PROJECT N. 037033

EXIOPOL

A NEW ENVIRONMENTAL ACCOUNTING FRAMEWORK USING EXTERNALITY DATA AND INPUT-OUTPUT TOOLS FOR POLICY ANALYSIS

Report documenting the results of the meta-data analysis linking the monetary values with the physical characteristics of forests

Report of the EXIOPOL project

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Executive Summary

Overview

This report is for the EXIOPOL project on linking the monetary values of forests with their physical characteristics. The work performed in this deliverable makes use of the database on forest externalities created in WP II.4a.

Forests provide numerous non-market goods and services; a comprehensive list of these externalities and their corresponding values was prepared in WP II.4a. In this Work Package we decided to focus only on some of these externalities. The choice was based on relative importance of the good/service and the data availability. Given these two criteria the following externalities have been selected:

- recreation
- carbon sequestration
- biodiversity protection (passive values)

Additionally wood and other non-wood marketed forests goods were included in the report.

In case of wood and non-wood forest products, values have been calculated using market prices. The marginal value of carbon sequestration has been calculated by using the monetary estimates obtained in the ExternE and IMPACT project.

In case of recreation and passive use values a meta-analytic framework has been applied. The variation in standardized WTP measures (WTP/ha/year) has been explained by using site characteristics and methodological variables. Obtained estimates of site characteristics have been used in a simple value transfer framework to produce estimates of recreation/passive values for other European countries.

This report uses the methodological framework applied in the COPI project (Markandya *et al.* 2007).

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1 Introduction

This deliverable provides the methodological approach and main results of the monetary valuation of a selected set of goods and services provided by European forests. This report is integrating outputs of work packages II.4a and II.4b, by linking the monetary values (observed in II.4a) with the physical characteristics of forests (resulting from II.4b). The report adapts the methodology presented in the COPI project (Markandya *et al.* 2007).

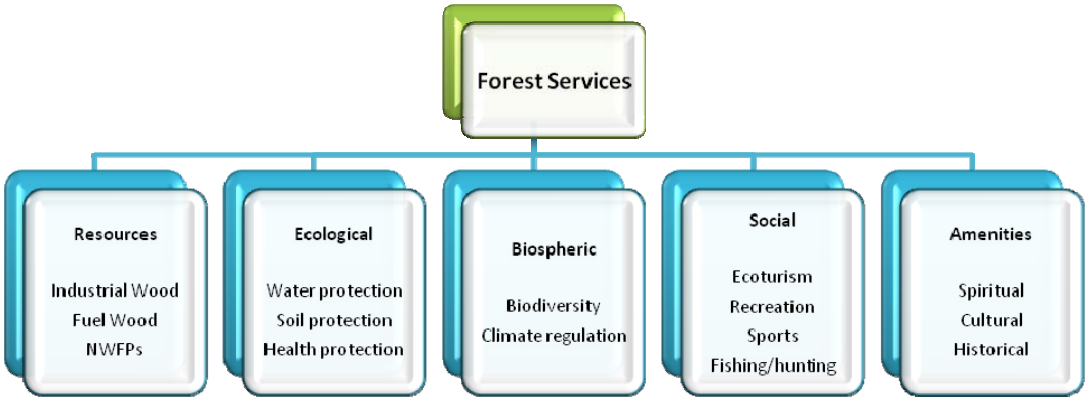


Figure 1: Major Classes of forest services (Source: MEA 2005)

Based on the review of the main forest goods and services (figure 1) and the valuation studies conducted in Europe (EXIOPOL Deliverable DII.4.b-1) a number of forest goods and services was selected to be included in the present report. The selection criteria were the relative importance of the good or service on the European level and the availability of results of valuation studies. Considering these selection criteria, it was decided to propose the following externalities:

- recreation
- carbon sequestration
- biodiversity protection (passive values)

Furthermore, it was decided also to include wood and other non-wood forest goods, listed under the group of resources, as the most traditional and widely marketed forest good.

The results of this report will be further used in task 5 of WS II.4. (Scenario analysis of the influence of different management approaches on the social value of forest). This aims to integrate all results of WS II4. The response functions from task 3 will be combined with the estimated economic values reported in this deliverable. The resulting dose-response functions shall link changes in land use to changes in the economic value of different forest goods and services. The estimated dose-response functions shall be used firstly for an economic valuation of policy impacts on forest land use in Europe for the scenarios defined in task 3. Secondly, the estimated, generic response functions shall be delivered to cluster III where they shall serve as input to the EE-IO framework.

This report is divided into five sections. The first four sections present the applied methodology and obtained results for different groups of forest goods and services; where the first section is dedicated to wood and non-wood forest products, section two deals with carbon sequestration, while sections three and four explore social services (recreation) and passive values (biodiversity) respectively. Finally, the report gives the main conclusions.

2 Resources: Wood and non-wood forest products

2.1 Data availability

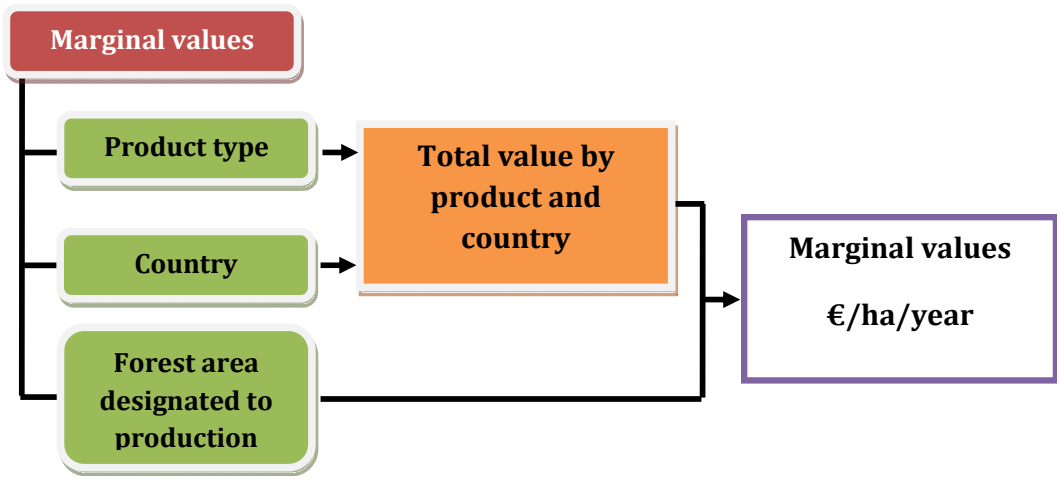
The economic value of resources is estimated as marginal value per hectare and year. The data used for the estimation of these values were taken from the FAO database (FAOSTAT 2009) Global Forest Resource Assessment report (FRA) (FAO 2006) and the Report on the State of Europe's Forests (MCPFE 2007). From the FAO database data on export and import values, export and import quantities and total domestic production for roundwood were used, while from the FRA data on the value of non-wood removals were obtained. Finally, the MCPFE report provided data on area of forests available for wood supply.

2.2 Methodology

The marginal values for resources vary according to the following characteristics (see also figure 2):

- product type
- country
- size of the forest area designated to production

Figure 2: Valuation framework



The calculation of the marginal values was done in two steps:

1. Calculation of the total annual values:

   Roundwood: To estimate the total value of roundwood production per country, first the marginal value of roundwood was calculated (EURO/m^3). This marginal value was calculated as an average of the marginal value of exported and imported roundwood values reported in the FAOSTAT database. Once this marginal value per m^3 was calculated the total value of domestically produced roundwood was calculated, by multiplying the marginal value with the total domestic production quantity. The total value is then converted into estimates of net income.

Non-wood forest products: The total value was taken from the FRA report and converted into net income estimates.

2. Calculation of marginal values: to estimate the marginal values per hectare, the total values are combined with the information on the total forest area devoted to the production of a certain forest good.

In the first step the resources were divided into two main categories: (i) wood forest products and non-wood products (for details see Table 1).

Table 1: Forest goods considered in the valuation of resources

Wood forest products	Non-wood forest products	
	Plant products	Animal products
Roundwood[1]	Food Fodder Raw material for medicine and aromatic products Raw material for colorants and dyes Raw material for utensils, crafts & construction Ornamental plants Exudates Other plant products	Living animals Hides, skins and trophies Wild honey and beeswax Bush meat Raw material for medicine and aromatic products Raw material for colorants and dyes Other edible animal products Other non-edible animal products

For each product the market values at the country level are taken. The value for roundwood was calculated as an average of the export and import value of the product.

$$mv_i = \frac{\left(\frac{EV_i}{Eq_i} + \frac{IV_i}{Iq_i}\right)}{2} \quad (1)$$

Where:
mv_i= marginal value (in EURO/m³)of roundwood in year by country i
EV_i = export value per year by country i
Eq_i = export quantity per year by country i
IV_i = import value per year by country i
Iq_i = import quantity per year by country i
i = country

The marginal values per m³ were calculated for the period 1997-2007. The calculation showed big oscillations of the value between years. To avoid the

[1] Wood in the rough. Wood in its natural state as felled, or otherwise harvested, with or without bark, round, split, roughly squared or other forms (e.g. roots, stumps, burls, etc.). It may also be impregnated (e.g. telegraph poles) or roughly shaped or pointed. It comprises all wood obtained from removals, i.e. the quantities removed from forests and from trees outside the forest, including wood recovered from natural, felling and logging losses during the period - calendar year or forest year. Commodities included are sawlogs and veneer logs, pulpwood, other industrial roundwood (including pitprops) and fuelwood. The statistics include recorded volumes, as well as estimated unrecorded volumes as indicated in the notes. Statistics for trade include, as well as roundwood from removals, the estimated roundwood equivalent of chips and particles, wood residues and charcoal (FAO 2009)

problem of selecting one year as the representative, an average for the period was calculated and used in the further calculation process.

Then the total value of the annual production of different types of forest goods and services was calculated:

(2) $$TV_i = Q_i mv_i$$

Where:
TV_i= total value per year by country i
mv_i= marginal value (in EURO/m^3)of roundwood in year by country i
Q_i =annual quantity (in m^3) produced in country i
i = country

The total values are expressed in 2005 €. Based on the total value the net income was calculated applying financial returns from wood forest production. Returns to the forest owner are made up of sales of timber (standing or felled), sales of other goods and services, increases in the value of the woodland (from annual increment or market factors), and the net income from subsidies (e.g. planting grants) less taxes. The owner's costs are made up of employment costs and other purchases (Forestry Commission 2008). The net return from forestry for the period 1998-2008 has been estimated to 5.6% per year (Forestry Commission 2008). However, it should be acknowledged that this estimate of the overall return is from commercial Sitka spruce plantations in mainland Britain and might be regarded as high when compared to the returns in natural or semi natural forests in some other European regions (e.g. Southern region). Nevertheless, due to lack of available values for other countries, this value was applied for the whole region considered in our study.

Considering forest area designated to production (MCPFE 2007), in the next step the marginal values per ha and year by country are calculated. The calculation follows the formula:

(3) $$MV_i = \frac{TV_i NR}{S_i}$$

Where:
MVi = value/ha/year by country i
TV_i = total value adjusted by profits per year by country i
NR = net return from forestry (5.6%)
S_i = forest area available for wood supply per country i

2.3 Results

Following the methodology presented above the following tables were generated:

- total value of wood and non-wood forest products by country and the total value adjusted for profits (table 2)
- marginal values of wood and non-wood forest products by country per year and hectare (table 3)

Table 2 presents the estimated total values of wood and non-wood forest products. The values for roundwood were calculated from the FAOSTAT data for the year 2007; while the data for the non-wood forest goods (NWFG) come from

the FRA 2005 report (FAO 20006). The data in table 2 are not adjusted for profits. All the data are converted to € 2005 values.

The total values adjusted for profit are presented in table 3. These values are used to calculate marginal values per hectare of productive forests.

Table 2: Total value and adjusted total value of wood and non-wood forest products by country (in 1000€, 2005) (calculated from FAOSTAT)

Country	Round wood	NWFP	Total	Total adjusted by profit
Austria	1,077,649,182		1,077,649,182	60,240,589
Belgium	257,350,072		257,350,072	14,385,869
Bulgaria	244,080,584		244,080,584	13,644,105
Czech Republic	769,827,730	162,663,773	932,491,503	52,126,275
Denmark	153,787,308	148,401,254	302,188,562	16,892,341
Estonia	242,150,296	3,859,818	246,010,114	13,751,965
Finland	2,850,662,412	124,311,551	2,974,973,963	166,301,045
France	4,703,776,708	26,525,199	4,730,301,907	264,423,877
Germany	3,831,625,306	154,047,102	3,985,672,409	222,799,088
Greece	100,873,788		100,873,788	5,638,845
Hungary	281,472,247		281,472,247	15,734,299
Ireland	340,380,289	241,138	340,621,427	19,040,738
Italy	1,902,177,988		1,902,177,988	106,331,750
Latvia	552,493,394		552,493,394	30,884,381
Lithuania	273,886,006		273,886,006	15,310,228
Luxembourg	11,860,703	1,655,012	13,515,714	755,528
Netherlands	59,676,775	12,201,592	71,878,367	4,018,001
Norway	461,480,702	115,907,885	577,388,587	32,276,022
Poland	1,620,449,159	17,473,676	1,637,922,835	91,559,886
Portugal	1,472,502,364		1,472,502,364	82,312,882
Romania	982,906,353		982,906,353	54,944,465
Slovakia	367,999,716	9,332,851	377,332,568	21,092,891
Slovenia	197,265,180	33,654,851	230,920,030	12,908,430
Spain	799,078,653	247,529,941	1,046,608,595	58,505,420
Sweden	4,567,530,775	163,813,198	4,731,343,973	264,482,128
Switzerland	368,058,598	30,041,797	398,100,395	22,253,812
United Kingdom	793,973,011	81,772,366	875,745,376	48,954,167

Table 3: Marginal values and adjusted marginal values of wood and non-wood forest products by country (in €/ha, 2005)

Country	Marginal value	Marginal values adjusted by profit
Austria	321.30	17.96
Belgium	385.83	21.57
Bulgaria	95.31	5.33
Czech Republic	370.33	20.70
Denmark	784.91	43.88
Estonia	117.71	6.58
Finland	148.72	8.31
France	320.85	17.94
Germany	362.86	20.28
Greece	29.19	1.63
Hungary	167.15	9.34
Ireland	519.01	29.01
Italy	213.21	11.92
Latvia	194.29	10.86
Lithuania	149.26	8.34
Luxembourg	156.98	8.78
Netherlands	243.66	13.62
Norway	88.84	4.97
Poland	194.60	10.88
Portugal	732.95	40.97
Romania	212.41	11.87
Slovakia	215.47	12.04
Slovenia	199.93	11.18
Spain	99.88	5.58
Sweden	222.81	12.46
Switzerland	335.67	18.76
United Kingdom	368.73	20.61

3 Biospheric service: Carbon sequestration

3.1 Data availability

The economic value of carbon sequestration is estimated as marginal value per hectare per year. The calculation is based on the information of the quantity of carbon sequestrated by a hectare of forest in different European countries, and information on the value per ton of carbon sequestrated.

The data about quantities of carbon sequestrated by forest in different European countries was obtained from the European Environmental Agency's Green House gas database (EEA 2009). The database provides data contained in the Annual European Community Greenhouse gas inventory 1990-2006 and inventory report 2008 (EEA 2008). It reports data on total amount of carbon emissions per emission source (IPCC sector) per year by country (Table 5).

The monetary value per ton of carbon sequestrated for the year 2005 was taken from the European Union Greenhous Gas Emission Trading Scheme (EU-ETS 2009), and from the IMPACT 2008 report for the year 2050.

3.2 Methodology

The calculation of the value of carbon sequestration was done in two steps:

1. Identification of the capacity of carbon sequestration by country (tCO_2/ha):

   The quantity of carbon sequestrated varies according to the forest type (total biomass of a forest) and the total area of forests in a country. Furthermore, since in some countries the annual values of sequestrated carbon can vary significantly (i.e for Sweden the change between the year 2005 and 2006 is almost 300%) an average value was calculated for the period 2000-2007. Thus to estimate the annual marginal values of carbon sequestration per hectare, we use the following equation:

   (4) $$MQC_i = \frac{\frac{1}{n}\sum_{n=1}^{m} QC_{ni}}{A_i}$$

   Where:
   MQC_i = marginal quantity of carbon dioxide sequestrated by country (in tCO_2/ha)
   QC_i = total quantity of carbon dioxide sequestrated by country (tCO_2)
   A_i = forest area available for wood supply by country
   i = country
   n= number of observations

2. Calculation of monetary value per country.

   Various methods can be applied to estimate the marginal value of carbon, for example (i) marginal damage cost, (ii) marginal abatement costs and (iii) spot and future prices in emission trading markets. The IMPACT project report (Maibach *et al.* 2008) recommends estimating the short-

term value of carbon on damage avoidance costs; while the long-term estimates should be based upon damage cost.

For the present deliverable marginal values for the year 2005 are based on damage avoidance costs and were taken from the ExternE report (Bickel and Friedrich 2005) and they are also in line with the spot values of the EU Emission trading scheme (EU-ETS 2009). The values for the year 2030 were taken from the IMAPCT study report (Maibach *et al.* 2008) and are based on damage costs.

Table 4: Monetary values for carbon (in Euro)

Costs in EURO/tCO_2			
Year 2005		Year 2030	
Lower bound value	Upper bound value	Lower bound value	Upper bound value
5	21	22	100

3.3 Results

Following the methodology explained in the previous section the value of carbon sequestration was calculated.

Table 5: Carbon sequestration in the European forests

Country	Average total CO_2 emissions in the period 2000-2007 (t)*	Forest area (ha)	Average marginal quantity of carbon emission in the period 2000-2007 (t/ha)
Austria	-19871416	3354000	-5.92
Belgium	-3293636	667000	-4.94
Bulgaria	-7967815	2561000	-3.11
Czech Republic	-6306345	2518000	-2.50
Denmark	-2806021	385000	-7.29
Estonia	-1603259	2090000	-0.77
Finland	-33507710	20004000	-1.68
France	-79153480	14743000	-5.37
Germany	-78139119	10984000	-7.11
Greece	-3948431	3455592	-1.14
Hungary	-3911786	1684000	-2.32
Ireland	-762049.2	656289	-1.16
Italy	-89746848	8921528	-10.06
Latvia	-14543592	2843700	-5.11
Lithuania	-8796058	1835000	-4.79
Luxembourg	0	86100	-0.00
Netherlands	-2470424	295000	-8.37
Norway	-31955789	6499000	-4.92
Poland	-45321184	8417000	-5.38
Portugal	-4802746	2009000	-2.39
Romania	-37383505	4627500	-8.08
Slovakia	-4065608	1751200	-2.32
Slovenia	-5295837	1155000	-4.59
Spain	-32846933	10479000	-3.13
Sweden	-19500540	21235000	-0.92

Switzerland	-1776876	1186000	-1.50
United Kingdom	-15100604	2375000	-6.36

* The negative sign of the emission valuse indicates that forest are a net carbon sink.

Table 5 shows the average total and average marginal annual carbon emissions from forests in European countries in the period 2000-2007. The values were estimated with the data on carbon emissions were taken from the European Environmental Agency (EEA 2009), while the forest areas were taken from the MCPFE report (MCPFE 2007). The negative sign of the emission valuse indicates that forest are a net carbon sink.

Next Table 6 summarizes the estimated annual marginal values per hectare. The values are reported for the year 2005 and 2030. Furthermore for each of these a lower and upper bound value is estimated. These estimated values can be used to obtain total values of forest areas contributing to carbon sequestration.

Table 6: Marginal values of carbon sequestration by forests in European countries (€/ha/year)

Country	2005		2030	
	Lower bound	Upper bound	Lower bound	Upper bound
Austria	29.62	124.42	130.34	592.47
Belgium	24.69	103.70	108.64	493.80
Bulgaria	15.56	65.34	68.45	311.12
Czech Republic	12.52	52.59	55.10	250.45
Denmark	36.44	153.06	160.34	728.84
Estonia	3.84	16.11	16.88	76.71
Finland	8.38	35.18	36.85	167.51
France	26.84	112.75	118.12	536.89
Germany	35.57	149.39	156.51	711.39
Greece	5.71	24.00	25.14	114.26
Hungary	11.61	48.78	51.10	232.29
Ireland	5.81	24.38	25.55	116.11
Italy	50.30	211.25	221.31	1005.96
Latvia	25.57	107.40	112.52	511.43
Lithuania	23.97	100.66	105.46	479.35
Luxembourg	0.00	0.00	0.00	0.00
Netherlands	41.87	175.86	184.24	837.43
Norway	24.59	103.26	108.17	491.70
Poland	26.92	113.07	118.46	538.45
Portugal	11.95	50.20	52.59	239.06
Romania	40.39	169.65	177.73	807.86
Slovakia	11.61	48.75	51.08	232.16
Slovenia	22.93	96.29	100.87	458.51
Spain	15.67	65.83	68.96	313.45
Sweden	4.59	19.28	20.20	91.83
Switzerland	7.49	31.46	32.96	149.82
United Kingdom	31.79	133.52	139.88	635.81

4 Social services: Recreation

4.1 Data availability

The main source of data used for the study was the database created within Working Package II.4.a activity. Only studies reporting willingness to pay (WTP) or consumer surplus (CS) per visit per person were included in the analysis. In total 49 studies from 8 countries were identified. These studies provided 253 observations that were included in the meta-regression.

4.2 Methodology

The methodological framework is based on the following steps:

a) Modifying the database created in WP II.4.a so that the meta-analysis could be performed.

b) Estimation of a meta-regression function based on suitable values

c) Application of a two-step value transfer approach

– transfer to the UK recreational sites

– transfer to other European countries

a) Meta-regression

In this study a meta-regression technique with normalized dependant variable (WTP/ha/year or CS/ha/year) has been applied. Only studies reporting CS or WTP[2] per person per visit[3] have been used. Normalized welfare measures were obtained by multiplying WTP/person/visit by total number of visitors and divided by area of a given site.

Only one meta-analysis of forest recreation values in Europe has been performed so far. Zandersen and Toll (2005) carried out a meta-analysis based on studies that have applied the travel cost method. In their analysis most of the variables relevant from the benefit transfer perspective turned out not to be statistically significant.

Since the main purpose of this meta-regression is to evaluate the impact of the site characteristics on WTP, increasing the number of sites by pooling observations from revealed preference (RP) and stated preference (SP) studies may increase the robustness of the estimates of forest site characteristics[4].

[2] Henceforth WTP will be used in the text, however whenever it is used it may denote also CS.
[3] If CS or WTP per group was calculated, this observation was included only if information on average group size was reported.
[4] Pooling SP and RP studies provided information on 82 different forests sites.

Using estimates from SP and RP studies in one meta-regression raises concern about inconsistencies between Marshallian and Hicksian welfare measures (Hanemann 1991). This is because WTP estimates are derived from a Hicksian demand function, while the CS estimates are derived from a Marshallian demand function. These conceptual differences between WTP and CS are accounted for by including a method dummy variable into the regression. Some authors have applied this approach in previous studies (for example: Shrestha and Loomis 2003).

Valuation studies often test several model specifications and report more than just one result of interest for the meta-analysis. In most cases multiple observations from one study were included in the meta-regression by adding methodological variables that enabled differentiation between them. However, even when all differences in specifications are accounted for, the observations within the same study are likely to share some non observable factors what in turn may result in correlated errors.

To account for this possibility the following specification was assumed:

(5) $$\mathrm{WTP}_{\mathrm{ha/year}} = \alpha + \beta x_i + \mu_i + e_{it}\,.$$

Where $\mathrm{WTP}_{\mathrm{ha/year}}$ is vector of standardized values from study i, x_i is a set of explanatory variables including study methodological descriptors and site characteristics. Error term is decomposed into two parts: error at the study level μ_i and e_{it} at the estimation level. Both are assumed to be normally distributed with zero mean and variances respectively: σ_μ and σ_e.

A random or fixed effect specification can be used to address the issue of common μ_i across multiple observations in the same study. In case of this dataset, testing allowed us to reject random effects in favor of a fixed effect specification, which in turn was rejected in favor of equal effects specification. As a result a classical ordinary least square (OLS) technique was used to estimate meta-regression model.

The main source of the data was database prepared in WP II.4a. Data on GDP and density were obtained from EUROSTAT. Variables included in the final meta-regression are listed in table 7 and regression results in table 8.

Table 7. Variables included in the meta-regression model

SYMBOL	VARIABLE
	METHOD VARIABLES
RP	1 - if Revealed Preference method (Marshallian measure) 0 if Stated Preference method (Hicksian measure)
DC	1 - if dichotomous choice elicitation format in SP 0 -otherwise.
OE	1 - if Open ended elicitation format in SP 0 -otherwise.
OValue	1 – if option value included, 0- otherwise
Ttime	1 – if value of time is accounted for,0 otherwise.
ML	1 if ML estimator was used in RP method, 0 otherwise.
	SITE VARIABLES
	Country dummies (8 countries + Northern Ireland) GB-reference level
Ln_Inc	Log of Income on country level (Euro 2000)
Alt	Elevation of the highest point in the forest area (in 100s of meters)
Ln_Size	Log of study site forest area (ha)
Protected	Protection status -1 if protected (national park, reserve or natural park) 0-otherwise
Ln_Density	Log of Population density (NUTS 3 level) (people/km^2)
	OTHER VARIABLES
Year	Year of data collection

Table 8. Regression results

SYMBOL	Coefficient	Standard errors
METHOD VARIABLES		
RP	1.959***	.425
DC	1.837***	.462
OE	1.306***	.459
OValue	.643	.430
Ttime	.435*	.261
ML	-.421	.456
SITE VARIABLES		
Ln_Alt	.131*	.079
Ln_Size	-0.451***	.069
Protected	1.06***	.2205
Ln_Density	.686***	.104
Ln_GDPPPP	-.054	.716
Year	.0531*	.0284
COUNTRY DUMMIES		
Austria	2.701***	.766
Germany	2.215***	.592
Ireland	2.483***	.632
Italy	.435	.366
Northern Ireland	1.062*	.599
Poland	1.701	1.102
Spain	1.887***	.527
R^2=0,61; N obs.=253		

Indicates statistical significance at: *** 0.01 level, ** 0.05 level.

The signs and significance of the variables are in most cases consistent with expectations and past recreation valuation studies. One serious exception is GDP per capita; variable used as a proxy of income level. Income is expected to have positive effect on WTP, however in this study coefficient by logarithm of income GDP per capita (PPP) has been found to be negative (not significant).A similar result was found in Zandersen and Toll (2005).

Dummy variable RP is positive and highly significant, indicating that contingent valuation method (CVM) studies produce lower estimates of WTP than do travel cost method studies (TCM), a result consistent with Carson et al. (1996), Walsh et al. (1989, 1992) and Shrestha and Loomis (2003).

Following site characteristics: altitude, forest area, protected area, density of population proved to be statistically significant. Since dependant variable was log of WTP/ha/year the coefficients by variables that are logarithmically transformed are estimates of the elasticities.

Different specifications of meta-regression function were tested. For example when altitude was employed into the regression in a linear form its coefficient was highly significant at 0,01 level. Estimated coefficient 0,073 indicates that an increase in elevation by 100m raises WTP/ha/year by 7,3%[5]. The question arises: do people prefer to visit forests that are situated in highlands or mountains or they just like highlands or mountains and it has nothing to do with presence of forest? Given the dataset we have this question is difficult to answer, however there are reasons to believe that people indeed may derive bigger recreational benefits from forests situated in the highlands or mountains comparing to forests in lowland areas[6]. Therefore this variable is employed into a value transfer function in the next section.

Another interesting result is coefficient by variable: *Protected*, indicates that if forest is protected then WTP/ha/year is higher by 106%.

Assuming that protection is an indicator of relative uniqueness of a given ecosystem, obtained results indicate that standardized recreational benefits are higher for forests in which the natural processes are relatively better preserved.

b) Value of recreation benefits in UK

Our study uses the same methodological framework as the study: *Economic Valuation of Forest Ecosystem Services: Methodology and Monetary Estimates* (Markandya et al. 2007). The main difference is that the study by Markandya et al. (2007) based their meta-analysis on studies from around the world and applied the value transfer to the other world countries while this study focuses on the European level.

[5] In fact what people may care more about is the difference in level between the highest and lowest part. However data on highest point are much easier to encounter and these variables are likely to be highly correlated.

[6] Mostly landscape amenities but also some recreational activities like: hiking, mountain biking, etc.

The main aim of this analysis is to produce mean estimates of non-market recreational benefits provided by forests at the country level.

- The first step requires the estimation of the mean recreational benefits (WTP/ha/year) provided by forests for some country for which the data are available. Of all the European countries the UK appears to be most suitable country for this purpose. The largest number of recreational studies for different forests types has been conducted there.
- In the second step the mean value obtained for the UK is transferred to the other European countries with the use of the value transfer function.

In the end of 1980's in the UK a large study of the non-market recreational benefits provided by the forests was undertaken. The main aim of this study was to produce aggregated national estimates of the recreation benefits provided by the Forestry Commission estate. In total 14 forests sites were chosen in which 5000 questionnaires were utilized representing over 15000 visitors (Benson and Willis 1990).

Different methods have been used (zonal travel cost method (ZTC), individual travel cost method (ITC), CVM) to produce estimates of the recreation benefits. However the national estimates of the recreation value (CS/ha/year) were possible only for the ZTC analysis - mean: 33 £1988/ha/year [7] was obtained.

Summary of the results is presented in the table 9

Table 9. Consumer surplus and CV estimates obtained in the study.

	ZTC* (CS/per person/visit)	**CS/ha**	**CVM (WTP/per person/visit)**
New Forest	0.93	276	0.43
Cheshire	1.25	280	0.47
Loch Awe	1.92	<1	0.50
Brecon	1.70	32	0.46
Buchan	1.67	16	0.57
Durham/N.Y. Moors	1.22	31	
Aberfoyle	1.88	21	
South Lakes	0.92	36	
Newton Stewart	1.24	2	0.73
Lorne	1.10	5	0.72
Castle Douglas	1.66	10	
Ruthin	1.72	14	0.44
Forest of Dean	1.61	159	
Thetford	1.84	151	
Mean	1.48	33	0.53

ZTC model was estimated under the following assumptions: perceived travel costs and a 43% wage rate time costs.

[7] ZTC Model was estimated under the assumption of perceived travel costs and 43% wage rate time costs. The results were averaged for the Forestry Commission estate (total area: 1 121 000 ha, total number of visits: 26 260 000). Source: Bateman 1996

As reported in Bateman (1996) CV estimates of the use value in this study are on average equal to 36% of the ZTC measure. Therefore we decided to scale the ZTC mean value by factor of 0.36 and make the transfer of the WTP measure more conservative [8]

In many applications a more useful measure than the average value is the marginal value. To our knowledge the study by Markandya *et al.* (2007) is the only one which provides estimates of the marginal value of a recreational forest site. Therefore, in addition to the mean value, we decided to use the marginal value estimated in Markandya *et al.* (2007) and transfer it to the other European countries.

c*) Transfer to other European countries*

Four different variants of value transfer function have been used to transfer UK value for forest recreation to other European countries:

1) Value transfer function includes: *β- forest size* coefficient and γ - *density of population*
2) Like variant 1 with additional δ-*altitude* coefficient.

3 and 4) Like variant 1 and 2 with λ=0,599 (income elasticity) estimated in study by Markandya et al (2007)[9].

Following transfer function was used:

$$V_i = V_{UK}\left(\frac{D_i}{D_{UK}}\right)^{\gamma}\left(\frac{Sr_i}{Sr_{UK}}\right)^{\beta}\left(\frac{Alt_i}{Alt_{UK}}\right)^{\delta}\left(\frac{PPPGDP_i}{PPPGDP_{UK}}\right)^{\lambda} \quad (6)$$

Where:
Vi = estimated value/ha/year for country *i*
Vuk = estimated value/ha/year for UK
Sri = Share of country i area covered by forest
Suk = Share of UK area covered by forest
Di = Density of population in country *i*
Duk = Density of population in UK
Alt_i = Average elevation in country i
Alt_{UKi} = Average elevation in UK
$PPPGDP_i$ = GDP per capita adjusted for PPP (purchasing power parity) in country *i*
$PPPGDP_{UK}$ = GDP per capita adjusted for PPP (purchasing power parity) in UK

[8] After scaling value of £1988/ha=11.88 per hectare was obtained. Using the GDP deflator this is equivalent to £19.50 in 2005 prices, given average exchange rate between GBP/EUR= 1.46 in 2005 this is equal to 28,47 (EUR2005).

[9] In the meta-regression GDPPPP variable turns out not to be significant and moreover has negative sign. Most valuation studies find positive effect of income on WTP, therefore this varaible is usually taken into account when value is transffered. We decided to consider variant of value transffer function with GDPPPP variable using estimates of income elasticity from the study by Markandya et al (2007). The estimate of λ=0,599 was obtained in the recreation use context.

Source of data: MCPFE, 2007, OECD Database, EUROSTAT.

To account for the differences in countries' sizes, share of land covered by a forest was used instead of total forest area. Average and marginal values of recreational forest services for European countries are presented in tables 10-17.

Table 10. Mean value of recreational forest services by European countries

Country	Value (size, density) WTP/year/ha (€2005)	Value (size, density, altitude) WTP/year/ha (€2005)
Austria	7.16	8.56
Belgium	25.67	25.58
Bulgaria	6.12	6.81
Czech Republic	10.36	11.50
Denmark	16.10	13.61
Estonia	3.00	2.71
Finland	1.56	1.53
France	9.68	10.03
Germany	16.41	17.24
Greece	6.29	7.01
Hungary	11.70	11.59
Ireland	11.12	10.68
Italy	13.23	14.92
Latvia	3.56	3.34
Lithuania	5.43	5.18
Luxembourg	12.86	13.48
Netherlands	41.99	31.47
Norway	1.96	2.16
Poland	10.70	10.77
Portugal	8.94	9.45
Romania	8.85	9.56
Slovak Republic	7.12	7.87
Slovenia	7.76	8.79
Spain	6.27	7.25
Sweden	1.85	1.94
Switzerland	13.50	16.64
United Kingdom	28.47	28.47

Table 11. Mean value of recreational forest services by European countries

Country	Value (size, density, income) WTP/year/ha (€2005)	Value (size, density, altitude, income) WTP/year/ha (€2005)
Austria	7.70	9.21
Belgium	27.42	27.31
Bulgaria	3.25	3.63
Czech Republic	8.03	8.90
Denmark	16.79	14.19
Estonia	2.18	1.96
Finland	1.58	1.56
France	9.63	9.99
Germany	16.33	17.15
Greece	6.12	6.83
Hungary	7.81	7.74
Ireland	11.74	11.30
Italy	12.28	13.86
Latvia	2.34	2.20
Lithuania	3.69	3.54
Luxembourg	18.75	19.66
Netherlands	45.97	34.45
Norway	2.56	2.85
Poland	6.65	6.69
Portugal	6.69	7.07
Romania	4.52	4.87
Slovak Republic	5.09	5.65
Slovenia	6.72	7.61
Spain	5.94	6.85
Sweden	1.94	2.02
Switzerland	15.77	19.46
United Kingdom	28.47	28.47

Table 12. Mean value (WTP estimates) of recreational forest services by European countries projections in 2030, (no discounting)

Country	Value (size, density) WTP/year/ha (€2005)	Value (size, density, altitude) WTP/year/ha (€2005)
Austria	10.39	12.42
Belgium	37.25	37.11
Bulgaria	8.88	9.88
Czech Republic	15.03	16.68
Denmark	23.36	19.75
Estonia	4.35	3.94
Finland	2.26	2.23
France	14.05	14.55
Germany	23.81	25.01
Greece	9.13	10.17
Hungary	16.98	16.81
Ireland	16.13	15.49
Italy	19.20	21.65
Latvia	5.17	4.84
Lithuania	7.88	7.52
Luxembourg	18.66	19.56
Netherlands	60.93	45.66
Norway	2.84	3.13
Poland	15.53	15.62
Portugal	12.97	13.72
Romania	12.84	13.88
Slovak Republic	10.33	11.42
Slovenia	11.26	12.75
Spain	9.10	10.52
Sweden	2.68	2.81
Switzerland	19.59	24.14
United Kingdom	41.31	41.31

Table 13. Mean value (WTP estimates) of recreational forest services by European countries, projections in 2030, (no discounting)

Country	Value (size, density, income) WTP/year/ha (€2005)	Value (size, density, altitude, income) WTP/year/ha (€2005)
Austria	11.17	13.36
Belgium	39.78	39.63
Bulgaria	4.72	5.26
Czech Republic	11.65	12.91
Denmark	24.36	20.59
Estonia	3.16	2.84
Finland	2.29	2.26
France	13.97	14.49
Germany	23.69	24.88
Greece	8.88	9.91
Hungary	11.33	11.23
Ireland	17.03	16.39
Italy	17.82	20.11
Latvia	3.40	3.19
Lithuania	5.35	5.13
Luxembourg	27.21	28.53
Netherlands	66.70	49.99
Norway	3.71	4.13
Poland	9.65	9.71
Portugal	9.71	10.26
Romania	6.56	7.07
Slovak Republic	7.39	8.20
Slovenia	9.75	11.04
Spain	8.62	9.94
Sweden	2.81	2.94
Switzerland	22.88	28.24
United Kingdom	41.31	41.31

Table 14. Marginal value of recreational forest services by European countries

Country	Value (size, density) WTP/year/ha (€2005)	Value (size, density, altitude) WTP/year/ha (€2005)
Austria	0.336	0.423
Belgium	1.124	1.119
Bulgaria	0.288	0.332
Czech Republic	0.476	0.544
Denmark	0.719	0.578
Estonia	0.147	0.128
Finland	0.079	0.078
France	0.445	0.466
Germany	0.736	0.784
Greece	0.296	0.342
Hungary	0.532	0.526
Ireland	0.504	0.479
Italy	0.601	0.702
Latvia	0.172	0.159
Lithuania	0.257	0.242
Luxembourg	0.584	0.621
Netherlands	1.787	1.228
Norway	0.097	0.111
Poland	0.489	0.493
Portugal	0.414	0.444
Romania	0.409	0.453
Slovak Republic	0.334	0.382
Slovenia	0.361	0.425
Spain	0.296	0.357
Sweden	0.093	0.098
Switzerland	0.611	0.803
United Kingdom	1.280	1.280

Table 15. Marginal value of recreational forest services by European countries

Country	Value (size, density, income) WTP/year/ha (€2005)	Value (size, density, altitude, income) WTP/year/ha (€2005)
Austria	0.361	0.454
Belgium	1.201	1.195
Bulgaria	0.153	0.177
Czech Republic	0.368	0.421
Denmark	0.750	0.603
Estonia	0.107	0.093
Finland	0.080	0.079
France	0.444	0.465
Germany	0.733	0.781
Greece	0.289	0.333
Hungary	0.355	0.351
Ireland	0.533	0.506
Italy	0.558	0.652
Latvia	0.114	0.105
Lithuania	0.175	0.165
Luxembourg	0.852	0.906
Netherlands	1.956	1.344
Norway	0.127	0.146
Poland	0.305	0.307
Portugal	0.310	0.333
Romania	0.209	0.231
Slovak Republic	0.239	0.273
Slovenia	0.313	0.369
Spain	0.280	0.338
Sweden	0.097	0.103
Switzerland	0.715	0.939
United Kingdom	1.280	1.280

Table 16. Marginal value (WTP estimates) of recreational forest services by European countries projections in 2030, (no discounting)

Country	Value (size, density) WTP/year/ha (€2005)	Value (size, density, altitude) WTP/year/ha (€2005)
Austria	0.487	0.613
Belgium	1.632	1.623
Bulgaria	0.418	0.481
Czech Republic	0.690	0.789
Denmark	1.043	0.838
Estonia	0.213	0.186
Finland	0.115	0.113
France	0.646	0.677
Germany	1.068	1.138
Greece	0.430	0.496
Hungary	0.772	0.763
Ireland	0.731	0.694
Italy	0.872	1.019
Latvia	0.250	0.231
Lithuania	0.373	0.352
Luxembourg	0.847	0.901
Netherlands	2.592	1.782
Norway	0.141	0.161
Poland	0.710	0.716
Portugal	0.600	0.645
Romania	0.594	0.657
Slovak Republic	0.484	0.554
Slovenia	0.524	0.617
Spain	0.429	0.518
Sweden	0.135	0.143
Switzerland	0.887	1.165
United Kingdom	1.857	1.857

Table 17. Marginal value (WTP estimates) of recreational forest services by European countries, projections in 2030, (no discounting)

Country	Value (size, density, income) WTP/year/ha (€2005)	Value (size, density, altitude, income) WTP/year/ha (€2005)
Austria	0.523	0.659
Belgium	1.742	1.733
Bulgaria	0.223	0.256
Czech Republic	0.534	0.611
Denmark	1.088	0.875
Estonia	0.155	0.135
Finland	0.116	0.114
France	0.644	0.674
Germany	1.063	1.133
Greece	0.419	0.483
Hungary	0.516	0.509
Ireland	0.773	0.734
Italy	0.809	0.946
Latvia	0.165	0.153
Lithuania	0.254	0.240
Luxembourg	1.236	1.315
Netherlands	2.838	1.950
Norway	0.185	0.212
Poland	0.442	0.446
Portugal	0.450	0.483
Romania	0.303	0.335
Slovak Republic	0.346	0.396
Slovenia	0.455	0.535
Spain	0.406	0.490
Sweden	0.141	0.149
Switzerland	1.037	1.362
United Kingdom	1.857	1.857

5 Cultural services: Passive Use of Forest Biodiversity Protection

5.1 Data availability

The value of passive use of biodiversity protection is estimated as marginal value per hectare per year. The data used for the estimation were primarily taken from the database of available valuation studies reported in WP II.4.a (Giergiczny, Mavsar et al. 2008). Information about the areas of forest protected for biodiversity conservation were taken from the MCPFE report (MCPFE 2007), which provided the data of areas of forest protected primarily for biodiversity by country in 2005.

5.2 Methodology

The estimation of marginal values is based on the following steps:

- Creation of a data set of valuation studies that valued the passive use of forest biodiversity protection
- Estimation of a meta-regression function based on usable values
- Application of value transfer

Creation of data set

The data set is created by primarily selecting valuation studies from the database reported in WP II.4.a. Only primary valuation studies in which the value of passive use plays a major role were selected. It should be noted that, in the reported database, care has already been taken not to double count value estimates that are reported in more than one study, and it has also excluded estimates that were derived through value transfer from studies also included in the database.

Meta-regression function

The meta-regression function was formulated by adapting the meta-regression function developed by COPI[10] (Markandya, Chiabai et al. 2008). The COPI function included two independent variables, i.e. the area of forest designated to conservation of biodiversity, and the income level in the form of GDP per capita. In addition to these two variables, in our meta-regression we also included population size, or household number, for each study site in our data set. It is taken into account because, when converting the WTP value per household into WTP per hectare, we shall multiply the relevant household numbers. Our expectation is that the population factor would positively affect the marginal value of passive use, as reported in Brander & Florax (2006). The meta-regression function is expressed as:

(7) $$LogWTP = \alpha + \beta LogSIZE + \gamma LogINC + \delta LogPOP$$

[10] Cost Of Policy Inaction: The case of not meeting the 2010 biodiversity target. See: http://ec.europa.eu/environment/nature/biodiversity/economics/pdf/copi.zip

Where:

WTP is the marginal value per hectare (willingness to pay, WTP) for passive use of a given forest site designated to conservation of biodiversity;

$SIZE$ is the size of the forest area designated to protection of biodiversity, hectares

INC is the income level measured in PPP (purchasing-power parity)- adjusted GDP per capita

POP is the relevant household number.

5.3 Results

The meta-regression function was estimated based on 10 contingent valuation studies, which are selected primarily from the database of available valuation studies reported in WP II.4.a. A strict requirement for a valuation study being able to enter into our data set is that the area of forest site(s) that the study covered should be explicitly reported or could be retrievable, based on the available information in the study. This requirement is necessary, because, all the valuation studies reported the value of passive use in per household term, and thus we need to convert them into WTPs per hectare. In doing so, the information on the site area and the relevant population size need to be known. After sorting out the studies that do not satisfy the area requirement, we obtain 10 valuation studies on valuing forest biodiversity conservation, in which passive use value plays a major role. These studies are summarized in Table 18. All the money terms are computed in 2005 UK £ (standardized WTP per hectare per year) by first using purchasing-power parity (PPP) to convert values to UK £ in the study year, then converted into 2005 £ by the UK's consumer price index, and finally converted into 2005 €. The valuation studies are from 5 EU states. Specifically, 4 studies are from UK, 4 studies from Finland, and 2 studies from Norway. Spain and Sweden each has one study. Regarding the size of forest sites being valued, it varies considerably, ranging from the smallest, 300 ha, in Norway to the largest, 705 000 ha, in Finland. The marginal value of passive use varies from 716€ to 30 693€/ha, showing considerable different marginal values that people put on the passive use of forest resources across countries. Two extremely large estimates have been observed. Kniivilä and Ovasainen (2002) reported a value estimate of 30 693€. In that study, the value included both the use and non-use value derived from the existence and maintenance of 20 000 ha conservation areas in the north-eastern Finland. The second large estimate, 16 387€/ha, is reported by Macmillan (2001), which valued a restoration of 80 000 hectare native forest in Affric, UK. These two studies were excluded from our data set.

From the remaining 8 valuation studies, we were able to extract 24 value estimates of passive use. When the study reported more than one value estimate of WTP for a site, or several value estimates associated with different sites of same size, we use their average value. Finally, we ended up with 14 usable observations for our meta-regression. The results of the meta-regression for passive use of forest biodiversity protection are reported in Table 19. The results confirm our expectations. The coefficient on conservation forest area, ß, is negative, showing that, there would be a marginal decrease in the value of

passive use of forest for biodiversity protection as forest area increases; the coefficient on income level, γ, is positive, showing that a marginal increase in income would result in a marginal increase in the value of passive use. As also we expected, the coefficient on population size, δ, is positive, showing that a marginal increase in population may result in a marginal increase in the value of passive use as well.

Value transfer

We used two approaches for value transfer: direct value transfer, and function value transfer based on the obtained meta-regression function presented in Table 19. For the countries, in which valuation studies exist, we used the value or average value of the valuation studies as the marginal value of passive use for forest protected for primarily biodiversity for the country level. For the other countries in which no valuation studies are available, we estimated the marginal value using the estimated meta-regression function. The inputs to the function are the country's area of forest protected primarily for biodiversity, the PPP-adjusted GDP per capita, and the country's total household number. Both the estimated marginal values and total values of passive use of forest biodiversity by country are presented in Table 20.

Table 18. Review of valuation studies on passive use of forest valuing biodiversity conservation.

Authors	Paper Year	Country	Forest Size (ha)	Standardised 2005 € (WTP/ha/yr)	Standardized 2005 € (WTP/hh/yr)
Kniivilä, Ovaskainen et al.	2002	Finland	20 000	30693.9	269.1
Lehtonen, Kuuluvainen et al.	2003	Finland	62 000 – 372 000	1460.6 - 4872.9	126.8 - 228.1
Siikamaki and Layton	2006	Finland	155 000 - 705 000	887.9 - 4216.8	274.4 - 466.5
Hoen and Winther	1993	Norway	25000 - 90 000	716.2 - 1023.0	14.7 - 37.0
Veisten and Navrudb	2006	Norway	300	1593.2	0.3
Mogas, Riera et al.	2006	Spain	321 000	2168.2 - 2928.5	50.0 - 67.6
Broberg	2007	Sweden	126 000	953.3	27.3
ERM	1996	UK	300 000	1197.8	15.2
Garrod and Willis	1997	UK	3 000	2093.3 - 6393.07	0.3- 0.8
Hanley, Willis et al.	2002	UK	12 000	980.1 - 3356.2	0.5 -1.6
Macmillan, Duff *et al.*	2001	UK	80 000	16387.9	52.4

Table 19. Results of the meta-regression for forest passive use values

Dependent variable	Coefficient (std. error)	Std. error
LogWTP		
Independent variables		
Constant	0.3343**	19.4056
LogSIZE	-0.0612	0.1360
LogINC	0.5537	1.8611
LogPOP	0.1474	0.1975
Nobs	14	
R^2	0.0996	
Adj R^2	-0.1705	

Table 20. Marginal values and total values of passive use of forest protected primarily for biodiversity by country (in 2005€).

Country	Forest Area [a] (1000ha)	Marginal value (€/ha)	Total value (million €/year)
Austria	117	1865	218.3
Belgium	12.3	2152	26.5
Bulgaria	150	896	134.4
Czech Republic	82	1517	124.4
Denmark	92	1787	164.4
Estonia	289	922	266.4
Finland*	1680	2631	4420.1
France	178	2321	413.1
Germany	2764.6	2066	5710.6
Greece	159	1590	252.8
Hungary	72.7	1354	98.4
Ireland	5.7	2077	11.8
Italy	2934	1853	5436.5
Latvia	296.2	868	257.2
Lithuania	193	973	187.8
Luxembourg	29.9	1962	58.7
Netherlands	54	2221	119.9
Norway*	156	1034	161.3
Poland	295	1313	387.5
Portugal	9.8	1638	16.0
Romania	398.4	966	385.0
Slovak Republic	334.4	1114	372.4
Slovenia	15.6	1332	20.8
Spain	136.4	2548	347.5
Sweden*	1175	953	1119.8
Switzerland	93.2	2015	187.8
United Kingdom*	145	2565	371.9

[a] Forest area protected primarily for biodiversity. Source: (MCPFE, 2007)
Note: (*) the marginal value was estimated by using direct value transfer approach.

6 Conclusions

This report provides the methodological approach and main results of the monetary valuation of a selected set of goods and services provided by the European forests. The objective is to build a link that links the monetary values with the physical characteristics of forests. Forest goods and services being valued include: wood and non-wood forest products, carbon sequestration, recreation, and forest biodiversity protection (passive uses). Valuation framework follows a valuation process mainly adapted from the COPI project (Markandya *et al.* 2007).

Marginal value of wood and non-wood forest products has been estimated taking into account products type, the country of production, and the size of the forest area designated to production. Regarding carbon sequestration, the marginal quantity of carbon sequestrated per hectare forest has been estimated by identifying the capacity of carbon sequestration by country and the total area of forest in a county. The marginal value of carbon sequestration is then estimated by applying the monetary value taken from the ExternE and IMPACT project reports.

The meta-analysis has produced significant results in terms of the effect of forest size, population density and the altitude of the area where the forest is located on the normalized recreational value of the forest site (WTP/ha/year). Income level proved not to be statistically significant. In the value transfer part of the study, the estimate of the average value of recreational forest services for UK equal to 28.47 (2005€/ha/year) has been assumed. This value is based on the study by Benson and Willis (1990). Subsequently the mean value for the UK has been transferred to other European countries.

Apart from the mean value we also used the marginal value equal to 1.28 (2005€/ha/year) from the study by Markandya et al. (2007) and transferred it to the other European countries.

For values of passive use, the meta-analysis shows that the estimated marginal value of forest biodiversity protection decreases with an increase of the forest size, and increases with an increase of the income level and household number. In the value transfer part, we have used direct value transfer approach to estimate the marginal value of passive use of forest biodiversity protection for the countries with valuation studies available, while for the countries without valuation studies reachable, we estimate the marginal value by using the obtained meta-regression function. Our work shows that further efforts on original valuation studies are necessary in order to get reliable estimates of values for forest biodiversity protection using value transfer approach.

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