A regional travel model for predicting the number of visitors in forests: application to the Walloon region

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Abstract — The Walloon forests are visited by local people and tourists but the importance of forest recreation is very different from one part of the Region to another. As it was particularly difficult to obtain quantified information by counting, a model has been built by GIS and taking results from different surveys (telephone survey and face-to-face interviews) into account. This model makes the distinction between local visitors and one-day tourists coming from the neighbouring regions (in a buffer zone of 50 km). A decay curve based on travel time is used for predicting the number of visits throughout all Walloon forests from each departure point. An attraction function is added to the model to attribute each visit to a woodland and different scenarios have been tested to obtain a distribution of people by regions of provenance as similar as the results of surveys. At a regional level, this model is a good alternative for counting and gives a good overview of the forests for which recreation activities are more relevant and have to be taken into account in forest management plans.

Index Terms — decay curve, forest recreation, GIS, travel model, Wallonia

1 Introduction

Located close to urbanised and populated regions, the Walloon forests (540,000 ha; woodland rate: 32 %) are visited by local people and tourists. The importance of forest recreation is nevertheless very different from one forest to another, considering woodland rate, types of ownerships, road accessibility and proximity of urban and tourist centres.

The number of visits in all the Walloon woodlands is an important indicator to consider in a multi-purpose forest policy but it is particularly difficult to estimate it at a regional level by counting [Jacsman, 1991], Taking results from different surveys (telephone survey and face-to-face interviews) into account, a GIS has been elaborated and a model has been built to estimate the annual number of visits for each forest in Wallonia. The model of potential use [Skov-Petersen, 2001] makes the distinction between local visitors, one-day tourists coming from the neighbouring regions and tourists staying at least one night in the region.

The sub-model presented here deals with local visitors and one-day tourists.

2 Methodology

The steps in the elaboration of the model are:

- the determination of the population concerned by forest recreation and the estimation of the number of visits which will be spread from each departure point;
- the use of a drive time decay function to estimate the distribution of visits within

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a series of *service area polygons* corresponding to different travel time classes;
- and the distribution of the visits among woodlands inside each *service area polygon*.

2.1 Number of visits and departure points

The number of visits from each centre of population (departure point) located in Wallonia and the neighbouring areas (in a buffer zone of 50 km) has been estimated considering frequencies of visits obtained by surveys. A telephone survey [Colson, 2006] has provided the proportion of local people visiting forests at least once a year. This proportion is correlated with the woodland cover. Another regional survey [Colson, 2007] which was carried out through face-to-face interviews (40 study areas all across the region; 4000 interviews collected at the end of the six successive periods) provided the frequency of the visits of people interviewed in forests. This second survey distinguishes local people and people coming from the neighbouring countries. This distinction enables to consider the differences of behaviour existing between local people and one-day foreign tourists.

With these data, the number of visits in forests has been calculated for all people living in the Walloon region or inside the territories located at less than 50 km from the border of the region (Flanders and the Brussels region, North-Eastern part of France, Grand-Duchy of Luxembourg, Western part of Germany and South of The Netherlands).

2.2 Travel

From each departure point (villages, cities), a decay curve [Ode and Fry, 2006] based on travel time has been applied to predict the number of visits through all Walloon forests. This curve has been obtained from the face-to-face interview survey and is the same for the visitors of all countries (Table 1).

TABLE 1:

Travel time decay curves by forest cover classes

Travel time classes		Forest Cover			
tmin	tmax	<20 %	20-39 %	40-59%	>60 %
0	15 min	31 %	50 %	57 %	48 %
15 min	30 min	33 %	34 %	30 %	40 %
30 min	45 min	14 %	8 %	8 %	7 %
45 min	60 min	9 %	4 %	3 %	4 %
60 min	75 min	5 %	3 %	1 %	1 %
75 min	90 min	5 %	1 %	1 %	0 %
90 min	120 min	3 %	0 %	0 %	0 %
120 min	180 min	0 %	0 %	0 %	0 %
Total:		100 %	100 %	100 %	100 %

Nevertheless, a travel time penalty has been considered for people coming from outside of Wallonia (which can be called a “crossing border effect”).

Another correction factor has been elaborated to consider only the visits that take place in the Walloon woodlands. This has been done by calculating the proportion of forest included in the *service area polygon* of each departure point that are respectively within and outside Wallonia. This differentiation was carried out using the CORINE landcover map [European Environment Agency, 2000].

As the number of access points in forests is particularly high, an intermediate level has been created: target points. Those points are located on road segments that cross woodlands in such a way that the minimum distance between 2 target points is not below 500 meters.

A second level is dealing with woodlands located around these target points.

A road network database was used to calculate the travel time from each departure point to each target point. These travel times have been computed by using specific network analysis tools: *Cost matrix function* from ArcGIS 9.2 and *Route calculate* method available in the routine library of Microsoft MapPoint 2004. The output takes the form of an Origin Destination matrix in which the travel time of each combination “departure point / target point” is stored.

2.3 Distribution of visits throughout the Walloon woodlands

As the travel time is not the only factor which influences the target selection, an attraction function [DE VRIES ET AL, 2004] has been added to the model.

The attraction function is based on:

- the afforestation rate: we consider that people who visit forests take into account the wooded character of the region and thus the afforestation rate;
- the urbanisation rate around each target point: we make the hypothesis that, for high travel time classes, a high urbanisation rate decreases the attraction of surrounding forests;
- the capacity of accommodation for tourists around the target points: with the hypothesis that the importance of accommodation for tourists around the target points reflects the attractiveness for all types of public visiting a wooded area;
- the density of access roads around and inside the woodlands: we make the hypothesis that the number of entrance points of a woodland has a big influence on its accessibility and thus on its annual number of visits;
- and a forest recreation level obtained by a qualitative survey: a regional map has been obtained from a qualitative survey [Colson et al., 2008]. Managers of the Walloon forest service were interviewed and they evaluated the level of visiting of each Walloon woodland with a four-level-qualitative scale. This survey brought to identifying forest recreation hotspots throughout the Region. This regional map was used in the attraction function.

A computer simulator has been developed to integrate all the parts of this model. It enables to test different scenarios with different sets of values for the attraction function and the correction factors. This simulator is built in Visual Basic for Application language in Microsoft Excel environment. All the data (input data and results) are stored in specific ESRI Personnal Geodatabases.

A serie of 50 scenarios has been tested, all the parameters values being fixed manually. Those scenarios have been compared considering the repartition of the total number of visits within the 3 main categories of recreationists: (i) from Wallonia, (ii) from the rest of Belgium, (iii) and from abroad. This comparison is made on the 40 study areas for which the simulated repartition can be compared to the repartition observed during the regional survey.

3 RESULTS

The list of departure points contains a total of 11,926 villages and towns corresponding to 17,300,000 inhabitants. The distribution of this population by region or countries is the following: Wallonia 19 %, other parts of Belgium 40 %, France 22%, Germany 11 %, Netherlands 5 % and Grand-Duchy of Luxembourg 3 %.

A total of 5,857 target points have been identified for 5,179 woodlands (mean area: 104 ha, stdev: 290 ha).

One of the *best* tested scenarios is presented below.

The total annual number of visits spread through all the Walloon woodlands is 90,700,000.

The scenario gives a distribution of visits by public provenance quite similar to the one coming from the regional survey (table 2).

TABLE 2:

COMPARISON OF DISTRIBUTION BY PROVENANCE OBTAINED BY SURVEY AND BY SIMULATION

Population	Regional survey	Model
Walloon Region	83.4 %	83.6 %
Flanders and Brussels	10.0 %	11.0 %
Neighbouring countries	6.7 %	5.4 %
Total	100 %	100 %

The spatial distribution of the visits produced by the model for this scenario shows

that about 40 % of the Walloon forest is concerned by a annual number of visits less than 50 per hectare.

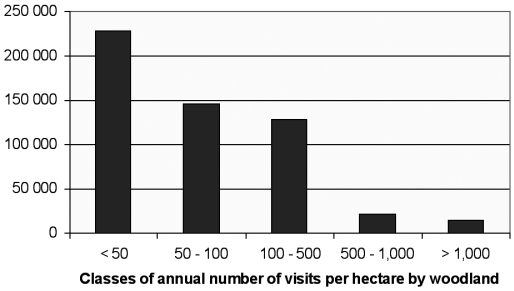

Figure 1: Distribution of the Walloon forest by classes of annual number of visits per hectare by woodland

The map obtained with this scenario shows that the highest annual number of visits per hectare concerns mainly the woodlands located in the north of the region. The southern part is in fact less populated and more concerned by tourists which aren't considered in the sub-model presented in this paper.

4 Conclusion

Considering the difficulties to provide effective counting of the annual number of visitors for the whole Walloon forest, a simulation model appears to be an interesting approach to give a good overview of the forests for which recreation activities are more relevant and have to be taken into account in forest management plans.

This model also provides data particularly interesting for calculating the regional value of forest recreation using, for example, the Travel Cost Method.

Nevertheless, difficulties encountered in the estimation of the parameters of the attraction function show the complexity of the problem due to, in particular, the mixing between local population and one-day tourists and the heterogeneity of forest recreation at regional level.

This problem could be solved by a calibration phase of the parameters of the attraction function. This could be done by using some appropriate optimization techniques [Doherty and Johnston, 2003].

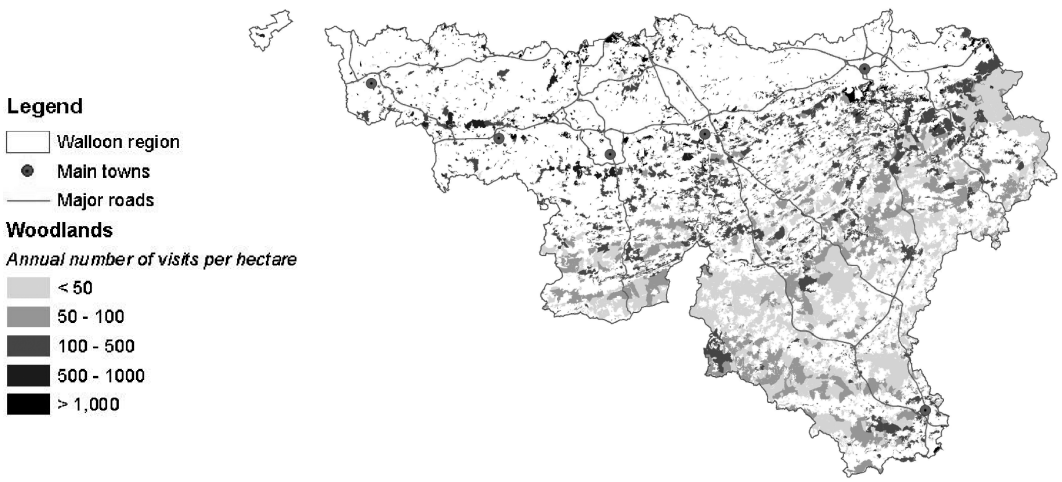

Figure 2. Annual number of visits by woodland in the Walloon forest

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