, the relation between slope and speed for subtracks would be expected to be less prominent as for the entire tracks. Tests and plots (not included) supported this expectation.

More work has to be conducted to compare the finding of the analysis with the recording made in field of the respondent's actual activities.

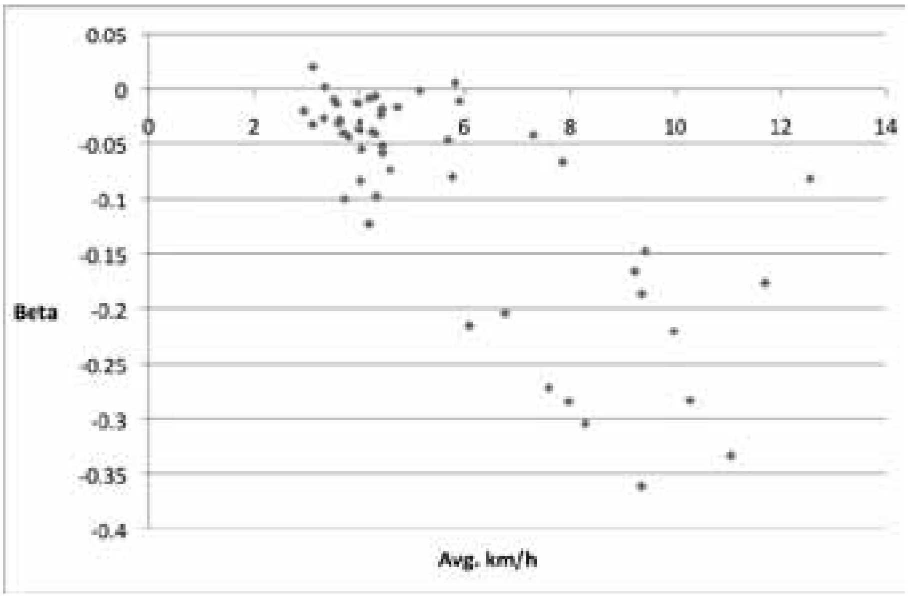

Figure 1. Relation between subjects' average speed and relation of speed and slope (n=50). The relation is expressed as the beta parameter of a linear regression of speed and slope of points recorded along the track(s) of individual subjects.

Extro

The results provide insights in visitors activities, preferences and behaviour. Further, the results can be applied as parameters to an Agent Based Model of the case area. Such parameters include: visitors' speed, speed/slope relations, destination choice, off-piste activities, and route choice behaviour. The presentation will conclude by provision of examples of application of such parameters to an ABM.