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Résumé

Carte et déterminants de la fréquentation des forêts en Wallonie.

La forêt wallonne dans son ensemble peut être considérée comme typique d'une zone rurale, bien que sa proximité de zones densément peuplées lui donne un caractère péri-urbain. Elle est visitée par une population locale mais aussi par des touristes (y compris des pays voisins). Pour fournir de l'information spatiale au niveau de la fréquentation des forêts en Wallonie, une enquête a été menée auprès des gestionnaires des districts de services forestiers (appelés aussi « cantonnements »). L'objectif était de cartographier les forêts pour voir la répartition spatiale des niveaux de fréquentation, et de les analyser afin de déterminer qualitativement les facteurs d'influence. Cette carte identifie les centres régionaux des forêts récréatives et, inversement, les zones où la fonction récréative est beaucoup moins importante. Le taux de fréquentation a été réduit à quatre niveaux allant de faible à très élevé. La cartographie a été complétée par une analyse statistique des données recueillies auprès des gestionnaires forestiers et aussi de différentes couches SIG (pente, hydrologie, usage des terres, etc.). Une équation du taux de fréquentation a été régressée sur un ensemble de caractéristiques de la forêt avec un modèle logit ordonné. Les résultats montrent que le type de propriété, le type de forêt, et les installations récréatives ont une influence significative sur le niveau de fréquentation des forêts. Ils montrent également que les visiteurs préfèrent tout type de forêt à une forêt composée principalement de conifères. Ces résultats et l'analyse des cartes sont particulièrement utiles pour l'élaboration d'une politique forestière et de tourisme ainsi que pour la gestion des forêts. Ils fournissent également des informations essentielles à l'étude économique régionale de récréation en milieu forestier.

Mots clés : Récréation en forêt, géotraitement, modèle Logit ordonné, enquête auprès des gestionnaires, enquête sur carte

Abstract

The Walloon forest taken as a whole can be regarded as typical of a rural area, although its proximity to densely populated areas gives it a peri-urban character. It is visited by the local population and also by tourists (including from neighbouring countries). To provide spatial information on the level of Wallonia woodland visitation, a survey was conducted among managers of Forest Service districts (also called “cantonnements”). The aim was to map the woodlands to show spatial patterns of visitation levels, and analyze them qualitatively to determine the influence factors. This map identifies regional hubs of recreation woodlands and, conversely, areas where the recreational function is much less important. The level of visitation was scaled in four levels ranging from low to very high. The mapping was supplemented with a statistical analysis of data collected from the forest managers and also from different GIS-layers (slope, hydrology, land use, etc.). An equation using the level of visitation as a dependent variable was fitted to a set of characteristics of the woodland with an ordered Logit model. The results show that type of ownership, type of forest, and recreational facilities significantly influence the level of woodland visitation. They also show that woodland visitors prefer any type of forest to mainly coniferous woodland. These results and the analysis of the maps are particularly useful for developing forest policy and tourism as well as managing the forest. They also provide key information to the regional economic study of woodland recreation.

Key words : Forest recreation, geoprocessing, ordered Logit model, managers’ survey, map survey
Classification JEL : C23, Q23, Q26, R10

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Introduction

Woodlands in Wallonia cover 30% [Environmental Protection Agency, 2000] of the region's total area (16,937 km²), a relatively high figure compared with regions farther north, such as Flanders, northern France, or the Netherlands. The population density is also relatively high (198 inhabitants/km²), but it is still considerably lower than most of the areas already mentioned. Table 1 shows clearly that Wallonia is a transitional area, not only in terms of forest cover, but also of population density, between the urban centers of Belgium, the Netherlands, western Germany, and northern France on the one hand, and the more rural areas farther south on the other hand.

The accessibility of the area is especially high thanks to an extremely dense road and motorway network (471 km per 100 km² including 5.2 km motorways per 100 km² (SPF Mobilité et Transports, 2005)). Moreover the woodlands are located close to living areas: 63% of the population live less than 1km away from a woodland of more than 5 hectares.

Table 1

These characteristics explain why the local population and people from neighboring regions visit Walloon forests so frequently, although they are very obviously managed for timber production. This production is especially important in the Ardenne region, where spruce stands are dominant and sustain an important wood chain. Figure 1 gives an overview of the forest cover and the large urban centers of Wallonia and its neighboring regions. Big cities are located in the northern part of the region and thus are rather far from the woodlands. More precisely, woodlands that are less than 15 km from cities of more than 20,000 inhabitants represent 25.4% of the woodlands of more than 5 hectares. Cities of more than 20,000 inhabitants represent 48% of the total population of Wallonia. Taken as a whole, Wallonia's woodlands can thus be considered as a ''rural'' forest set in a peri-urban environment.

Figure 1

Overall, in the Walloon forest policy ("Code forestier", e.g. Gerard, 2008) the forest is considered as multifunctional (economic, ecological, and social functions) even if, locally, one particular function of the forest, *e.g.* the recreational activities, may assume greater importance for forest management.

Wallonia's forest recreation policy is mainly oriented towards regulating the movement of visitors in its woodlands. This approach is comparable to that of other densely populated countries or regions in which forest policy measures are designed to control recreational activities rather than to develop them (Bell *et al.*, 2007). However, the average level of visitation in the Walloon forest is lower than that observed in peri-urban woodlands in the Brussels and Flemish region farther north (Roovers *et al.*, 2002). In Wallonia, any woodland road that does not display a keep-out sign is deemed to be open to the public, although forest owners have the right to close private roads to the public by placing appropriate signs (Gerard, 2008). This regulation explains why forest recreation is less developed in private forests. On public roads, the access is restricted depending on the category of visitor and the type of way (footpath, track, or road).

The recreational management of the forest mainly consists in sign posting to encourage tourism but also to route visitors away from areas where the non-disturbance of wildlife and the conservation of sensitive habitats are priority management aims (Gerard, 2005). Nevertheless, these forest recreation management projects are mostly elaborated by local tourism organisms and local services of the Walloon forest department (Nature and Forest Department).

The latter is organized into 37 geographical forest districts called ‘cantonnements’. The 37 managers have a relatively accurate knowledge of the different woodlands in their districts, *i.e.* the publicly owned woods and forests. Their knowledge of privately owned woodlands, which cover 54% of the total forested area (Lecomte *et al*, 2002), can also be considered satisfactory, which is not surprising since the managers are responsible for enforcing environmental regulations in the whole regional territory. In this general context, we can consider that the spatial analysis of regional woodland visitation levels is particularly useful to develop sustainable forest management.

The aim of the present study was to obtain a regional overview of forest recreation hotspots and understand their determinants. Although certain woodland sites were known or presumed to have high visitation levels, no systematic mapping had ever been made at the regional level.

Many counting methods are available to estimate the number of visitors in a woodland or other delimited recreation areas, such as parks. Reviews of these methods can be found in the literature (Muhar *et al.*, 2002, Cessford et al., 2003, Kajala *et al.*, 2007). In a regional study, these methods of counting visitors are difficult to apply (Jacsman, 1991), at least on a reasonable timescale.

The particularly high fragmentation of the Walloon forest (Colson *et al.*, 2002) and its high accessibility have strongly increased the number of points of entry into woodlands for visitors. Estimating the number of visitors with quantitative methods is thus particularly hard.

METHODS

The research question of this study is to get an overview of forest recreation hubs for all the Walloon woodlands and to try to identify the determinants of the level of visitation.

SURVEY

The method used here to obtain the visitation levels in the Walloon forest is innovative in that it is based on interviews conducted among forest managers. Moreover, the study comprises a map-survey at a regional level. Surveys among forest managers are less frequent than among visitors and can be quite subjective (Arnberger and Grant, 2008).

Forest recreation mapping studies consist principally in modeling the number of visitors on the basis of quantitative data. These models refer to travel simulations (e.g. De Vries et al, 2004) or extrapolation of sample of counts (e.g. Brainard et al., 2001).

Other recreation mapping studies are based on surveys made generally among the general public. These studies deal mostly with place attachment and are carried out at the local level (e.g., Tyrvaïnen et al., 2007; Brown and Raymond, 2007) rather than at a regional level (e.g. Alessa et al., 2008).

Our objective here was thus not to estimate the number of visitors, but to determine and to study the relative spatial distribution of the woodland visits based on the frequency of the visits. The survey's underlying question regarding each woodland is not "how many visits can we observe in this woodland" but "how often can we observe visitors in this woodland". To answer this question, forest managers determine for each woodland the level of visitation that can be interpreted as a recreation intensity index.

We set out to evaluate the levels of visitation of all the woodlands in Wallonia, taking into account spatial variations, and with a requirement to optimize the cost (time)/accuracy ratio. Our method consisted in interviewing forest managers and asking them for qualitative data on the woodlands located in their respective districts.

This option to interview forest managers makes senses considering the high knowledge they have of their districts. No other administration has such a territorial organization. In Wallonia forests managers are thus the only group of people able to answer a survey dealing with this topic.

The managers were consulted individually and asked to categorize the woodland cover in their 'cantonnement' according to visitation level.

As explained before, we dismissed in this regional analysis any method based on the gathering of quantitative data, and a qualitative evaluation scale was thus designed. This scale defines four visitation levels, from low to very high. To achieve objective scoring, reference criteria were defined (the frequency with which visitors were seen, frequency of approved recreational activities organized by associations (hikes, cycling tours, etc.). The evaluation scale is shown in Table 2.

Table 2

The criteria used for this evaluation scale thus concerned the frequency (on an annual basis) more than the number of visitors, which was more difficult to evaluate qualitatively. This is important to take into account because, for a given level, the number of visitors can be quite different from one woodland to another, and seasonal variations can exist.

In the case of woodlands where seasonal variations are particularly important, the evaluation scale presents thus certain limits. For example, sites that attract youth group camps illustrate this, as do the few sites visited sporadically in the winter by fans of snow sports (mostly cross-country skiing).

This simple approach leaves room to the subjectivity of the managers' appraisal, but it allows us to discuss our research question, i.e. to identify the major visitation spots in Wallonia in terms of relative levels of visitation in different sub-regions. The interpretation of this scale by the managers can be quite different due to regional variations. Nevertheless, the validation phase will reduce the risk of such a bias and the analysis of the determinants of woodlands visitation will try to identify it.

The level of visitation has been determined for each woodland. As forest regulations require the public to keep to the paths, the visitation levels should strictly concern paths rather than stands. However, forest management is defined on a spatial basis and, furthermore, the density of paths in the Wallonia woodlands is particularly high, and the impact of public visiting, especially as regards noise, are such that it was felt to be more useful to delimit areas rather than path segments.

The meetings with the 37 managers gave us an initial version of a regional forest visitation map. This map was hand-drawn by the managers on the 1:50000 topographic map, which is probably for them the best-known map available for Wallonia .The symbology of the original topographic map makes identifying the forest cover quite easy. The categorization made by managers concerns all forest areas in their district. The woodlands delimited by the managers on the paper version of the topographic map were then digitized with the ArcGIS 9.1 software, making sure that a visitation level was assigned to each spatial area classified as wooded on the topographic map. This second step yielded the *raw digital* version of the map, which contains 1,195 polygons.

In the third step, the "cantonnement" managers 'were again consulted to validate the map thus produced, not only for their districts, but also for the neighboring districts. This step enabled us to smooth any inconsistencies found in woodlands located across district boundaries.

GEOPROCESSING

Forest information was not restricted to visitation levels. Sets of descriptors covering both the physical characteristics of the woodlands and the present infrastructure were also drawn up. The list of descriptors has been made principally on the basis of visitor surveys carried out in Wallonia that gathered, among others, data on the public's preferred activities [Colson, 2006; Colson, 2007]. This primary list has been completed by a set of descriptors of forest recreation supply selected among those compiled in the framework of the COST Action E33 [Sievänen et al, 2008]. This information came from three separate sources:

1) Qualitative variables obtained from interviews with managers: Type of ownership, presence of facilities, sports trails, areas for orienteering, nearby campsites, visits by youth groups, extent of picking activities.
2) Qualitative variables resulting from visual interpretation of the basic 1:50000 topographic map during the digitization phase: Forest types (broadleaves vs. conifers) and hydrographic features (from brooks to rivers).

3) Quantitative variables obtained by geoprocessing layers added to the GIS (topography, land use, Natura 2000 label, location of tourist attractions, watercourses, urban areas and main roads).

For the latter category, the spatial data layers used in the geoprocessing are presented in Table 3.

Table 3

The quantitative variables were obtained with one of the following three approaches:

1. Mean Euclidian distance

The mean Euclidian distance of the pixels $\left(DMEAN_{ij}\right)$ composing a woodland relative to items considered favorable or unfavorable to forest recreation was calculated with the zonal statistics $(MEAN)$ function of ArcGis 9.1:

$$DMEAN_{ij} = \frac{1}{n_i}\sum_{k=1}^{n_i} d_{jk} \,, \qquad (1)$$

where n_i is the number of pixels composing the woodland i (*zonal feature*) and d_{jk} is the distance between pixel k and the item j studied (*input value*).

The items considered in this type of processing were:

- Tourist attractions;
- Watercourses;
- Urban areas with populations over 20,000 inhabitants (which indicate the peri-urban character of the woodland);
- Regional roads.

2. *Relative surface area*

The relative area ($AREA\%_{ij}$) of a woodland influenced by an item considered favourable or unfavourable for the recreational function has been estimated by the intersection between the woodland layer and the layer describing this item (intersect function of ArcGis 9.1):

$$AREA\%_{ij} = \frac{AREA_{ij}}{AREA_i} \times 100, \qquad (2)$$

where $AREA_{ij}$ is the surface area (in ha) of the woodland i concerned by the item studied j and $AREA_i$ is the total surface area (in ha) of woodland i.

The items taken into account for this calculation were extracted from the spatial data layers concerning:

- The main hydrographic network (with a buffer zone of 25 meters);
- Natura 2000 protected sites;
- Broadleaved *versus* coniferous stands;
- Topography, specifically slopes of less than 10° and slopes of more than 30°. For each woodland, the mean and standard deviation values of the slope were calculated from a SLOPE layer derived from a 1:10000 digital elevation model.

3. *Descriptive statistics*

All the qualitative and quantitative variables evaluated for the 1.195 delimited woodlands are presented in Tables 4 and 5. One of the specific features of the data set is that it contains many variables that are discrete, sometimes multinomial, but not ordered. These discrete variables were converted into binary variables (absent/present) for each of their values.

Tables 3, 4 and 5

The visitation map obtained after digitization thus shows, for each delimited woodland, a set of attributes that may be considered as factors likely to determine visitation levels.

To identify these factors and study their effects on levels of visitation, we adjusted an ordered Logit model (e.g. Maddala, 1983). This type of model is used when the values taken by a discrete multinomial dependent variable notated y (here the visitation level) correspond to intervals that include the continuous latent (*i.e.* unobserved) variable $y*$ (Gurland et al., 1960). We can consider here that this measures the appeal (or the utility) of woodlands for visitors according to the characteristics of the site. If this utility is below a certain threshold value (notated s_1) for a woodland, then levels of visitation will be low. If it is above s_1 but below a threshold s_2, then the level of visitation is medium, and so on, according to the number of levels studied. In our survey, the number of visitation levels was set at four. Thus three threshold (or boundary) values had to be estimated.

$y = 1$ (low visitation level) if $y* \leq s_1$

$y = 2$ (medium visitation level) if $s_1 < y* \leq s_2$

$y = 3$ (high visitation level) if $s_2 < y* \leq s_3$

$y = 4$ (very high visitation level) if $s_3 < y* \leq s_4$

For each woodland $i(=1,\ldots,N)$, the latent variable y_i* is specified as a linear regression:

$$y_i* = X_i\beta + \varepsilon_i, \qquad (3)$$

where X_i is a row vector of K factors explaining y_i*, β is the column vector of K parameters (to be estimated) associated with X_i, and ε_i is the error term incorporating the effect of unobserved factors. The set of explanatory variables X_i includes the attributes described in the previous section, and are derived from the following three sources of data: interviews with managers, visual interpretation of the topographic map, and geoprocessing from spatial data layers. Moreover, we added dummy variables for each “cantonnement” in the set of explanatory variables. “Cantonnements” are geographical subdivisions that depend on territorial characteristics. These specific variables might take into account local unobserved characteristics that can affect visitation levels in woodlands but also non-standardized appraisals by the interviewed managers.

The probability of observing a visitation level with modality *j* is written:

$$\Pr\left[y_i = j \mid X_i, \beta, s_j \right] = \Pr\left[s_{j-1} < y_i* \leq s_j \mid X_i, \beta \right] = F(s_j - X_i'\beta) - F(s_{j-1} - X_i'\beta),$$

$$j = 1, \ldots, J, \qquad (4)$$

where F represents the distribution function of the logistic law, with $F(\varepsilon) = \exp(\varepsilon) / (1 + \exp(\varepsilon))$. We also have: $s_0 = -\infty$, $s_J = +\infty$ and $s_{j-1} \leq s_j$.

RESULTS

INTERPRETATION

The digitized map obtained comprised 1,195 woodlands, but some of them were made up of several multipart polygons. Scattered woods with the same characteristics, such as farmland groves, are treated as single woodland.

Figure 2a, b

A simple visual analysis of the map (Figure 2a, b) immediately brings out marked regional variations in the levels of woodland visits for recreational purposes. When we superimpose the hydrographic network and the urban centers with populations over 20,000, we find that the most heavily visited locations correspond to three specific situations:

- Woodlands located near large urban centers in the north of the region;
- The wooded valleys of the Ardenne, and especially those around the tourist centers located there;
- The Hautes-Fagnes plateau (in the north-east) located in a tourist region and close to very densely populated regions in Wallonia but also in Germany and the Netherlands.

This way we obtain the global map of the level of visitation for the Walloon forest. The bias due to the difference of appraisals by managers does not appear really but has to be analyzed in the following step. The woodlands with high seasonal variations have generally been classified at a level above that given by the estimated mean annual visitation level, even if the period can be quite short since the objective of the map-survey was not to assess the number of visits but only to identify forest recreation hotspots.

THE ORDERED LOGIT MODEL

The results of the estimation of the ordered Logit model are given in Table 6.

Table 6

Several statistics are also reported to measure the global goodness of fit of the model to the observed data. First, the pseudo-R^2 (similar to the R^2 measure in the familiar linear regression model) used as an indicator of the global significance of parameters is a bit more than 0.25. Second, the proportion of correctly predicted observations measuring the accuracy in forecasting observed responses is 58%. These results are quite satisfactory for an ordered multinomial model and indicate good global parameter significance and good predictivity for the level of visitation. The results concerning the model predictions are given in Table 7.

Table 7

In addition, the estimated boundaries $\hat{s}_1$, $\hat{s}_2$ and $\hat{s}_3$ were all significantly different from zero at $p = 1\%$, so that $\hat{s}_1 < \hat{s}_2 < \hat{s}_3$, indicating that the choice of four different levels of visitation was sound.

The type of ownership proved to be one of the criteria that presented the highest explicative power for woodland visitation levels. Legislation and forest policy in

Wallonia result in lower visitation levels in private than in publicly owned woodlands, at least in the case of large estates with non-accessible private ways.

The qualitatively evaluated forest type is also an explicative factor for visitation levels. The coefficient signs associated with conifer-dominated woodlands or woodlands combining conifers and broadleaved trees were all significantly negative (at $p = 1\%$). Our results show that woodlands that are not composed entirely of broadleaved trees are less attractive to visitors. This pattern is strengthened by the continuous variables concerning the proportions of broadleaved trees (Prop_broad) and conifers (Prop_conif) calculated trough a GIS analysis. The estimated coefficients of these variables confirm that broadleaved woodlands have greater appeal to visitors than coniferous ones.

The criteria concerning recreational facilities, the existence of sports trails, campsites, areas for youth groups also show a significant positive effect on visitation levels. On the basis of the observed characteristics of the woodland, such facilities guarantee a higher visitation level, the remaining characteristics being equal.

The hydrographic environment also seems to be a criterion of appeal to visitors. The presence of water areas (and most significantly lakes) attracts the public and the woodland itself becomes less important (Colson, 2007). Likewise, map processing shows that a strongly present hydrographic network in the area visited (Prop_hydro) correlates with increased visitation levels.

The other variables obtained during the geoprocessing phase provide additional information on the motives underlying woodland visiting. Slope variables have a significant impact on woodland visiting and suggest that woodlands located on slopes attract more visitors (positive coefficient of the variable Slop_mean). However, slopes that are too steep (Slop_sup30) have the opposite effect and lower visitation levels. We should mention here that these steep slopes include some spots where rock-climbing can be practiced.

Distances from tourist centers can also affect woodland visiting. For example, the greater the minimal distance from a tourist attraction or an urban center, the lower the visitation level is.

Finally, a likelihood ratio test enabled us to test the null hypothesis of nullity of parameters associated with the “cantonnement” dummy variables. This null hypothesis was highly rejected, showing the necessity to take into account the effects specific to the “cantonnements” variable, so as to be able to minimize the bias in estimates linked to the presence of non-observable heterogeneity related to these “cantonnements”.

Discussion

The Wallonia forest visitation map we have drawn up identifies the most heavily visited areas and conversely areas that apparently present no recreational appeal. The importance of forest recreation in the public-owned woodlands in the north of the region is clearly highlighted, for example. It provides thus spatialized information at the regional scale and thereby constitutes a real tool for forest policy making and planning. In particular, this tool can help decision-makers to go forward in restricting the recreational function of woodlands by sub-region.

Thanks to the methodology based on a map-survey carried out among forest managers we have been able to gather a qualitative assessment of the location of forest recreation hubs throughout Wallonia quite easily.

Forest managers themselves appreciate that the spatialization of forest recreation in their district has been formalized. They can use the map to plan where to set up future facilities and where to reserve areas of fauna conservation. It can also justify the time that rangers spend on forest recreation among the various tasks they have.

This map also gives a particularly interesting layer of information for a regional economic study designed to make better use of the recreational function of woodlands. It can be used also as an aggregated index to elaborate an attraction function in a model that spreads out visits from living places.

The ordered logistic regression is well adapted to explain the woodland visitation level, an ordered categorical variable. It makes it possible to quantitatively measure the effect of a set of explanatory variables obtained by different means (interviews, maps and GIS) on the dependant variable. Among the variables selected, the value of the coefficient can give additional information on those that seem to influence visitation levels most. If we look at binary variables, we find that the type of ownership, the type of forest and the presence of recreational facilities, sports trails, orienteering areas, and areas for youth groups are the variables that have the greatest impact on visitation levels.

Among the weaknesses of our data collection method, we note that the regional cover results from the compilation of 37 subjective, and as a result different, appraisals, with no common basis for comparison.

The degree of precision in delimiting the woodlands depends directly on the knowledge that the forest managers have of their districts. However, the aim here was to identify heavily visited spots at the scale of the “cantonnement”, and not at the very local scale as would be necessary when planning facilities.

Another weakness consists in the seasonal variations that are not precisely taken into account in this map. We have to keep in mind that the main objective of this map was to have a regional overview of forest recreation with the best cost (time)/accuracy ratio.

This work describes a situation at a given time, and it may become obsolete if major modifications are made in terms of tourist or recreational facilities and activities. However, updating this visitation map would in fact validate it and could thus be part of a monitoring process. The difficulty would then be to differentiate the modifications due to a different appraisal from those due to a real, visible modification on the ground. However, if the managers can justify the change in visitation levels, the bias would be reduced significantly.

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Figure legends

Figure 1: Forest cover and urban centers with populations over 20,000 in Wallonia and areas less then 50 km from its borders.

Figure 2a, b: Map of levels of visitation obtained from surveys among managers and map showing main watercourses, urban centers and forest-related tourist attractions.

Table 1: Woodland cover and population densities in Wallonia and neighboring regions.

Country	Region	Woodland cover*	Population density*		Road density (all types of roads)	
			inh./km²	Source	km/km²	Source
Belgium	Wallonia	30%	198	Population by statistical sector on 1 January 2001. Institut National de Statistique (INS), Brussels	4.73	SPF Mobilité et Transports - Direction Mobilité (Routes), Brussels,
	Brussels	10%	5938		5.16	
	Flanders	7%	412		11.65	
France	Nord-Pas-de-Calais	8%	462	Population by commune, communal inventory, 1998. Institut National de la Statistique et des Etudes Economiques (INSEE), Paris	2.40	Institut National de la Statistique et des Etudes Economiques (INSEE), Paris
	Picardy	10%	47		1.83	
	Champagne-Ardennes	32%	62		1.13	
	Lorraine	29%	118		1.47	
Grand Duchy of Luxembourg		35%	181	Population by commune on 1 January 2007. Service Central de la Statistique et des Etudes Economiques (STATEC) Luxembourg	1.97	European Road Statistics 2007
Germany	Saarland	28%	147	Population by commune on 31 March 2007, Statistisches Landesamt Saarbrücken, Saarbrücken	2.89	*Statistiche Ämter des Bundes und der Länder*
	Rheinland-Pfalz	41%	34	Population by commune on 30 June 2007. Statistisches Landesamt Rheinland-Pfalz, Bad Ems	0.97**	
	Nordrhein-Westfalen	24%	396	Population by commune on 31 December 2006. Landesamt für Datenverarbeitung und Statistik NRW, Düsseldorf	0.93**	

Netherlands	Limburg	10%	734	Wijk- en buurtkaart 2007. Centraal Bureau voor de Statistiek (CBS), Voorburg/Heerlen	5.27	*Centraal Bureau voor de Statistiek (CBS), Voorburg/Heerlen*

** woodland cover and population density for neighboring regions were calculated for areas located less than 50 km from the boundaries of Wallonia*

Woodland cover was calculated on the basis of the spatial data layer CORINE Landcover 2000 [Environmental Protection Agency].

***Road density is probably underestimated for these two regions (municipalities' road network is not taken into account in the statistics available).*

Table 2: Qualitative evaluation scale for level of visitation of woodlands in Wallonia

CODE	LEVEL OF VISITATION	INDIVIDUAL VISITORS	ACTIVITIES ORGANISED BY ASSOCIATIONS
1	Low	Visitors seen only **exceptionally**	**No** activities
2	Medium	Visitors seen **occasionally** *(mostly on week-ends and during the tourist season)*	**Exceptional** activities *(less than once a year)*
3	High	Visitors seen both on **week-ends** and **in the week**	**Regular** activities *(at least every year)*
4	Very high	Visitors seen **constantly**	**Very regular** activities *(several times a year)*

Table 3: Spatial data layers used

Layer	Description	Data Type
DEM	Digital elevation model	Raster (pixel 20 m)
Slope	Layer derived from DEM describing slope of terrain (in degrees)	Raster (pixel 20 m)
Landcover	Digital land use map of Wallonia	Raster (pixel 20 m)
Natura	Boundaries of Natura 2000 protection areas	Vectorial: polygons
Hydro	Hydrological network	Vectorial: lines
Buffer_hydro	Buffer zone of 25 m around watercourses	Vectorial: polygons
Tourist_ski	Location of main tourist attractions (including ski runs) related to forest and the natural environment	Vectorial: points
Tourist	Location of main tourist attractions (except for ski runs) related to forest and the natural environment	Vectorial: points
Urban	Location of urban centers with populations over 20,000 in Wallonia and neighboring areas less than 50 km from borders.	Vectorial: points
Roads	Main regional road network in Wallonia	Vectorial: lines

Table 4: Binary qualitative variables of woodlands

Variable	Domain	Description	Mean	Source
Public	Ownership	Publicly-owned woodland	0.36	M.I.*
Maj_Pub	Ownership	Mostly publicly-owned woodland with some private plots	0.23	M.I.
Maj_Priv	Ownership	Mostly privately-owned woodland with some publicly-owned plots	0.13	M.I.
Priv	Ownership	Privately-owned woodland	0.28	M.I.
Open	Type of forest	Moors and other semi-open woodland	0.02	V.I.**
Broad	Type of forest	Broadleaved woodland (broadleaves represent more than 80% of the woodland area)	0.14	V.I.
Broad_conif	Type of forest	Woodland composed of broadleaved trees with some coniferous stands	0.53	V.I.
Conif_broad	Type of forest	Woodland composed of conifers with some broadleaved stands	0.27	V.I.
Conif	Type of forest	Coniferous woodland (conifers represent more than 80% of the woodland area)	0.04	V.I.
Hydro_0	Hydrographics	No watercourse or other water area present	0.42	V.I.
Brook	Hydrographics	Brooks present	0.44	V.I.

River	Hydrographics	River present	0.07	V.I.
Pond	Hydrographics	Pond present	0.06	V.I.
Lake	Hydrographics	Lake present	0.01	V.I.
Facil	Recreational facilities	Presence of recreational facilities other than simple sign-posting	0.18	M.I.
Sport	Sports trails	Presence of sports trails with infrastructures (most of them concern health trails)	0.05	M.I.
Youth	Youth groups	Seasonal presence of youth groups (mainly with camp sites during July and August)	0.21	M.I.
Camp	Campsites	Presence of a campsite near the woodland	0.05	M.I.
Pick_0	Picking	No picking (berries, mushrooms, flowers) in the woodland	0.83	M.I.
Pick_1	Picking	Light picking in the woodland	0.13	M.I.
Pick_2	Picking	Heavy picking in the woodland	0.04	M.I.
Orient	Orienteering	Presence of an area accessible for orienteering in the woodland (the only one activity –except youth activities - allowed inside stands in public woodlands)	0.05	M.I.

*M.I. Manager interviews.

**V.I. Visual interpretation of map.

Table 5: Quantitative variables of woodlands

Variable	Domain	Description	Mean	Source	Type
Dist_hydro	Water proximity	Average distance to the closest watercourses	2.906 km	Hydro	DMEAN
Dist_tour_ski	Tourist attractions	Average distance to the closest tourist attractions including ski runs	4.938 km	Tourist_ski	DMEAN
Dist_tour	Tourist attractions	Average distance to the closest tourist attractions except for ski runs	5.134 km	Tourist	DMEAN
Dist_urban	Urban proximity	Average distance to the closest urban centers with populations over 20,000	20.119 km	Urban	DMEAN
Dist_road	Road proximity	Average distance to the closest main roads	1.012 km	Roads	DMEAN
Dist_min	Proximity of roads or attractions	Minimum distance (the closest tourist attractions other than skiing OR the closest urban center with populations over 20,000)	5.109 km	Urban & Tourist	DMEAN
Prop_broad	Proportion of tree species	Proportion of woodland area taken up by broadleaved species	0.56	Landcover	AREA%

Prop_conif	Proportion of tree species	Proportion of woodland area taken up by conifers	0.26	landcover	AREA%
Prop_other	Proportion of tree species	Proportion of woodland area not taken up by broadleaved species or conifers (semi-natural areas)	0.18	landcover	AREA%
Prop_natura	Proportion Natura 2000	Proportion of woodland protected by Natura 2000	0.29	Natura	AREA%
Prop_hydro	Proportion close to water	Proportion of woodland located less than 25m from a main watercourse	0.01	Buffer_hydro	AREA%
Slop_inf10	Slope	Proportion of woodland on slopes less than 10°	0.79	Slope	AREA%
Slop_sup30	Slope	Proportion of woodland on slopes greater than 30°	0.01	Slope	AREA%
Slop_mean	Slope	Average slope	7.09°	Slope	-
Slop_std	Slope	Standard deviation of slope	4.71°	Slope	-

Table 6: Ordered Logit model with fixed effects estimated by maximum likelihood

Variable	Coefficient	Standard deviation	*t*-stat	Prob
Public	2.4942	0.1840	13.5538	0.0000
Maj_pub	2.0103	0.2014	9.9831	0.0000
Maj_priv	0.7079	0.2214	3.1972	0.0014
Broad_conif	-1.0902	0.3660	-2.9785	0.0029
Conif_broad	-0.7796	0.3248	-2.3999	0.0164
Conif	-1.1281	0.3078	-3.6647	0.0002
Pond	0.3496	0.2432	1.4374	0.1506
Lake	0.6683	0.2629	2.5424	0.0110
Facil	1.8978	0.8065	2.3532	0.0186
Sport	1.8212	0.1860	9.7909	0.0000
Youth	1.3874	0.2871	4.8327	0.0000
Camp	0.6034	0.1726	3.4963	0.0005
Orient	0.7887	0.2878	2.7401	0.0061
Slop_mean	0.2611	0.0831	3.1428	0.0017
Slop_inf10	2.4042	1.4683	1.6374	0.1015
Slop_sup30	-5.9180	2.8659	-2.0649	0.0389
Prop_broad	0.0203	0.0046	4.4465	0.0000
Prop_conif	0.0115	0.0048	2.4205	0.0155
Dist_tour	0.1510	0.0609	2.4777	0.0132
Dist_tour_ski	-0.0756	0.0465	-1.6260	0.1040
Dist_min	-0.1438	0.0494	-2.9123	0.0036
Prop_hydro	0.1119	0.0354	3.1627	0.0016
s_1	7.7132	1.8914	4.0780	0.0000
s_2	9.8798	1.9014	5.1962	0.0000
s_3	12.0973	1.9140	6.3204	0.0000

# Observations	1195
# Cantonnements	37
Log-likelihood	-1160.23
Pseudo-R^2 of McFadden	0.2534
Correct predictions	58%

Notes: Sample size (N) = 1195. Prob is the p-value giving an indication of the significance level (the smaller the p-value, the most significant the result is). Only the most significant variables have been kept in the final regression. In order to save space, the estimated parameters of dummy variables for "cantonnement" are not reported here.

Table 7: Predictions with the ordered Logit model

Observed values	**Predicted values** Y1	Y2	Y3	Y4	Total
Y1	313	103	10	0	426
Y2	114	207	51	8	380
Y3	17	101	124	24	266
Y4	4	29	43	47	123
Total	448	440	228	79	1195

Figure 1

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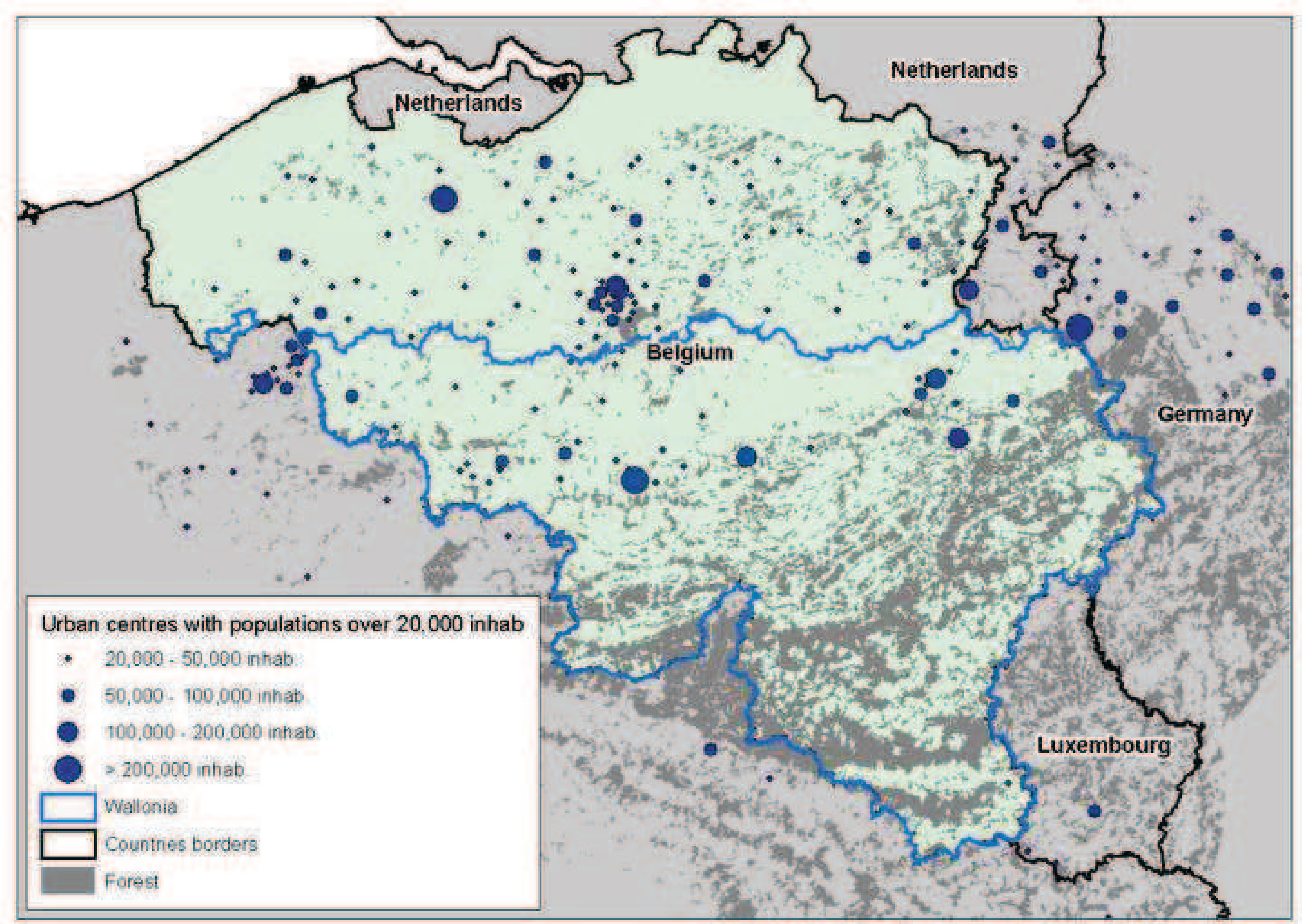

Figure 2a

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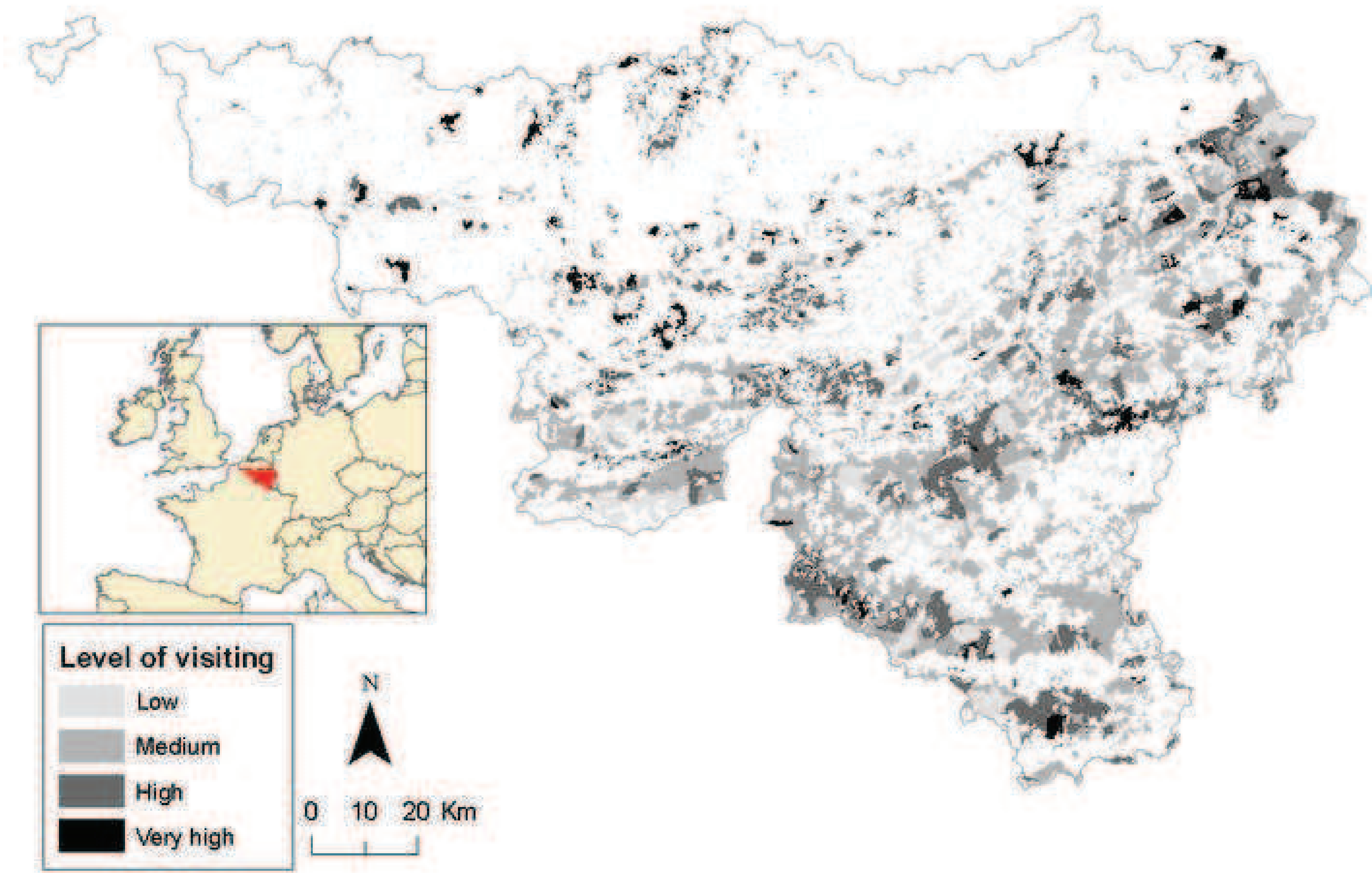

Figure 2b
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