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# Spatial valuation of recreation activities in forest systems: application to province of Segovia (Spain)

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## Abstract

During the past few years there has been an important boost in the application of environment valuation techniques in forest ecosystems. In Spain these studies have been characterized, among other features, by having been carried out in Protected Natural Areas and by not having included the spatial component of the territory. In this paper, it is aimed to make a valuation of the recreation activities for all the forest systems in a specific province (Segovia), integrating the space component by means of the CORINE Land Cover 2000 cartography. For that purpose, the results of 41 research works conducted in Spain have been taken, and, through a meta-analysis exercise, a model has been set up to estimate the willingness to pay for any recreation activity in the above forests. The model has different explanatory variables, including the inhabitants situated at a certain distance from the forest, the provincial income or the forest category associated with the CORINE polygon. The number of visitors has been obtained from the occupation degree of the accommodation in the rural dwellings of this province. Thus, the results obtained could be taken as being a low threshold of the recreation value associated with these ecosystems.

**Key words**: recreation activities, benefits transfer, spatial valuation, econometric models.

## Resumen

**Valoración espacial de la actividad recreativa en sistemas forestales. Aplicación a la provincia de Segovia (España)**

Durante los últimos años se ha producido un gran auge en la aplicación de técnicas de valoración ambiental en los ecosistemas forestales. Para el caso de España estos estudios se caracterizaban, entre otras peculiaridades, por estar realizados en Espacios Naturales Protegidos y por no estar realizados incluyendo la componente espacial del territorio. En este trabajo se pretende realizar una valoración de la actividad recreativa para la totalidad de los sistemas forestales de una provincia determinada (Segovia) integrando la componente espacial a través de la cartografía CORINE Land Cover 2000. Para ello se han tomado los resultados de 41 trabajos realizados en España y a través de un ejercicio de meta-análisis se ha construido un modelo para estimar la disposición a pagar por la actividad recreativa en los citados montes. El modelo presenta distintas variables explicativas, incluyendo aspectos como la población situada a unas determinadas distancias del monte, la renta provincial o la estructura promedio de la masa forestal en cada polígono CORINE analizado. El número de visitantes se ha tomado a partir del grado de ocupación de las casas rurales situadas en esta provincia. Por ello, los resultados obtenidos podrían tomarse como un umbral inferior del valor recreativo asociado a estos ecosistemas.

**Palabras clave**: actividad recreativa, transferencia de beneficios, valoración espacial, modelos econométricos.

## Introduction

The gradual integration of different goods and services offered by forest systems to society into decision-making in the management of these resources makes it necessary to have tools available which permit a valuation of the natural assets associated with these ecosystems; for instance, recreational activities, characterized by an incessant demand in forest systems from many years previously. It seems to make sense to think that if it is wished to set up any wise forest planning of activities which entail a management of the resources (forest exploitation, reserve establishment, fire prevention, etc.), it would be necessary to integrate into it, from an economic perspective, the different goods and services taken into consideration. Therefore, to make that integration effective, a spatial component should

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be introduced, which includes the values associated with the different forest outputs, such as certain precise information on each one of them, and all of it linked to a geographic information system (Beverly *et al.*, 2008).

Among the outputs associated with many forest systems, recreation activity has become one of the amenities most demanded by society. However, it is not easy to provide data to justify this due to the absence of any statistics integrating this service, which almost always lacks any market price, with other items which do have a direct relationship with commercial activities. Furthermore, if it were wished to calibrate its importance with indicators such as the number of visitors, in Spain it is only possible to obtain partial data associated with areas with protection figures, or in zones without any specific link to forest systems.

To perform valuations of recreation activities, the techniques usually resorted to are those based either on the design of a hypothetical market, including surveys using those members of the public likely to benefit from the environmental assets being assessed here, or those studying certain surrogated markets. These procedures encompass both the declared preferences methods, in which contingent valuation is the methodology most used, and the revealed preferences method, in which the most popular one would be the travel cost method. However, the use of any of these techniques means an important associated cost, both in time and resources. That is why, in recent years, some studies have appeared which attempt to fix a value on a specific place based on studies made in other comparable ones, where measurements have been made of similar values or environment quality changes to those it is aimed to obtain here (Navrud and Ready, 2007). This is known as a benefit transfer, which is the methodology used in this work. This technique has already been the subject of an extensive bibliography, and although, since its origins, its applications have been focused on areas characterized by the presence of water, they have been extended to other ecosystems. Recently, different works have been published aiming to estimate the recreation value in forests (Scarpa *et al.*, 2007; Zandersen and Tol, 2009).

Furthermore, with this type of study, the spatial component underlying it has to be taken into consideration (Bateman *et al.*, 2002). Referring to their scale, some works have been designed to give answers at a national level (Azqueta and Tirado, 2008), regional (Bateman *et al.*, 2005), or county (Chen *et al.*, 2009) level, whereas most of them refer to a certain location. Leaving aside this latter case, where the study is focused at a more aggregate level, it would seem to be essential to add a spatial component to it. However, there are few works in the literature incorporating this element, although one of the pioneer ones is that of Eade and Moran (1996), who used the benefit transfer methodology to calculate a value per unit of surface for ten amenities and services associated with a watershed in Belize. Additionally, Bateman *et al.* (2005) obtain, for some United Kingdom regions, values associated with different forest goods and services (timber, carbon, recreational aspects), and integrate them at a spatial level with the aid of a GIS. Another recent work integrates a spatial component in making a valuation of a recreation activity in forest systems (Termansen *et al.*, 2008).

The mapping used in this work is from the CORINE Land Cover project, whose fundamental objective, originally, was the capture of numerical and geographical data for the creation of a European database on a 1:100,000 scale of the coverage and use of the territory (land occupation) at a European level, which follows homogeneous criteria when assigning the different types of cover. The information is based on images obtained by the satellite Landsat 7 ETM, basically in year 2000. The use of this cartography as a tool in forestry research, conservation and environment policies is widely extended. CORINE Land Cover distinguishes five levels, the last two being national ones. In this current work, level 5 has been employed. The cartographic precision is of at least 100 m, the smallest polygon represented being of 25 ha. This database is used by the European Environment Agency for the integration of environment information from countries in Europe, especially for assessing the land use changes occurring in past years, and in forestry studies of diverse aspects (Cruickshank *et al.*, 2000; Pascual-Hortal and Saura, 2007). Some authors have declared that, in the future, this could be the support for economic accounting at a spatial level (Weber, 2007).

In this context, the main objective of this work is to present a methodology which obtains a recreational value at a provincial level, using previously available information and results. It should be taken into account that the development of this work is strongly conditioned by the hypotheses considered, mainly on the assignation and handling of the different values used per territory unit. Thus, firstly, it should be emphasized that the work aims exclusively to estimate the recreation value associated with forest ecosystems at a provincial level; that is to say, no other goods or services characteristic of those forest stands will be integrated into the valuation, nor is it intended to set up an agroforestry accounts system (Caparrós *et al.*, 2001; Caparrós *et al.,* 2003; Campos *et al.,* 2008) for the forests in this province, or include other non-forested lands. With regard to recreation activity, no particularities associated with the capacity of the different forest ecosystems to offer different types of services will be introduced into the analysis. Finally, the year taken as a reference is 2005.

Due to the methodology used, no surveys have been made in forest areas. This fact implies that, among other reasons, in this study, no environmental self-consumption that owners of the forest systems might make was taken into account in spite of its importance in some forest ecosystems (Campos and Caparrós, 2006; Campos *et al.,* 2009). This was due both to technical reasons (the titularity of the forest properties being studied was unknown), and to the use of the benefit transfer method.

It is important to highlight that same-day visitors have not been considered as no disaggregated statistics were available. Therefore, in view of the impossibility of counting on reliable statistics of visitors to a certain forest system, it was opted to restrict the study to the valuation of those visitors staying overnight in rural dwellings. For that reason, the results obtained here should be interpreted as being a minimum threshold use of the recreation activity associated with these forest ecosystems.

The work is structured as follows. First, the information necessary for carrying out this analysis is described, and then the benefit transfer models used are shown. Next, the results obtained are given, and, to finish up, there is a discussion section.

## Material and methods

This section is divided into four sub-sections. First, the case, the literature sources and the rest of the material employed are presented. The basic characteristics of the benefit transfer model are explained next. The last sub-sections refer to the variables used in the models and to the calculation of the willingness to pay (WTP). Finally, it has been considered appropriate to present the expressions of the benefit transfer model in the Results section.

### Material

The study area comprised the province of Segovia, whose diverse areas, both for their nearness to Madrid and attractiveness, are characterized by their receiving a large number of visitors. It should be remembered that in this province there are two Natural Parks (Hoces del Duratón and Hoces del Río Riaza) and the forthcoming Regional Park of the Sierra del Guadarrama.

Of the 685,000 ha making up the province of Segovia, 48% is covered by forest area, 74% of which is tree-covered, with 275 forests catalogued under Public Utility. Thus, nearly 9% of the province is subject to some type of protection, whether this be natural parks, beauty spots, nature reserves or natural sites, with the future Regional Park of Guadarrama not being included in this count. As for the tree species, among the conifers *Pinus sylvestris* L., which is spread over a surface of 10,768 ha, *Pinus pinaster* Ait. stands out, and *Pinus pinea* L. also covers a notably important area. The most representative deciduous trees are *Quercus ilex* L. and *Quercus pyrenaica* Willd. The forest coverage assigned by CORINE Land Cover to the province of Segovia was of 410,313.6 ha, composed of 995 polygons, which had an average surface of 375.7 ha each.

The first step in this methodology entails the selection of suitable existing studies to provide a basis for a benefit transfer. In our case, we start with a database of 56 studies, 41 of which have been chosen. The studies discarded did not meet the usual data quality conditions (Plummer, 2009). Some of them are inadequate (with a zero Fraction of canopy cover), others have been developed in non-forested areas according to the CORINE codes, and some studies are not clearly related to recreational aspects. Besides, in the initial database there were that did not specify the studied area accurately, and, thus, we rejected them. In order to subsequently dispose of homogeneous information on areas and visitors, the results of the different studies always refer to Protected Natural Areas. Thus, the study on the Cíes Isles (González *et al.*, 2001) extends to the Atlantic Islands of Galicia National Park and the one on Pla de Boaví (Riera *et al.*, 1994) reaches the Natural Park del Alt Pirineu. On the other hand, the study on natural areas in the west of Grand Canary (León, 1995) is focused on the Natural Park of Tamadaba. In other areas, where these environmental valuation methods have been applied, the survey area exceeds the protected areas where they are located. This is the case of the

Natural Park of Peñalara (Caparrós and Campos, 2002) and the National Park of Monfragüe (Campos *et al.,* 1996). In these cases, only the area with the highest protection degree has been considered in the benefit transfer model. Table 1 contains a summary of their characteristics, and some clarifications on them follow here.

Besides, it should be noted that, as a reference year, the economic results of the willingness to pay refer to

**Table 1.** List of studies used to set up the benefits transfer model

| Place | Year of survey | Area (ha)* | Protection fig. | Method | WTP (€$_{2005}$) | Source |
|---|---|---|---|---|---|---|
| Dehesa del Moncayo | 1994 | 9,907 | Natural Park | CV | 5.20 | Rebolledo y Pérez y Pérez (1994) |
| Alt Pirineu | 1994 | 69,870 | Natural Park | CV | 8.14 | Riera *et al.* (1994) |
| Tamadaba | 1993 | 7,479 | Natural Park | CV | 13.88 | León (1995) |
| Señorío de Bertiz | 1995 | 2,054 | Natural Park | CV | 5.98 | Pérez y Pérez *et al.* (1996) |
| Monfragüe | 1993 | 18,403 | National Park | CV | 10.33 | Campos *et al.* (1996) |
| Ordesa y Monte Perdido | 1995 | 15,665 | National Park | CV | 6.74 | Barreiro y Pérez y Pérez (1997) |
| Teide | 1997 | 18,984 | National Park | CV | 13.66 | León *et al.* (1997) |
| Caldera de Taburiente | 1997 | 4,354 | National Park | CV | 11.98 | León *et al.* (1997) |
| Monte Aloia | 1994 | 789 | Natural Park | CV | 2.87 | González (1997) |
| Aigüestortes i Estany de Sant Maurici | 1997 | 13,935 | National Park | CV** | 10.72 | Riera *et al.* (1998) |
| L'Albufera | 1995 | 20,998 | Natural Park | CV | 5.60 | Del Saz y Suárez (1998) |
| Posets-Maladeta | 1996 | 34,176 | Natural Park | CV | 6.07 | Pérez y Pérez *et al.* (1998) |
| Peñalara | 1999 | 738 | Natural Park | CV | 5.15 | Caparrós (2000) |
| Mondragó | 1997 | 750 | Natural Park | TCM | 0.13 | Riera Font (2000) |
| Islas Atlánticas Gallegas | 1998 | 1,176 | National Park | CV | 15.55 | González *et al.* (2001) |
| Hornachuelos | 1999 | 60,047 | Natural Park | CV | 1.45 | Arriaza *et al.* (2002) |
| Sierra Mágina | 1999 | 19,978 | Natural Park | CV | 1.68 | Arriaza *et al.* (2002) |
| Andújar | 1999 | 74,903 | Natural Park | CV | 3.10 | Arriaza *et al.* (2002) |
| Cazorla-Segura | 1999 | 210,123 | Natural Park | CV | 2.70 | Arriaza *et al.* (2002) |
| Desert de les Palmes | 2003 | 3,042 | Natural Park | CV | 0.80 | Bengoechea (2003) |
| Doñana | 2001 | 54,999 | National Park | CV | 7.77 | Júdez *et al.* (2003) |
| Aigüestortes i Estany de Sant Maurici | 1997 | 13,935 | National Park | CV** | 7.48 | Farré (2003) |
| Somiedo | 2003 | 29,164 | Natural Park | CV** | 6.66 | García y Colina (2004) |
| Sierra Espuña | 2002 | 17,702 | Regional Park | CV** | 3.32 | Vidal *et al.* (2004) |
| Sierra de Espadán | 2002 | 31,182 | Natural Park | CV** | 3.16 | Plá y Vidal (2004) |
| Los Alcornocales | 2002 | 167,755 | Natural Park | CV | 12.11 | Oviedo *et al.* (2005) |
| El Montgó | 2005 | 2,083 | Natural Park | CV** | 5.67 | Riera (2005) |
| Sierra de María-Los Vélez | 2004 | 22,561 | Natural Park | TCM | 20.00 | Castillo *et al.* (2007) |
| Garrotxa | 2002 | 13,942 | Natural Park | TCM | 6.14 | Creel y Farell (2008) |
| Aiguamolls | 2002 | 4,760 | Natural Park | TCM | 3.23 | Creel y Farell (2008) |
| Montserrat | 2002 | 3,513 | Natural Park | TCM | 9.64 | Creel y Farell (2008) |
| Montseny | 2002 | 29,493 | Natural Park | TCM | 8.43 | Creel y Farell (2008) |
| Cadí-Moixeró | 2002 | 41,060 | Natural Park | TCM | 2.54 | Creel y Farell (2008) |
| Cap de Creus | 2002 | 13,844 | Natural Park | TCM | 3.78 | Creel y Farell (2008) |
| Ports de Beseit | 2002 | 35,050 | Natural Park | TCM | 1.42 | Creel y Farell (2008) |
| Sant Llorenç del Munt i l'Obac | 2002 | 9,638 | Natural Park | TCM | 1.57 | Creel y Farell (2008) |
| Garraf | 2002 | 12,425 | Special Protection Plan | TCM | 4.83 | Creel y Farell (2008) |
| Collserola | 2002 | 8,500 | Special Protection Plan | TCM | 14.84 | Creel y Farell (2008) |
| Montnegre | 2002 | 14,796 | Special Protection Plan | TCM | 1.60 | Creel y Farell (2008) |
| Calblanque, Monte de las Cenizas y Peña del Águila | 2007 | 2,453 | Regional Park | CV | 4.19 | Martínez *et al.* (2008) |
| Doñana | 2004 | 54,999 | National Park | TCM | 21.15 | Martín-López *et al.* (2009) |

CV: contingent valuation. TCM: travel cost method. * The area considered is the Protected Area (in some studies the survey has covered more surface). ** The study also used the travel cost method, but in this work only the results obtained by contingent valuation have been employed.

the year in which the data were collected for the study (year of the survey), and not the year of publication of that study. Only 14 of the 42 works selected employ the travel cost method, the rest have either used contingent valuation, or both methods, but in this study only the results obtained by contingent valuation have been considered. Willingness to pay data are expressed as willingness to pay per visit. The selected works offer a WTP coming from a non homogeneous payment vehicle, since it sometimes represents a total value (the consumer surplus) and in other cases it is a change value. In this paper, regarding WTP, both kinds of works have been considered, but, following Campos and Caparrós (2009a,b) it should be borne in mind that those studies that offer a total value do not allow the aggregation of other market values offered by forests.

The information on visitors to each protected area has been obtained from diverse sources and personal communications[1]. The information related to rural accommodation has been obtained from the Institute for Tourism Studies (IET, 2006), as well as from other publications and databases[2]. Finally, it should be pointed out that both the Spanish Forest Map and the Spanish Forest Inventories (Dirección General de Conservación de la Naturaleza, 2004) have been used for the calculation of different variables included in the benefit transfer models.

## Benefit transfer

The methodology applied in this work is known as benefit transfer, and it is a type of analysis increasingly used in the sphere of environment valuation. There are basically three transfer procedures: average willingness to pay transfer (WTP) of a study on the context objective, value function transfer, and a benefit function transfer by means of a meta-analysis (Lavandeira *et al.*, 2007). In this work, it was opted for this latter procedure, through which it has been attempted to condense different study values into one single-value function. A meta-analysis to carry out the benefit transfer is a widely-used option in this type of research due to its various advantages (Shrestha *et al.*, 2007). However, this method shows weaknesses and error sources that could limit the accuracy of the benefit transfer studies (Bergstrom and Taylor, 2006; Rosenberger and Stanley, 2006).

Although the above methods have been received with increasing interest in recent years, it should be emphasized that almost all the valuation exercises made up to date have focused on National or Natural Parks or similar places, as can be seen in other works (Prada, 2001). Therefore, it should be realized that exercises of this type carried out in Spain are not very exhaustive, and, in addition, they have rarely been made in areas in which a joint production activity is produced, at least associated with wood production and a recreation activity. As practically all the works employed are linked to protected natural areas, there is certain homogeneity between them, in the sense that they show, on a higher or lower scale, contrasted environment attributes.

One aspect to be considered refers to the determination of the total number of visitors in protected natural areas (PNA) homogeneously, since, in some of them, the only information available was that on the visitors to interpretation centres, but not their total number. To solve this problem, the authors have calculated the logarithmic regression shown in [1] based on the values of 49 protected areas supplied by EUROPARC (2008):

$$\ln(visitot) = 1.3328 + 1.01206 * \ln(vcen) \qquad [1]$$

where *visitot* is the total number of visitors to each PNA, while the interpretation centre visitors are integrated into the variable *vcen.* Using this regression function, the total number of visitors for 7 of the PNAs shown in Table 1 has been obtained: (Moncayo, María-Los Vélez, Sierra Mágina, Los Alcornocales, Maladeta, Cazorla-Segura, Andújar, and Hornachuelos).

Once the studies permitting the obtainment of the willingness to pay for the recreation service estimations have been selected, the next step covers the variables to be used in the meta-analysis in order to estimate, with econometric methods, the willingness to pay of each visitor. Finally, this value is transferred spatially in the province of Segovia. The following sections go into these issues in greater depth.

## Variables selected in the model

The following is an analysis of the potential explanatory variables for the meta-analysis made, included in Table 2. In this model, the dependent variable is

[1] EUROPARC (2008); Fundación EROSKI; Cabildo de Gran Canaria.
[2] Patronato Provincial de Turismo de Segovia, 2008; INEbase.

willingness to pay (*wtp*), the rest being independent variables. The first of them (the variable *area*) refers to the surface of the PNA, and it has been obtained in a preferred raster format.

With regard to the total number of visitors, its calculation needs to be clarified as different possibilities can be presented. Firstly, if they are PNAs, the methodology described above will be applied, basically using the data of total visits during 2005 supplied by EUROPARC (2008). When the number of visitors to the PNA interpretation centres was available but not the total number of visitors, we resorted to the loga-

**Table 2.** Variables tested in the model

| Variable | Meaning | Mean | Std. dev. |
|---|---|---|---|
| WTP | Willingness to pay | 6.9 | 5.2 |
| Area | Park area | 29,568.0 | 41,939.4 |
| Total visitors | Total number of visitors | 384,100.6 | 701,266.7 |
| Influx | Number of visitors per hectare | 54.6 | 120.1 |
| Age | PNA declaration year | 20.5 | 14.6 |
| Interpretation Centres | *Dummy* = 1, if there are interpretation centres in the PNA | 0.6 | 0.5 |
| Recreation areas | *Dummy* = 1, if there are recreation areas in the PNA | 0.6 | 0.5 |
| Protection figure | *Dummy* = 1, if it is a National Park | 0.2 | 0.4 |
| Protection figure 2 | *Dummy* = 1, if it is a Natural Park | 0.8 | 0.4 |
| Study | *Dummy* = 1, if the Willingness to Pay data (WTP) come from a contingent valuation study | 0.6 | 0.5 |
| Islands | *Dummy* = 1, if PNA is inside an island | 0.1 | 0.4 |
| Wet area | *Dummy* = 1, if PNA is located in a wet area | 0.3 | 0.5 |
| Period 1 | *Dummy* = 1, if the study was made before 1995 | 0.2 | 0.4 |
| Period 2 | *Dummy* = 1, if the study was made between 1996-2001 | 0.2 | 0.4 |
| Period 3 | *Dummy* = 1, if the study was made after 2001 | 0.6 | 0.5 |
| Forested area | Percentage of the forested area in the province | 40.8 | 15.1 |
| Natura 2000 network area | Percentage of Natura 2000 network area in relation to forested area in the province | 30.1 | 15.4 |
| Density | Density of population in the province (inhabitants/ha) | 1.7 | 1.8 |
| Income 2005 | Per capita income in the province (year 2005) | 13,443.9 | 2,198.2 |
| Income Relative | *Dummy* = 1, if provincial per capita income is less than Spanish per capita income | 0.5 | 0.5 |
| Fcc | Fraction of canopy cover | 35.5 | 22.6 |
| Tfc (Total forest categories) | Weighted forest categories based on the CORINE Level 3 codes refered to total park area | 1.9 | 0.8 |
| Rfc (Relative forest categories) | Weighted forest categories based on the CORINE Level 3 codes refered to forested park area | 2.1 | 0.7 |
| State | Silvicultural class based on diameter at breast-high | 1.7 | 0.6 |
| Mixed Forested Area | Percentage of forested area with three or more tree species | 17.7 | 19.2 |
| SPA | *Dummy* = 1, if it is a Special Protection Area | 0.7 | 0.4 |
| Maximum slope | Maximum slope in the PNA | 29.7 | 20.9 |
| Average slope | Average slope in the PNA | 95.4 | 57.3 |
| b5 | Number of inhabitants located in a ring buffer at 5 km or less from the PNA | 175,173.7 | 474,359.7 |
| b10 | Number of inhabitants located in a ring buffer at 10 km or less from the PNA | 246,973.0 | 565,657.2 |
| b25 | Number of inhabitants located in a ring buffer at 25 km or less from the PNA | 678,429.8 | 1,008,502.0 |
| b50 | Number of inhabitants located in a ring buffer at 50 km or less from the PNA | 1,574,985.0 | 1,747,979.0 |
| b100 | Number of inhabitants located in a ring buffer at 100 km or less from the PNA | 3,039,115.0 | 2,141,622.0 |
| b5/10 | Number of inhabitants located in a ring buffer between 5 and 10 km away from the PNA | 75,246.4 | 110,600.1 |
| b10/25 | Number of inhabitants located in a ring buffer between 10 and 25 km away from the PNA | 429,034.1 | 649,376.4 |
| b25/50 | Number of inhabitants located in a ring buffer between 25 and 50 km, 50 and 100 km, and between 100 and 200 km | 913,318.7 | 1,135,131.0 |
| b50/100 | Number of inhabitants located in a ring buffer bet ween 50 and 100 km away from the PNA | 1,464,130.0 | 1,197,994.0 |

PNA: protected natural area.

rithmic regression shown in [1] above. It is also necessary to make some reservations in this case. If they are forest surfaces not subject to protection figures, when no portion of the CORINE polygon has been occupied by a PNA, it is considered to be convenient to estimate the number of visitors as a function of the affluence of travellers to rural accommodation. Thus, if there is a rural dwelling located in the CORINE polygon, the number of annual tourists is determined from the information available on the rural accommodation through the expression:

$$\begin{aligned} &\textit{Visitors} = \textit{number of places} \times \\ &\times \textit{degree of occupation} \times \textit{number of days} \end{aligned} \quad [2]$$

where the *Number of places* in rural accommodation is determined on the basis of the sources available previously mentioned (Instituto de Turismo de España, 2008; Patronato Provincial de Turismo de Segovia, 2008), the *Degree of occupation* per Autonomous Community can be obtained from the Survey of Occupation in Rural Tourism Accommodation 2005, and, finally, the *Number of days* corresponding to 2005 is established considering holidays of one month. If there is more than one rural dwelling in the polygon, the values obtained for each of them are added. Finally, when there are no rural dwellings in the polygon, a minimum value is assigned to them as will be seen in the following sub-section. Other variables introduced related to PNAs are the *influx* (number of visitors per hectare) and the PNA declaration year.

One variable considered initially was the existence of interpretation centres in the park in the PNAs, defining this variable as a dummy: presenting the value 1 if there are interpretation centres and 0 if there are not. Another aspect related to recreation activities included in these models as a dummy variable is the existence of these areas in each PNA. Additionally, and given that some environmental valuation exercises have been carried out in areas with a higher protection level, two dummy variables haven been defined for the Protection Figure associated with each Park. One of these takes the value 1 if the PNA is a National Park, and 0 if not, and the other takes the value 1 if the PNA is a Natural Park, which possesses fewer environmental attributes than National Parks. Other dummy variables have been incorporated into the model. Thus, following the studies of Bergstrom and Taylor (2006) or Rosenberger and Stanley (2006), we have resorted to a dummy variable which takes the value 1 if the PNA study was made following the contingent valuation method and 0 if the travel cost method was adopted. The same as in other studies (Prada, 2001), an independent dummy-type variable has been introduced if the park or natural area is located in a wet area. Moreover, due to the specific conditions regarding environmental valuation studies in PNAs on islands (Canary Islands, Balearic Islands), a dummy variable has been included. This dummy takes the value 1 if PNA is located on an island. In order to check if the study age is relevant in the WTP, three dummy variables have been defined according to the period in which these studies have been made (Barrio and Loureiro, 2008).

A group of variables associated with the provinces in which each PNA is located has also been included. It was assumed that the perception of the recreation value was influenced by the region in which the environment valuation study was made. However, in other countries, this fact has been rejected empirically (Rolfe and Windle, 2008). Thus, two of them are linked to the characteristics of the forested area in the province: *forested area* is the percentage of the forested area, and another variable measures the Natura 2000 network area. As the population density in the province could possibly affect the WTP, a variable for this (*density*) has been introduced. Finally, to check the influence of the per capita net income, a value usually included in this kind of model, two variables were established: the per capita income in the province (year 2005), and a dummy variable which takes the value 1 if the per capita net income was higher than the Spanish average per capita income, and 0 otherwise.

Another group of variables regarding the forest characteristics of the site has been added. At first, the Fraction of canopy cover (*Fcc*) was also taken as a variable. The idea underlying this was that the density of the forest stands present is directly related to the affluence of a larger number of visitors to the park, or to the rural accommodation located in the polygon considered. Other studies have introduced a direct measurement of density (Hoon Cho *et al.*, 2008) into the models, but we believe that this only makes sense when agricultural and forest systems are analysed. In this particular case, as the non forested area is being discriminated from the outset, it would seem to be better to use a measurement as *Fcc.* Other explanatory variables introduced into the model were: *Tfc,* total forest categories, and *Rfc*, relative forest categories. These data have been calculated for each park by making a weighting based on the CORINE CLC level 3 codes, assigning value 1 to pastures and scrub (321, 322, 323), value 2 to a transition wooded brushland (324), value 3 to deciduous or coniferous woods (311, 312), and value 4 to mixed woods (313). In one case, this weighted result has referred to the total park area, and in the other, only to the forested area, following CORINE CLC. It is assumed (i.e., Scarpa *et al.*, 2000) that attributes associated with the composition of the forest may influence the greater or lesser affluence of visitors. A variable related to the silvicultural class based on diameter at breast-high (*State*) has been introduced. Since there is no reliable measurement of the forest age in each park, this variable could be taken as a proxy of the age. It is important to remember that the old mature stands are usually more appreciated by the visitors, and this attribute is included in some benefit transfer studies (Scarpa *et al.,* 2000). In addition, two variables regarding the environmental quality of the parks have been included. First, the percentage of mixed forested area. In this case, superimposing the Spanish Forest Map (SFM), the area with at least three tree species has been measured. The hypothesis underlying this idea is that the mixed stands are better from a biodiversity point of view, and, hence, are better esteemed by the visitors (Hoon Cho *et al.,* 2008). Also, a dummy variable related to the possibility that the forested area of each park is included in a Special Protection Area has been added. These Special Protection Areas are strictly protected sites classified in accordance with UE Directives on the conservation of wild birds. Finally, in order to verify if one of the features most demanded in these PNAs was a steep area, two associated variables were introduced: the maximum and medium slopes in each polygon.

The last group of variables makes reference to the inhabitants inside a ring buffer nearest to each forest system. It is necessary to remember that spatial factors of these characteristics are usually employed in similar works (Rosenberger and Phipps, 2007). The ring buffers have been used in two ways: in an absolute way and of an accumulative nature. In the first case, the variables measure the census of inhabitants located in ring buffers from the PNA (5 km, 10 km,...100 km). In the second, a census was taken of the inhabitants at a previously fixed distance from each polygon. In order to prevent possible multicollinearity problems, rings associated with the inhabitants residing in a zone located between two distances previously mentioned were chosen (b5/10, b10/25, b25/50, b50/100), in which b5/10 would be the inhabitants residing in a ring located between 5 and 10 km of the reference element; b10/25, those residing in a ring situated between 10 and 25 km, etc.

## Calculation of the willingness to pay per hectare

To calculate the WTP a model has been estimated, starting from the 41 studies presented in Table 1. Different functional forms and estimation methods have been compared. The appropriate parameter and residue diagnoses were made, as well as exploring the possible existence of a multicollinearity between the explanatory variables, and problems derived from heterokedasticity have been examined (Novales, 2000; Wooldridge, 2006).

The determination of the willingness to pay, which occupies the sixth column of the Table cited, was made taking to year 2005 the willingness to pay per visit value determined in each study. For this purpose, we used the annual variation in the consumer price index (INEbase, 2008).

It is also necessary to clarify that for each CORINE polygon, the values of the explanatory variables considered have been incorporated into the Model. Reality shows us that only a small part of those polygons presents one or more rural dwellings inside it. That is to say, in the surroundings of the polygons attributed to forest areas, rural accommodation is frequently found and those who visit it enjoy staying in this form of environment. That is why, as no significant number of rural dwellings were found within the polygons, it was preferred to use a buffer around them, in order to include a representative number of rural accommodation elements existing in the province. The dimension of that buffer was not too long, so as to prevent excessive overlapping, nor too small, so that too little information from the rural accommodation was made available. To be specific, for the province of Segovia, buffers of 1 km were taken, thus including 78 rural dwellings of the 95 existing in the province. In addition, the sources consulted supplied us with the value of 917 places corresponding to 77 of those 78 establishments.

On the other hand, it was verified that the model showed some inconsistencies for those polygons with no rural accommodation. The problem lay not in the number of visitors but in the impossibility of determining the inhabitants inside a ring buffer present at a distance of 5 km around the rural dwelling (b5), between 10 and 25 km from it (b10/25), or between 25 and 50 km from it (b25/50). So, the minimum value of those calculated was assigned for those polygons of a forest condition, in which information on the rural accommodation was available. In this way, the relationship between the inexistence of rural accommodation, the number of visitors and the willingness to pay were integrated.

## Results

Taking into account that not all the variables initially considered turned out to be significative, the expression of the model, explained above, was as follows:

$$\begin{aligned} \ln(wtp) = & -63.86452 - 0.30995 \bullet \ln(b5) + \\ & + 0.37653 \bullet \ln(\frac{b10}{b25}) - 0.0905 \bullet \ln(\frac{b25}{b50}) + \\ & + 0.21797 \bullet \ln(visitot) - 0.36995 \bullet Tfc + \\ & + 0.40167 \bullet \ln(area) - 2.44079 \bullet \\ & \bullet\ Income\ relative + 6.41401 \bullet \ln(income) \end{aligned} \quad [3]$$

where:

$\ln(wtp)$ = neperian logarithm of willingness to pay (€$_{2005}$).

$\ln(b5)$ = neperian logarithm of the number of inhabitants located at a distance of 5 km from the PNA.

$\ln(b10/b25)$ = neperian logarithm of the number of inhabitants inside a ring buffer located at a distance of between 10 and 25 km from the PNA.

$\ln(b25/b50)$ = neperian logarithm of the number of inhabitants inside a ring buffer located at a distance of between 25 and 50 km from the PNA.

$\ln(visitot)$ = neperian logarithm of total no. of visitors to the PNA.

*Tfc* = weighted forest categories based on the CORINE Level 3 codes referred to total park area.

$\ln(area)$ = neperian logarithm of the PNA area.

*Income relative* = dummy variable equal to 1 if provincial per capita income is less than Spanish per capita income and 0 otherwise.

$\ln(Income)$ = per capita income in the province (year 2005).

For the validation of the model presented in this work, and the detection of possible specification errors, a standard methodology including parameter and residue diagnoses was followed. Thus, the t-test to prove the individual significance of the explanatory variables, and the *F*-test to determine the overall significance, were made, adopting as a decision rule that the value of *F* obtained from the sampling data should be higher than the theoretical value given in the *F* distribution tables. As can be seen in Table 3, all the independent variables are statistically significant when α is included between 0.005 and 0.25. As for the other test, for a level of significance $\alpha = 0.05$, and a reference value $F_{a,b}$, this being a random *F* value with a (k–1)

**Table 3.** Results of the estimation for the model

| Variable | Coefficient | Std. error | t-statistic | α* |
|---|---|---|---|---|
| C | –63.86452 | 16.09583 | –3.96777 | 0.0004 |
| Ln(b5) | –0.30995 | 0.115652 | –2.67999 | 0.0115 |
| Ln(b10/25) | 0.37653 | 0.172307 | 2.18520 | 0.0363 |
| Ln(b25/50) | –0.09053 | 0.040358 | –2.24318 | 0.0319 |
| Ln(visitot) | 0.21797 | 0.085034 | 2.56334 | 0.0153 |
| Tfc | –0.36995 | 0.165204 | –2.23938 | 0.0322 |
| Ln(area) | 0.40167 | 0.113415 | 3.54162 | 0.0012 |
| Income relative | –2.44079 | 0.556953 | –4.38239 | 0.0001 |
| Ln(income) | 6.41401 | 1.702156 | 3.76817 | 0.0007 |
| Nº observations | 41 | | | |
| $R^2$ | 0.56169 | | | |
| Adjusted $R^2$ | 0.45211 | | | |
| F-statistic | 5.12599 | | | |
| Prob(F-statistic) | 0.00037 | | | |
| Durbin-Watson | 1.73557 | | | |
| Jarque-Bera | 0.27114 | | | |

* Significance level for a one-trailed test.

degrees of freedom in the numerator and b (n–k) degrees of freedom in the denominator, in the model it is observed that $F > F_{7.33}$ (5.13 > 2.33). It was thus verified that the model explains appropriately the variations in the willingness to pay (Martín *et al.*, 1997).

Similarly, the goodness of fit seems to be reasonable based on the value taken by the coefficient of determination (0.56), and on the Standard deviation of the explanatory variables (values of between 0.08 and 1.70) and the regression function (0.73). The Sum of Squared Residuals (or residual sum of squares) is also discrete (16.85) with respect to other models assayed. The existence of an approximate multicollinearity has been checked by the use of one auxiliary regression function for each explanatory variable, and by the analysis of the corresponding $R^2$ (always below the critical value of 0.9). With regard to the analysis of the residues, no atypical data were identified after using the interval of confidence of ± 3 × standard error. The independence of the residues was proven by resorting to the Q-Statistics Correlogram of residues, and, finally, its normality cannot be discarded on the basis of the Jarque-Bera test (0.027, lower than the critical value of 7). In order to detect the presence of heteroskedasticity, the White test was used (no cross terms), concluding that there was no evidence of any heteroskedasticity at a significance level of 0.05. Therefore, the value resulting from multiplying the coefficient $R^2$ of the auxiliary regression employed in the test due to the size of the sample was compared to the critical value $\chi^2$ at the significance level selected. In the case of this being higher, the non heteroskedasticity hypothesis can be discarded. On the contrary, we obtained that $(R^2 \times n) <$ critical $\chi^2$ (8.96 < 15.51).

The possible existence of an autocorrelation between the error terms was studied using the Durbin-Watson test, in this case with a significance level of 0.05. In keeping with the decision rules of that test, and for the values of the Durbin-Watson *d* statistic shown in Table 3 (1.74), we accepted that there was no negative autocorrelation. However, we cannot conclude whether or not there was a positive autocorrelation (indecision zone), the critical values for 41 observations and 8 regressors being: $d_L = 1.064$ and $d_U = 1.997$ (Gujarati, 2006). Finally, it would be necessary to obtain some more exhaustive information on the 41 research works considered in order to find a reasonable explanation for the sign associated with the variables regarding the number of inhabitants considered inside the ring buffers.

If, in accordance with the above mentioned model corresponding to the forested surface of the province of Segovia is introduced, the map shown in Figure 1 will be obtained. It can be seen how the values are, in almost all cases, below 30 €/ha, except the area corresponding to the Sierra de Guadarrama, and the Natural Parks of Hoces del Río Riaza and Hoces del Río Duratón.

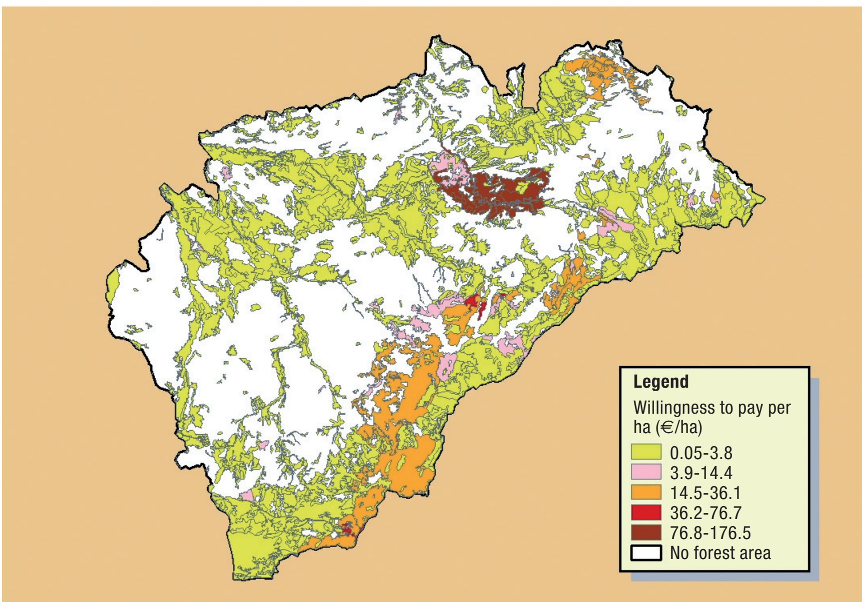


**Figure 1.** Willingness to pay for the recreation activity in forest areas in the province of Segovia. *Source:* Information from the authors.

## Discussion and conclusions

Analyzing the variables used in the model, it should be noted that it was considered convenient to introduce some others. As in other studies (Beverly *et al.*, 2008), it was intended to introduce the road density associated with each CORINE forest polygon as a variable. This possibility was rejected because of the lack of enough information to integrate it with the studies on those which had been set up with the econometric model. Nor was the possibility contemplated of selecting, through a digital land model, those areas with the greatest visual attractiveness and which, in principle, could have received most visits (Chen *et al.*, 2009). In another sense, some limitations of the NFI, such as the absence of measurements of the ages of trees making up the different plots, prevented the introduction of a variable to distinguish the more mature stands, as has been done in other studies (Termansen *et al.*, 2008).

As this work was constrained to afforested surfaces, the agricultural area was at no time considered as being a possible explanatory variable. For this reason, some other studies were also rejected, like those conducted on Motril (Calatrava, 1996) or on Las Alpujarras (Sayadi *et al.,* 2004), where the percentage of agricultural land was clearly in the majority. The average altitude did not appear to us to be relevant in comparison to the average slope or the range of slopes (maximum and minimum slope), for the obvious reasons of the allure of the landscape.

As reported by Lavandeira *et al.* (2007), a series of intrinsic circumstances, such as the heterogeneity of the studies participating in the application of a meta-analysis, or the fact that the data incorporated into reports or articles are usually insufficient, encourage the appearance of heteroskedasticity if we apply Ordinary Least Squares (OLS). As has been commented in a previous section, this eventuality has been rejected using the White test.

Throughout this exercise we had thought of estimating the total number of visitors as being dependent on the visitors staying overnight in rural accommodation. The initial idea was, with the data of some of the studies described previously in Table 1, to make this estimate provided that these visitors were asked if they were staying in rural accommodation. The authors of some of these works have been contacted and it was found that on some occasions the rural dwellings were encompassed with other accommodation types, and the percentage of same-day visitors staying in rural accommodation greatly varied between the different Autonomous Communities. In other cases (*i.e.* Natural Park of Peñalara), carrying out this operation signified overestimating the visitors. It was also attempted to extend the sample with the surveys made for the economic valuation included in the III NFI, but, again, the same problems arose with regard to how the question had been formulated. For all the above, it was decided to only compute the visitors to rural accommodation as visitors to the Centres. We are aware that this is an infravaluation, but it should be remembered that the willingness to pay applied in forest areas with no protection figure proceeds from PNAs, so that on this side things are probably being overvalued. This affirmation has not been contrasted as there are no studies like those described previously in the province of Segovia or in any other forest areas in Spain not subject to protection figures.

On the other hand, some studies abroad (Cole, 1996; Loomis, 2000) propose the estimation of the number of visitors to a natural area by multiplying the number of those staying overnight by 2.5. A tentative study was made to introduce this kind of method but it was discarded, because the areas to which these works referred possessed very different characteristics to those in the areas being studied here. Actually, there are no works quantifying which proportion should be cited, and the trials made in neighbouring areas would oblige the introduction of a higher coefficient than 2.5.

A study set in the same geographical context was made and which valued other productions in this province, such as timber or carbon (López-Peredo *et al.,* 2009). The general trend of the recreation values obtained in that study was clearly inferior to the values of those assets, but the areas in which each of them reached their highest figures (foothills of the Sierra de Guadarrama) were similar to those in this current work. If, for example, the layers associated with the recreation value and timber production for this province were aggregated, it would be necessary to justify some new hypotheses, such as assuming that both assets constitute a case of joint production, even when studies (Caparrós, 2000) have documented, in some nearby areas, the decline in satisfaction of the visitors due to timber production activities.

The results shown in this work are based on a methodology increasingly being used world-wide to estimate, in accordance with similar benefit transfer techniques to those shown above, environment values without resorting to direct sources (surveys, questionnaires, etc.), with all that this signifies in economic savings. Also, the figures obtained from the application of the above model for the province of Segovia, provide minimum values as only the rural accommodation visitors have been computed.

Certainly, an immediate line of improvement would be that of bettering the total estimation of visitors for each CORINE forest polygon in this province, including both those from outside it (same-day visits, accommodation in hotels, camping sites, private accommodation, etc.), and those from the actual inhabitants of the province. However, the current statistics do not allow a disaggregation level to enable to make any true estimations of how many people visit each Segovian forest ecosystem in one year.

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