A Benefit Transfer of Ecosystem Values – Recreation in Forests

Marianne Zandersen, Ph.D. Student, Hamburg University, Research Unit Sustainability and Global Change, ZMK, Troplowitzstraße 7, 22529 Hamburg, Germany, zandersen@dkrz.de
Richard S.J. Tol, Michael Otto Professor of Sustainability and Global Change, Centre for Marine and Climate Research, Departments of Geosciences and Economics, Hamburg University, Hamburg, Germany

Abstract

A benefit function transfer of forest recreation values will be carried out at a global level and is expected to deliver a recreational demand function that is partly dependent on forest attributes. The demand function is the result of a meta-analysis of forest recreation valuation studies using travel cost methods (TCM).

The demand function for forest recreation allows a non-market ecosystem service to be included in the optimisation of a land use allocation model, which lets agriculture, industry, forestry, housing and nature recreation compete for land. The work is part of the ECOBICE project, an integrated, dynamic assessment model linking climate, ecosystem and economic models, that looks at development scenarios and policy questions in relation to climate change over the next 100 years.

JEL codes: Q23, Q26
Keywords: Travel Cost Method, Meta-analysis, Recreation, Forestry

1. Introduction

Recreation is one of the numerous services provided by ecosystems. The value that users attach to nature recreation can be substantial although it is not reflected by market prices and is provided as a quasi-public good. Taking these values into account can make a difference in the management, conservation and planning options for nature recreation.

This paper focuses on forests as one particular ecosystem, producing a range of recreation opportunities. We estimate a general forest recreation benefit function by conducting a benefit function transfer, using the meta-analysis technique. The meta-analysis statistically summarizes the findings of valuation studies which have used the travel cost method. By measuring the price of access across different sites, we obtain a benefit function based on the valuation of identical types of changes (ie. price of access).

The travel cost method is generally regarded as a robust methodology and theoretically well suited for benefit function transfer, although modelling assumptions do have an influence on the results (Loomis, 1992; V.K. Smith & Y. Kaoru,1990). However, few meta-analyses include studies which measure the same type of change in quality or quantity at the study site, such as in V. Kerry Smith (1990) or Desvousges,W.H. et al (1992). Also, few meta-analyses include exogenous data to make up for the lack of individual site attribute data in the valuation studies. As attributes vary across study sites, they may be essential to control for in a meta-analysis whereas environmental attributes are constant at the individual study site and hence individual valuation studies do not report on these. Exception exist, of course, where the aim of the primary valuation study has been to value environmental characteristics, such as Hanley and Ruffel (1993).

In relation to ecosystem typology, several benefit transfers have been undertaken for wetlands, lakes and rivers (e.g. Brookshire, 1992; Brouwer, 1999; Woodward, 2001) and to our knowledge, only two meta-analyses focus on forests (as opposed to general outdoor recreation). These are limited to the UK (Bateman 1999 & 2003).

The valuation function derived from the meta-analysis aim to provide the demand for forest recreation in the land-use-allocation model of the ECOBICE project. The meta-analysis makes use of additional, exogenous data on a 1X1 degree grid cell level on population density, per capita income, forest density, forest cover as well as measures on tree species diversity. ECOBICE is funded by the VW foundation and developed by the University of Oldenburg, Hamburg and the Max Planck Institutes in Jena and Hamburg.

2. Forest Recreation

Recreation depending on environmental resources, such as forests, is a quasi-public good, characterised by:

- **non-excludability:** people have free access to beaches, forests, lakes and rivers (in most countries);
- partly rival as **non-rival** at quiet times, but **rival** at congested times, when all people in town go to a certain forest, park or beach**.** This can also be described as **capacity constraint**[1]; and
- although an improvement in a recreational good benefits all in society, assuming free access, there will always be **spatial constraints**, ie. people far away from a forest supplied by the public will not benefit from improvements.

Although recreation in nature is a quasi-public good, it has traditionally been provided as if it was a public good – ie. free at point of delivery and financed from taxes. However, an important part of forests open for recreation in Europe is privately owned, where forest owners supply even costly recreation services free of charge[2]. We assume that the non-excludability of forest recreation holds in all cases and that the public pays for the management and infrastructure necessary for recreation (or for increased recreation utility).

2.1. Measuring Recreational Values

Utility is not derived from environmental resources per se, but from the **goods** and **services** produced by these environmental resources. Forests, for instance, are valued for regulating atmospheric chemical compositions and local temperatures, controlling erosion, improving

[1] The level of congestion, which would actually stop somebody else from using the same recreation resource is in most cases very high, especially close to major conurbations [this may be a result of lack of perfect substitutes).
[2] In Germany, for instance, more than 40% of forests are private and offer free access for recreation.

air quality, or for providing indirect recreational opportunities in the form of advanced amenity services important to bikers, joggers, walkers etc.

Estimating the value of recreational non-market goods can be done through revealed and stated preference techniques. The revealed preference techniques use directly observable values and comprise techniques such as the travel cost method, discrete choice models, hedonic pricing or averting behaviour. These techniques can only estimate *use values*. Stated preference methods can estimate both use and non-use values, by asking people hypothetical questions. These are classified into contingent valuation and choice modelling techniques.

Valuation of forest recreation is based on **perceptions** and observed **behaviour**. This means that only characteristics or attributes in nature, which are *observable* by individuals, are valued. V. Kerry Smith (1992) formulates this as 'When environmental quality affects an observable use of the resource, we can expect that values for it will be linked to the choke price for that use'. Forest site characteristics should therefore be measured subjectively in terms of visitors' perceptions.

2.1.1. Measuring Changes in the Environmental Resource

Stated estimation methods should value a *change* in quality or quantity, and not a steady *state* of a resource. The estimated level of the willingness to pay (WTP) for an improvement or willingness to accept (WTA) for a degradation in a environmental resource will depend on the *type of change* hypothesised in the stated valuation technique. In relation to the ECOBICE project, there are a wide range of possible *changes* in the quantity or quality of forests, which the valuation would need to take into account. Examples of changes are listed below:

- *Extension* of an existing recreation forest (where the former land use could be industry, residential, agricultural land, plantation forest);
- *Reduction* in size of an existing recreation forest (where the recreational forest can be converted into forest plantation, industry, residential, or agricultural land);
- *Total conversion* of an existing recreational forest (where the former land use could be industry, residential, agricultural land or plantation forest);
- *Construction* of a new residential forest, not linked to an existing forest (where the former land use could have been industry, residential area or agricultural land); and
- *Preservation* of a forest from conversion (which could be industry, residential use, agricultural land or plantation forest).

These changes in land use (Santos,1998) can be qualitative, such as:
- *continuous*, gradual changes due to changes in land management practices, for instance abandoned farm land leading to natural afforestation;
- *considerable* changes in landscape character such as afforestation, scattered light housing development; or
- *abrupt*, considerable changes in character resulting from conversion to moderate to heavy industrial, housing or commercial development of farmland.

As a consequence, the recreation value derived will vary according to the type of change. In order to develop a general forest recreation valuation function, the meta-analysis would need to include studies, which value these different types of possible changes in ECOBICE.

2.1.2. Using the Travel Cost Method

A solution is to let the meta-analysis focus on studies which apply identical types of changes, such as travel cost models (TCM) which all value the *price of access*. It measures the consumers' surplus from current price to the choke price (the price at which the consumer will no longer go to the forest). It is one of the most widely used non-market valuation technique, particularly for estimating the value of outdoor recreation sites which are free of access (Freeman, 1993; Loomis & Walsh, 1997).

The method can also seek to obtain marginal valuations, or prices, for characteristics of environmental resources, for instance for the characteristics of forest recreation, fishing trips, water quality and visits to beaches (e.g. Hanley and Ruffell (1993), Smith Desvousges and McGivney (1983), Loomis, Sorg and Donnelly (1986), and Bell and Leeworthy (1990)). Despite the potential of travel cost methods, the non-market value of *different* site qualities has rarely been studied (Englin and Mendelsohn, 1991). Meta-analysis offers a novel way of looking at values linked to forest characteristics across different types of forests and locations, requiring, however, extensive use of exogenous variables.

TCM is based on reported behaviour of consumers who maximise their utility subject to budget and time constraints. The main assumption of the travel cost method is that individuals perceive and respond to changes in the travel part of the cost of a trip in the same way they would respond to a change in the admission price, i.e. an assumed weak complementary relationship between the travel consumer's surplus and the site consumer's surplus. As travel prices increase, demand for the recreation service is driven towards zero.

In addition, TCMs are theoretically well suited for benefit function transfers (Loomis, 1992): "The size and spatial distribution of the population around the unstudied recreation site can be explicitly accounted for" and "using trips per capita as the dependent variable implicitly accounts for both the probability a person in a given population will take a trip and the number of trips the person would take".

3. *The Meta-analysis*

The meta-analysis focuses on studies that have applied the travel cost method, and where forests are the main attraction (as opposed to eg. fishing studies). It includes studies, where recreation is directly linked to services provided by forests but excludes those, where other non-forest ecosystems such as water, grassland, tundra etc. are the main reasons for visiting a site.

The meta-analysis is based on microeconomic theory (Walsh 1992) where the dependent variable of the demand function – quantity demanded – is explained by proxies for the price of access (travel distance, travel cost per km, opportunity cost of time), the price and availability of forest substitutes, socio-economic variables (e.g. income, age, group size) and preferences (crowding, characteristics of the site).

The meta-analysis is conducted in three levels of detail:

- 1st level comprising of data from the studies, supplied with additional data from the authors;
- 2nd level including exogenous data from other databases, such as forest characteristics, population density and average household income level;
- 3rd level representing data obtained directly from the forests on precise site characteristics (e.g. forest age, phenology characteristics).

In order to study the impact of different site qualities on preferences for forest recreation, we include following exogenous variables on physical characteristics, deemed important in earlier research (Hanley, N. and Ruffell, R., 1993) and complemented with own additions:

- Percentage of forest accounted for by the phenology classification of the Lund-Potsdam-Jena vegetation model (See Annex 1);
- Forest density where closed forest represents 40-100% canopy cover and open/fragmented forest represents 10-40% canopy cover;
- Diversity of tree species;
- Diversity of tree age classes;
- Site management type (designated area, natural commercial forest, plantation);
- Proportion of the forest as open space;
- Presence of water features;
- Provision of other visitor facilities than trails;
- Forest size; and
- Total annual visitors.

Annex A contains the full list of variables.

3.1.3. Preliminary Statistical Results

The regression analysis model is based on the basic form: $y_i = \alpha + \beta' x_i + \varepsilon_i$, where

i indexes each observation, *y* is the consumer surplus per person per visit adjusted to USD2000, α and β are respectively the intercept and the slope coefficients to be estimated, x_i is a matrix of explanatory variables including valuation study methodology, site and user population characteristics, and ε is the error term with mean zero and variance σ_ε^2.

The preliminary results do not include variables on forest characteristics and covers a subset of the collected studies. Exogenous data and gap-filling of reported data from the studies are currently being collected from forest authorities and authors. The analysed dataset comprise 138 observations in 52 forests surveyed in the UK, Denmark, Germany and Finland, comprising a total of five studies.

Table 3.1 presents the regression results of four different specifications: linear and log linear functional forms and weighted and unweighted by study dominance[3]. Variables selected cover proxies for price (travel cost, time cost, distance), one socio-economic variable (average household income), measure of crowding (total site visitors), and a number of methodological variables (TCM type, functional specification, country and author).

The adjusted R^2 of 138 observations indicates that between 74% and 99% of the variation in the consumer surplus is explained by the variables included in the function. The statistical tests are bound to be influenced by the panel nature of the observations, with heteroskedasticity and multicolinearity likely to be present as more observations are drawn from the same studies. We chose the White consistent covariance estimates of standard errors to calculate the *t*-statistics to alleviate the heteroskedasticity effect.

Looking at the proxies for price, we would expect negative coefficients to describe the relationship of decreasing visits for increasing price of access. The preliminary results show a positive relationship of increasing costs lead to increasing benefits. One reason could be the consistent underestimation of travel costs that lead to an overestimation of consumer surplus. The coefficients of the regression analysis would in that case belong to the right hand side of the benefit equation and provide a downward correction of the consumer benefit. Alternatively, the panel effect of the data could still remain, despite correction by the White consistent covariance estimates of SEs and weighting the data sets for study dominance.

The methodological variables show a negative relationship between the benefit measure and zonal travel cost method and between consumer surplus and forest recreation valued in Denmark. Omission of time cost and generally lower km costs in the Danish study may play a role.

The weighting by study dominance increases the explanatory power of both the linear and log-linear functions but also lowers the precision of the estimate (loglikelihood decreased).

We attempted weighting the data by maximum distance and also by length of stay, using a classification of holiday makers and day-visitors. Both weightings proved non-significant.

[3] For instance, the Christensen (1988) study contains 12 observations. These are weighted by 1/12.

Table 3.1 OLS Regressions of Forest Recreation Values in Europe

Dependent variable: Consumer Surplus per Person per Visit (USD 2000)

Regressor	linear (1)	Linear weighted (2)	Log-linear (3)	Log-linear weighted (4)
Cost per km (USD per km)	7,63** (1,8)	-17,32 (22)	3,05** (0,21)	2,91** (0,29)
Opportunity cost of time (% of hourly wage)	11,9* (5,42)	162,94** (37,3)	1,26** (0,16)	2,12** (0,03)
TCM type (1=zonal)	-33,52** (4,71)	-139,34* (60,5)	-0,71 (0,32)	-0,96* (0,39)
LHS functional form	104,55* (50,8)	59,26 (92,28)	0,56 (0,76)	-0,58 (1,20)
Danish study	-102,97* (51,1)	8,8 (99,8)	-1,93* (0,90)	-0,80 (1,52)
Max. distance	0,01 (0,02)	0,23 (0,19)	-0,003 (0,003)	-0,003 (0,004)
Average distance	0,01 (0,03)	-0,24 (0,27)	0,01** (0,004)	-0,02 (0,008)
Total site visitors	1,24W-07 (1E-07)	9,51E-08 (5,03E-06)	-5,01E-06 (3,83E-06)	1,54E-05** (4,28E-09)
Average household income	-1,04E-05 (8,07E-05)	-0,0003 (0,001)	-8,32E-06 (8,38E-06)	-1,18E-05 (1,40E-05)
Author Willis	-1,28 (3,41)	31,95 (61)	-0,96* (0,47)	-1,27* (0,58)
Intercept	30,6** (8,55)	78,6 (105,6)	1,09 (0,87)	1,47 (1,44)
Summary Statistics				
SER	8,83	66,5	0,52	0,31
R^2 adj.	0,74	0,94	0,80	0,99
n	138	138	138	138

Note: All regressions use the White heteroskedasticity-consistent standard errors and covariance. ** and * are significant at the 0,01 and 0,05 level respectively. Standard errors are shown in brackets. Weighing by study dominance.

These results are very much preliminary, rough runs of regression of a subsample of collected data and observations. We expect to have the following information included by the workshop end of August :

- Link benefit measures to forest characteristics;
- Expand the analysed dataset to ca 250 observations for Europe; and
- Include a comparison with travel cost studies from the US, based on the research of Rosenberger and Loomis (2000).

References

Bateman, I.J., Lovett, A.A. and Barinard, J.S. (1999) Developing a methodology for benefit transfers using geographical information systems: modelling demand for woodland recreation. *Regional Studies* **33**, 191-205.

Bateman, I.J., Pones, A.P., Nishikawa, N. and Brouwer, R. CSERGE, (Ed.) (2000) Benefits transfer in theory and practice: a review. GEC 2000-25, pp.1-88.

Brouwer, R., Langford, I.H., Bateman, I.J. and Turner, R.K. (1999) A meta-analysis of wetland contingent valuation studies. *Regional Environmental Change* **1**, 47-57.

Brookshire, D.S. and Neill, H.R. (1992) Benefit Transfers: Conceptual and Empirical Issues. *Water Resources Research* **Vol. 28, No 3**, 651-655.

Christensen, J.B. (1988) An economic approach to assessing the value of recreation with special reference to forest areas. In: Anonymous Unpublished Ph.D. Thesis pp. 123-178. Frederiksberg, Denmark: Royal Veterinary and Agricultural University

Desvousges, W.H., Naughton, M.C. and Parsons, G.R. (1992) Benefit Transfer: Conceptual Problems in Estimating Water Quality Benefits Using Existing Studies. *Water Resources Research* **28**, 675-683.

Elsasser, P. (1996) *Der Erholungswert des Waldes*, Frankfurt am Main: J.D. Sauerländer's Verlag.

Hanley, N. and Ruffell, R. (1993) The valuation of forest characteristics. In: Adamowicz, W., White, W. and Phillips, W.E., (Eds.) *Forestry and the environment: economic perspectives*, pp. 171-197. Oxon, UK: CAB International.

Loomis, J.B. (1992) The evolution of a more rigourous approach to benefit transfer: benefit function transfer. *Water Resources Research* **28**, 701-705.

Luttmann, V. and Schröder, H. (1995) *Monetäre Berwertung der Fernerholungs im Naturschutzgebiet Lüneburger Heide*, Frankfurt am Main: J.D. Sauerländer's Verlag.

Ovaskainen, V., Mikkola, J. and Pouta, E. (2001) Estimating recreation demand with on-site data: An application of truncated and endogenously stratified count data models. *Journal of Forest Economics* **7**, 125-142.

Rosenberger, R.S. and Loomis, J.B. (2000) Benefit transfer of outdoor recreation use values. RMRS-GTR-72, pp.1-59. Rocky Mountain Research Station: U.S. Department of Agriculture, Forest Service.

Santos, J.M.L. (1998) *The economic valuation of landscape change. Theory and policies for land use and conservation*, Cheltenham, UK. Northampton, MA, USA: Edward Elgar.

Smith, V.K. (1992) On Separating Defensible Benefit Transfers From 'Smoke and Mirrors'. *Water Resources Research* **28**, 685-694.

Smith, V.K. and Kaoru, Y. (1990) Signals or Noise? Explaining the variation in recreation benefit estimates. *American Journal of Agricultural Economics* **72**, 419-433.

Walsh, R.G., Johnson, D.M. and McKean, J.R. (1992) Benefit transfer of outdoor recreation demand studies, 1968-1988. *Water Resources Research* **28**, 707-713.

Willis, K.G. (1991) The recreational value of the forestry commission estate in Great Britain: A Clawson-Knetsch travel cost analysis. *Scottish Journal of Political Economy* **38**, 58-75.

Woodward, R.T. and Wui, Y.S. (2001) The economic value of wetland services: A meta-analysis. *Ecological Economics* **37**, 257-270.

ANNEX A – Description of Variables

Variable	Definition of variable
Dependent variable	Consumer surplus converted to per person per visit, adjusted to USD2000 using PPP and CPI.
SAMPLE	
Sample Size	Total sample size,
Survey Returns	Number of surveys returned
Response Rate	Response rate percent
Surveytype	1,2,3; 1=face-to-face; 2=phonesurvey; 3=mailsurvey;
Sample frame	1,2,3,4; 1=On-Site; 2=User List; 3=General Population; 4=Others;
STUDY SITE CHARACTERISTICS	
TrBE	Tropical broad-leaved evergreen % in forest
TrBR	Tropical broad-leaved raingreen % in forest
TeNE	Temperate needle-leaved evergreen % in forest
TeBE	Temperate broadleaved evergreen % in forest
TeBS	Temperate broadleaved summergreen % in forest
BoNE	Boreal needle-leaved evergreen % in forest
BoNS	Boreal needle-leaved summergreen % in forest
BoBS	Boreal broadleaved summergreen % in forest
Forest density	1,0; 1=closed forest 40%-100% canopy cover; 0= open forest 10-40% canopy cover
Tree age diversity	Shannon index of tree age classes
Tree Species Diversity	Shannon index of tree species
Areasize	Study Site Size in ha
Site Type	1,2,3,4,5; 1=designated area (national park, wildlife refuge, Ramsar etc); 2= natural commercial forest; 3=plantation; 4=mangrove/freshwater swamp; 5=sparse trees & parkland
Longitude	Degree West/East
Latitude	Degree North/South
Water	1.0; 1= Presence of water features
Openland	1,0; 1= Presence of open land landscapes
Congestion	Population density in a 1 Degree X 1 Degreesgridcell
DETAILS OF TCM APPLICATION	
TCMTYPE	1=Zonal 2=Individ 3=RUM/MNL 4=Hedonic TCM
Number of zones	number of zones or origins in zonal TCM.
TCM equation type	1=OLS; 2=2SLS or SUR; 3=TOBIT; 4=Count data (POISSON, Neg Binomial); 5=Others (includes MNL, NMNL, when TCMTYPE=3,
Opportunity cost of time	Opportunity cost of time, measured in % of hourly wage
Cost per km	$ per km (USD2000 PPP adjusted)
Average distance	Average one-way distance in km from site
Max Distance	Max one way distance in km
Substitution	1,0; 1= Price of Substitution given, or Avail of Subst.(if demand equation include a variable for substitute)
LHS functional form	1=Linear 2=Log, Pois, Negative Binomial; 3=other
RHS functional form	1=Linear 2=Log 3=other
Travel cost	1,0; 1=fuel cost only; 0=full running costs

Variable	Definition of variable
RECREATION	
Average time on site	Average on-site time per trip, in hours (convert multiple days by using 12 hrs/day)
Average group size	Average number of people in group
Total site visitors	Total number of visits to the Area/Site per year
Recreation development	2,1,0;2=*extensively* developed for tourism/recreation; 1=site studied had developed *some* recreation facilities available (such as arranged tables etc., eg, camping, boating etc.)
Dispersion of recreation	Qualitative variable: 1 if site studied was dispersed recreation with no formal site or facilities (eg, hunting, hiking, etc).
Recreational activities	Activities such as picnic, wildlifeviewing, swimming, hunting, hiking, skiing,
SOCIO-DEMOGRAPHICS	
Average income	average income of visitors
Average gender	average education of visitors
Average age	average age
Average sex	Average male respondents

Note: The coding scheme is adapted from the meta-analysis of Rosenberger and Loomis (2000).