CHARLES UNIVERSITY
FACULTY OF HUMANITIES
Environment Centre

Study programme: Environmental Studies

Revealed preferences for outdoor recreation in natural areas - Czech and European perspective

Doctoral Dissertation

Author: **Ing. Kateřina Kaprová**
Supervisor: **Ing. Jan Melichar, Ph. D.**
Year of the defence: 2019

Reference

KAPROVÁ, Kateřina. *Revealed preferences for outdoor recreation in natural areas - Czech and European perspective.* Dissertation thesis (Ph. D.). Prague: Charles University, Faculty of Humanities, Environment Centre, 2019. 201 pages. Supervisor: Ing. Jan Melichar, Ph. D.

Summary

The dissertation thesis focuses on the investigation and synthesis of recreation welfare benefits associated with natural areas in the Czech Republic and in Europe. The dissertation thesis consists of five case studies. These represent various geographic levels of analysis: the level of one single recreation locality, the national level that takes into account large natural recreation sites in the Czech Republic (including protected areas), and a synthesis of results of studies on the European level. The methodological approach is based on the theory of environmental economics and employs non-market valuation techniques based on methods of revealed preferences, namely the hedonic pricing method and two types of travel cost modelling.

In Study I, we examine how the presence and characteristics of urban greenery affect property prices in Prague. The results confirm that proximity to greenery and its area are important determinants of housing prices in Prague, which means that residents realize the positive values provided by urban greenery, including recreational ecosystem service. Benefits to residents differ with the type of greenery. Urban forests have the largest effect on property prices. Specially protected areas also affect property price positively, but the effect is smaller. The study also suggests that Prague residents prefer smaller units of urban greenery to large parks.

In the subsequent two studies, I focus on the recreational values of the Šumava National Park. In a single site travel cost model, I estimate the recreation use value of this natural area and discuss how the result may be further employed. I also find that the methodological approach (the definition of the shadow price of recreation and endogenous sampling) significantly affect both the modelling results and the estimates of recreation use value.

In Study IV, we apply a travel cost model based on random utility framework to disentangle the determinants of demand for Czech large-scale natural recreation areas. The outcomes propose that visitors prefer larger recreation areas for their trips, and have a significant preference for natural areas where the dominant forest is broadleaved or coniferous rather than sites with mixed forest stands. Among Czech large-scale natural recreational areas, national parks are more probably chosen for a trip than protected landscape areas, and unprotected sites have the lowest probability of visitation.

Study V is based on a meta-analysis of the previous travel cost studies in Europe. The scope of this study is twofold: i) to disentangle the effect of environmental and methodological variables on the recreation value, and ii) to derive a model appropriate for a benefit transfer of forest recreation values in Europe, including Central and Eastern European natural sites. The key results from our meta-analysis of European forest recreation values are that higher recreation values are associated with remote forests in sparsely populated areas consisting of broadleaved forest stands and that protected sites are not associated with significantly different recreation values.

All studies covered in the thesis prove that natural areas are associated with positive recreation values. Based on discussion of the evidence from the Studies I to V and other recent scientific evidence, the thesis brings a set of recommendations for benefit transfers of recreation values to natural areas in the Czech Republic.

Key words

Recreation demand, recreation value, recreation welfare, protected areas, natural areas, urban greenery, forests, travel cost method, single-site model, random utility model, hedonic pricing method, benefit transfer, meta-analysis, non-market valuation, revealed preferences

Shrnutí

Disertační práce se zabývá analýzou a syntézou rekreačních hodnot spojených s přírodními územími v České republice a v Evropě. Práce sestává z pěti případových studií s různou geografickou úrovní analýzy: od analýzy jedné rekreační lokality přes analýzu velkých přírodních rekreačních území v České republice (včetně chráněných území), po syntézu výsledků evropských studií poptávky po rekreaci. Metodologie práce vychází z teorie environmentální ekonomie a netržního oceňování environmentálních statků a služeb, konkrétně je aplikována metoda hedonické ceny a metoda cestovních nákladů.

Studie I se zabývá vlivem městské zeleně (městských lesů a maloplošných zvláště chráněných území) na cenu nemovitostí v Praze. Výsledky studie ukazují, že blízkost k zeleni a plocha zeleně jsou významnými faktory ovlivňujícími ceny nemovitostí, což naznačuje, že obyvatelé Prahy pozitivně vnímají přítomnost městské zeleně včetně jejích rekreačních přínosů. Velikost přínosů poskytovaných rezidentům se liší podle typu městské zeleně. Městské lesy ovlivňují ceny nemovitostí nejvíce. Maloplošná zvláště chráněná území mají rovněž pozitivní vliv na cenu nemovitostí, ale efekt je nižší než efekt lesů. Preferovány jsou spíše menší plochy obou typů zeleně.

Následující dvě studie (II a III) se zaměřují na odhad rekreační hodnoty Národního parku Šumava. Odhad je proveden na základě aplikace metody cestovních nákladů, konkrétně modelu jednoho místa. Ve studiích jsou zkoumány dopady metodologického přístupu k definici stínové ceny rekreace a dopady administrace výběru respondentů s ohledem na jeho reprezentativnost na výsledky modelu a rovněž na výši odhadu rekreační hodnoty. Studie dále diskutují využití výsledků modelování.

Studie IV aplikuje model náhodného užitku, který je další technikou v rámci modelování cestovních nákladů, s cílem určit determinanty poptávky po velkých přírodních rekreačních územích v České republice. Závěry studie ukazují, že návštěvníci upřednostňují větší rekreační území s dominantním pokryvem buď jehličnatými, nebo listnatými lesy (tedy nikoli lesy smíšenými). Pravděpodobnost návštěvy je vyšší pro národní parky než pro chráněné krajinné oblasti, a je nejnižší pro přírodní oblasti mimo velkoplošná zvláště chráněná území.

Studie V je založena na meta-analýze evropských aplikací metody cestovních nákladů. Účelem studie je: i) určit, které environmentální a metodologické proměnné ovlivňují výši odhadu rekreační hodnoty spojené s návštěvou přírodního území, a ii) odhadnout meta-analytický model vhodný pro přenos rekreačních hodnot (benefit transfer) lesů v rámci Evropy, včetně středoevropských a východoevropských zemí. Podle výsledků studie jsou vyšší rekreační hodnoty spojeny s listnatými lesy a přírodními územími nacházejícími se v málo zalidněných oblastech. Rekreační hodnoty chráněných území nejsou významně odlišné od rekreačních hodnot ostatních území.

Všechny studie v disertační práci ukazují, že přírodní území poskytují společnosti značné rekreační přínosy. Závěr práce je věnován doporučením pro přenos rekreačních hodnot na přírodní území v České republice; tato doporučení jsou zpracována na základě výsledků Studií I až V a zohledňují také výsledky nedávných evropských výzkumů.

Klíčová slova

Poptávka po rekreaci, rekreační hodnota, rekreační užitek, rekreační území, chráněná území, přírodní území, městská zeleň, rekreace v přírodě, lesy, metoda cestovních nákladů, model jednoho místa, model náhodného užitku, metoda hedonické ceny, přenos hodnot, meta-analýza, netržní oceňování, metody odhalených preferencí

Table of Contents

Declaration of the author

1. I hereby declare that I have compiled this thesis by myself, using the listed literature and resources only.
2. I declare to be the author of the following steps of design and accomplishment of the particular studies that constitute the thesis (numbered to match the respective chapters of the thesis):
    I. Data analysis, overall design of the article (with co-operation of the main author), first version of the manuscript (all texts but Introduction and Conclusion), revision of the analysis and Discussion section after Major revisions.
    II. Complete design and accomplishment.
    III. Complete design and accomplishment.
    IV. Overall design of the article, GIS analysis, data analysis, first version of the manuscript.
    V. Design of the study, secondary data collection, marginal assistence with GIS analysis to the co-author, design of the article, first version of the manuscript.
3. I hereby declare that my thesis has not been used to gain any other academic title.
4. I give approval to make this thesis accessible by Charles University libraries and the electronic Thesis Repository of Charles University, and to be utilized for study and scientific purposes in accordance with the copyrights.

In Prague on 18 February 2019 Ing. Kateřina Kaprová

Declaration of the co-author of the scientific articles that constitute the thesis

1. As a co-author, I hereby declare that I agree with inclusion of the published articles that are found in Chapters I - III and the manuscripts of articles in Chapters IV - V into the text of this dissertation thesis by Kateřina Kaprová.
2. As a co-author, I hereby declare that I agree with the statement of contribution of Kateřina Kaprová that she declared above in the Declaration of the author (part 2), to the design and accomplishment of the articles and manuscripts found in Chapters I - V of this dissertation thesis.

In Prague on 18 February 2019 Ing. Jan Melichar, Ph. D.

Acknowledgements

First of all, I would like to express my gratitude to my advisor Jan Melichar. I am also very grateful to my colleagues and friends at the Charles University Environment Center: Markéta Braun Kohlová, Vojtěch Máca, Milan Ščasný, Jan Urban, Markéta Sychrovská, Lukáš Rečka, Martin Kryl, Hana Škopková and all the collective – they have always been a great source of inspiration for my work and I have learned a lot from them both on professional and personal level.

I have also very much appreciated the suggestions and comments made by the thesis opponents, Ing. Jan Brůha, Ph. D. and Prof. Ing. Petr Šauer, CSc., dr.h.c. that we discussed during the mock defense of this thesis, which allowed me to significantly improve the text.

The data collection and research on particular case studies was supported by the following projects and grants:

- *GAUK 1544314: Specification of distance, time and cost in recreation demand models (2014-2015)*
- *TAČR TD020049: The use of pricing mechanism for tourism directing and financing the management of specially protected areas in the Czech Republic (2014-2015)*
- *7th FP EC: Global-IQ: Impacts Quantification of global changes (2011-2014)*
- *NPV I 1R56014 (Ministry of Agriculture): Monetary valuation of recreational and aesthetical functions of forest in the Czech Republic (2005–2007)*

The support is gratefully acknowledged.

Preliminary results and follow-up research topics have been presented and discussed at national and international conferences and seminars:

- *Conference of the European Association of Environmental and Resource Economists (2012, Prague, Czech Republic)*
- *Mathematical methods in economics (2012, Karviná, Czech Republic)*
- *International days of statistics and economics (2013, Prague, Czech Republic)*

- *Environmental Economics and Policy: Young Researchers Perspective (2013, Prague, Czech Republic)*
- *EAERE/FEEM Belpasso Summer School on Environmental Economics: Spatial Context and Valuing Natural Capital for Conservation Planning (2014, Belpasso, Italy)*
- *Ulvön Conference on Environmental Economics (2015, Ulvön, Sweden)*
- *Morrison School of Agribusiness series of seminars (2015, Phoenix, USA)*
- *Aktuality šumavského výzkumu VI. (2015, Ludwigsthal, Germany)*
- *Public recreation and landscape protection - with nature hand in hand... (2015-2018, Křtiny / Brno, Czech Republic)*
- *International conference on monitoring and management of visitors in recreational and protected areas (2014 Tallinn, Estonia; 2016 Novi Sad, Serbia; 2018 Bordeaux, France)*
- *The 20th Annual Conference „Environmental Economics, Policy and International Relations“ (2018, Prague, Czech Republic)*

I would like to thank the parcipants of these events for their valuable insights and suggestions on the research topic.

List of abbreviations

CBA..............cost-benefit analysis

CE.................choice experiment

CEE ....Central and Eastern European countries (in Study V)

CM................choice modelling

CPI................consumer price index

CS ....consumer surplus

CV, CVM .....contingent valuation method

CZK..............Czech koruna (Czech crown)

EU.................European Union

FE ....fixed effects

GDP..............gross domestic product

GIS ....geographic information system

HICP ....Harmonised Index of Consumer Prices

HP, HPM......hedonic pricing method

IIA ....independence of irrelevant alternatives

IID ....independent and identically distributed

IP ....information point (in Study III)

LC.................land cover

LM................Lagrange Multiplier test

LU.................land use

MA ....meta-analysis

MNL.............multinomial logit

MP ....market prices

MXL.............mixed logit

N/A...............not available

NFI ....net factor income

NL.................nested logit

NP.................National Park

NUTS ....Nomenclature of Units for Territorial Statistics

OLS ....ordinary least squares

PF ....production function

PLA ....protected landscape area

PPP ....purchasing power parity

RC.................replacement cost

RE.................random effects

RP.................revealed preference

RUM.............random utility model

SP ....stated preference

SPA...............specially protected area

SSM..............single-site (travel cost) model

TC.................travel cost

TCM ....travel cost method

TE.................transfer error

UES ....urban ecosystem services

UK................United Kingdom

US, USA.......United States of America

VIF ....variance inflation factor

WNS.............Western, Northern and Southern European countries (in Study V)

WSUT...........weak structural ulility theoretic approach

WTP ....willingness to pay

Introduction

In the Czech Republic, the information on recreation values associated with recreational areas and open spaces, as well as information on factors affecting the demand for recreational areas has remained relatively scarce until the development of studies involved in dissertation thesis. The existing research on recreation demand that would prove that Czech natural areas bring substantial recreation values to their visitors encompassed only two natural sites: Jizerské mountains (Melichar, 2007; later published as Melichar, 2014) and Bohemian Paradise UNESCO Geopark (Špaček et Antoušková, 2013). As both the studies focused on analysis of a single site, they could not discuss which environmental attributes are perceived as important for recreational use by the visitors (e. g. are broadleaved forests more preferred than coniferous sites? Does the type of management of the area play a role for recreation use? Do the recreation preferences differ among types of visitors, length of stay or recreation uses?). Similarly, it has not been analysed yet whether Czech recreationists prefer to visit natural sites that promote enhanced biodiversity or the presence of rare types of landscape or biotopes rather than other types of landscape. Even European evidence on the determinants of recreation values has not been uniform (Schägner et al., 2018, Zandersen and Tol, 2009, de Salvo and Signorello, 2015).

The deficiency of environmental valuation studies that would shed light on the recreation values of natural areas is not only related to the Czech context, but to the whole of Central and Eastern Europe (with the exemption of a few existing studies, e. g. Czajkowski et al., 2014). In terms of time and resource constraints, transfer of values from published studies to different natural sites (e. g. Daněk et al., 2018; Melichar et al., 2016; Frélichová et al., 2014) remain the most feasible way to express the value of a natural site for which the primary valuation study is not available; which actually encompasses most natural sites in the post-transition countries. The magnitude of the perceived recreation value of a specific natural area is affected by the characteristics of the population of recreationists and their preferences regarding leisure and landscape (as the values are "co-created by visitors" - Mayer and Woltering, 2018) and also depends on the context of the landscape involved (the character of the area, the abundance of different types of recreation sites, their accessibility). With insufficient evidence, it has been difficult to discuss the validity of benefit transfer of values in the post-transition countries, and of international transfers of values in particular. Even though several quantitative (meta-analytic) reviews on European recreation values have been conducted (Zandersen and Tol, 2009; Kaprová and Melichar, 2014; Schägner et al., 2018), the predominate body of meta-analytic research has focused on natural areas in Western, Northern or Southern Europe, so uncertainty regarding the transferability of values to Central and Eastern European context prevails.

It has been proven that values associated with recreational use may vary substantially according to the methodology applied. Research on recreation values has been based on many different methodological approaches - valuation techniques, data collection techniques, estimation techniques and on various geographic scales. This contributes to the fact that up to the present, findings on recreation values associated with particular recreation sites in Europe are of high range, due to which it is not at all straightforward to draw any generalized conclusions based on the empirical results. Existing meta-analytic reviews on European recreation values (e. g. Schägner et al., 2018; de Salvo and Signorello, 2015) employ only binary variables on a general methodological level, e. g. to distinguish between stated and revealed preference studies. The only meta-analytic study focusing on European revealed preferences (more precisely travel cost models) by Zandersen and Tol (2009) shows slightly more detailed results, but does not focus on the latest methodological advancements in recreation demand modelling. None of these previous syntheses has incorporated evidence from Central and Eastern Europe (CEE).

This thesis brings new insights into the revealed preferences for recreation services associated with urban and natural areas in the Czech Republic. The results of the thesis substantially widen the set of primary results of revealed preferences for natural areas in the Czech Republic. I hope to contribute to the overall knowledge on the drivers of recreation values of natural areas by establishing several valuation models at different geographical levels.

The analyses presented in the dissertation thesis stem from the theory of environmental economics. In particular, I apply several non-market valuation techniques based on revealed preference methods: i) the hedonic pricing method and ii) two models of travel cost method (on-site single-site model, off-site random utility model). In addition, I develop a meta-analytic model of European forest recreation values including values derived in CEE countries, originating in travel cost methodology.

The dissertation thesis consists of five case studies, which represent various geographic levels of analysis:

- Level of one natural area (the Šumava national park) and its recreation values (Studies II and III)
- Level of one residential area (Prague) and the benefits provided by its urban greenery units (including recreation value) (Study I)
- Country scale level - estimation of recreation demand for large-scale natural recreational areas in the Czech Republic, including specially protected areas (Study IV)
- European level, where I examine the existing evidence on European forest recreation values using the technique of meta-analysis (Study V)

In the first three Studies (two of which, Study II and III, are devoted to Šumava National Park, one, Study I, to Prague greenery), I present the results on these study sites. Study IV is focused on a country-level random utility model. The results of the Study V provide a synthesis of European evidence on forest recreation values and provides measures of validity of the potential value transfer from European sites to the Czech context.

The Discussion section provides a summary of the findings on the research questions and hypotheses of the thesis based on the results of Studies I to V encompassed in the thesis, and its discussion with regard to the other latest scientific evidence. This section also provides a broader discussion on recreation valuation beyond the scope of Studies I to V and focuses on the implications of their findings for benefit transfer exercises of recreation values in the Czech Republic.

The main findings of the thesis are summarized in brief in the Conclusion section. The conclusions of the thesis may be important not only for the employment of social values of recreation in policy analyses (such as cost-benefit analysis exercises), but also as an inspiration for benefit transfers of social values of other ecosystem services across Europe (in particularly into areas where the results from primary research are still not very common, such as Central and Eastern Europe), where similar questions as those on which I focus on are highly relevant.

References

Czajkowski, M., M. Giergiczny, J. Kronenberg, P. Tryjanowski (2014). The economic value of a white stork nesting colony: a case of ‘stork village’ in Poland. *Tourism Management 40,* 352-360.

Daněk, J., D. Vačkářů, E. K. Lorencová (2018). Economic value of ecosystem services in Protected Landscape Areas in the Czech Republic. *Beskydy 10 (1,2),* p. 99-112.

De Salvo, M., G. Signorello (2015). Non-market valuation of recreational services in Italy: A meta-analysis. *Ecosystem Services 16,* p. 47-62.

Frélichová, J., D. Vačkářů, A. Pártl, B. Loučková, Z. V. Harmáčková, E. Lorencová (2014). Integrated Assessment of Ecosystem Services in the Czech Republic. *Ecosystem Services 8*, p. 110-117.

Kaprová, K., J. Melichar (2014). *Review and meta-analysis of monetary values for non-market goods and services affected by climate change: land use, ecosystem, leisure.* Deliverable No. D2.1 „Analysis of key determinants of costs and benefits of mitigation policy“of GLOBAL IQ - Impacts Quantification of global changes (Project no 266992). Chapter 1.

Mayer, M., M. Woltering (2018). Assessing and valuing the recreational ecosystem services of Germany’s national parks using travel cost models. *Ecosystem Services 31*, p. 371-386.

Melichar, J. (2007). *Aplikace metody cestovních nákladů v oblasti Jizerských hor.* Dissertation thesis. Prague: University of Economics, 150 p.

Melichar, J. (2014). Measuring recreation benefits of forest quality change with contingent behavior model. *Journal of Landscape Management 2,* p. 10-15.

Melichar, J., K. Kaprová, M. Ščasný (2016). The biodiversity change in the Czech Republic, driving forces and associated welfare impacts. *Journal of Landscape Management 7/2*, p. 37-44.

Schägner, J. P., L. Brander, J. Maes, M. L. Paraccini, V. Hartje (2016). Mapping recreational visits and values of European National Parks by combining statistical modelling and unit value transfer. *Journal for Nature Conservation 31*, p. 71-84.

Špaček, J., M. Antoušková (2013). Individual single-site travel cost model for Czech Paradise geopark. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis LXI (7),* p. 28512858.

Zandersen, M., and R. S. J. Tol (2009). A Meta-analysis of Forest Recreation Values in Europe. *Journal of Forest Economics 15*, p. 109-130.

Research aim and questions

The main objective of the dissertation thesis is to derive demand for recreation services of natural areas and open spaces in the Czech Republic, to disentangle the implicit recreation value that people associate with particular sites and to identify and discuss the factors that affect these values (including the environmental attributes of the recreation sites).

The central hypothesis of the thesis is that surrogate markets in the Czech Republic positively reflect recreation values of natural and urban recreation areas. With regard to the current level of knowledge summarized in the Introduction section, the thesis specifically focuses on the following research questions:

1. Which attributes affect the revealed preferences of people for recreation?

a) Which environmental characteristics of natural sites do people prefer for recreation use?

b) Are protected areas associated with a significantly different recreational value than other open space areas?

2. Does the methodology of recreation studies play an important role in estimating recreation values?

3. What are the recommendations for benefit transfer of recreational values:

a) from one site in the Czech Republic to another site in the Czech Republic,

b) from an international transfer (with special regard to meta-analytic transfers) to the Czech Republic,

to minimize the benefit transfer errors?

To answer the research questions, a series of five case studies has been accomplished. The methodological extent of the series of studies within the dissertation thesis is sufficiently broad to elaborate on the research questions stated. The methodological framework focuses on values accrued to the main two groups of recreational beneficiaries: visitors and residents; and the analysis is developed on three geographical levels: level of one single recreation locality, national level that takes into account 27 large natural recreation sites in the Czech Republic (including specially protected areas), and a synthesis of results on the European level, incorporating studies from all across Europe.

Theoretical framework

Outdoor recreation and underlying economic values have been studied using a variety of non-market valuation techniques, i. e. techniques that account for the absence of existing markets for recreational services of natural areas, where these services would be explicitly traded and from which we could derive their market value (Haab and McConnell 2002, Freeman 2003, National Research Council, 2005). Environmental economic theory usually distinguishes between two main approaches to non-market valuation (Markandya et al., 2002, Haab and McConnell 2002, Freeman 2003, Mäler and Vincent, 2005): methods of revealed preferences and methods of stated preferences. The former employ data on real behaviour of people on an existing market to disentangle values of a non-marketed environmental good, such as recreation in nature. These methods include travel cost method (TCM) and hedonic pricing method (HPM). In stated preference surveys, the researcher employs hypothetical market situations to derive the potential behaviour of people in making trade-offs among the hypothetical situations and to value non-market goods. Choice experiment techniques (CE) and contingent valuation method (CVM, as a specific case of choice modelling - CM) fall within this category (Shrestha, Loomis 2001). Combination of approaches and methods also exist, most important of which are the contingent behavior methods (i. e. a combination of TCM and CVM as in Melichar, 2014) or joint models combining of TCM and CM (Adamowicz et al., 1994, not yet applied in the Czech Republic) and hedonic travel cost method (i. e. a combination of HPM and TCM employed for estimation of values associated with secondary housing; not yet applied in the Czech Republic). Unlike the two revealed preference methods that I have just introduced, the benefit transfer is a method of valuation where the researcher does not collect primary data on individuals. On the contrary, the method relies on secondary data from studies that have been published in a different geographic, time or policy context.

The empirical models in this dissertation thesis are based on the following environmental valuation methods:

- Travel cost method
- Hedonic pricing method
- Benefit transfer (meta-analysis)

In the following text, I introduce the theoretical framework and the state-of-the-art of the three approaches in more detail, including the description of the specific models applied in this thesis.

1. Travel cost method

Recreation demand models are also referred to as travel cost models because the costs of travel are major part of accessing the recreation area. The methodology of recreation demand stems from the neo-classical microeconomic theory of demand. The basis of recreation demand models stem from the fact that each visit to a recreation area requires that the visitor must incur travel costs to access the site. Travel cost models link the quantity demanded (visitation) with the travel cost as a shadow price of the visit; and as in any conventional demand analysis, we observe that with increasing travel costs, the quantity demanded decrease (Freeman, 2003; Phaneuf and Smith, 2005). Travel costs reflect real travel expenses (e. g. on fuel) and also opportunity cost of time that the visitor need to spend to get to the recreation site. The opportunity cost of time is estimated using wage as a shadow value of time. Thus, all recreation demand models are models of the allocation of time; they must meet the individual’s time constraint and income constraint.

Recreation demand models have considerably developed since their initial use in the 1950´s. Models of the demand for recreation currently range from the most complex corner solution models to much simpler single site demand model. In this thesis, I focus on two commonly applied models: the single site travel cost model, and the site choice model that is based on random utility theory (Parsons and Massey, 2003).

1.a. Single-site travel cost model

Single site demand models represent downward sloping models of individual demand curves. The quantity demanded is the number of trips realized by individual to particular recreation site and the price are travel costs. The number of trips is usually measured per year and modelled as a function of independent variables, which include travel costs, income and other socio-economic variables. The environmental quality of the recreation site is however usually fixed for the given period of past visitation for all visitors in the sample and therefore is not explicitly modelled[1].

[1] These characteristics may be varied by combining the data on past behaviour with stated data in a model of contingent behavior, as stated above.

Since the data on quantity of trips are non-negative integers, count data models are preferred over ordinary least squares regression for the analysis. The simplest form is the Poisson model, the probability function of which may be expressed as:

$$\Pr(Y = y \mid \lambda) = \frac{e^{-\lambda}\lambda^{y}}{y!}$$

where Y denotes the number of trips, the parameter λ is the expected number of trips and is a function of independent variables specified in the model. The expected value and the variance of Y are equal to λ. The number of trips is a non-negative variable and therefore λ usually takes a log-linear form:

$$\lambda_{ij} = exp(x_{ij}\,\beta_1 + p_i\beta_2)$$

where x_{ij} are j socio-economic variables of respondent i and other variables determining his/her trip, and p_i are the travel cost spent by the respondent ($i = 1, 2, \ldots, n$) on the trip. β_1, β_2 are unknown regression parameters.

The Poisson model imposes the restriction that the mean and variance have to be equal (i. e. require no overdisperion in the data). Real data on trips of the individual taken to the recreation site are often of a large range, and typically a large portion of the sample of recreationists take just one trip. The data therefore do not comply with this assumption and the variance typically significantly exceeds the mean. The consequence of overdispersion is the fact that the standard errors in the case of the Poisson model would be underestimated (Haab and McConnell, 2002).

Negative binomial models are less restrictive in this respect - they allow for differences between mean and variance and are frequently more suitable for the data. The negative binominal regression model addresses the failure of the Poisson model by adding a parameter, α, that reflects unobserved heterogeneity among observation. The negative binominal distribution assumes the following form of the probability distribution (see e.g. Haab and McConnell, 2002):

$$\Pr(Y = y \mid \lambda) = \frac{\Gamma(y+\alpha^{-1})}{y!\,\Gamma(\alpha^{-1})}\left(\frac{\alpha^{-1}}{\alpha^{-1}+\lambda}\right)^{\alpha^{-1}}\left(\frac{\lambda}{\alpha^{-1}+\lambda}\right)^{y}$$

Where $\Gamma()$ is the gamma function. The expected value of the negative binominal distribution is equal to λ. However, the variance of the dependent variable is $V = \lambda\,(1 + \alpha\,\lambda)$. The parameter α

is the overdispersion parameter. If $\alpha = 0$, no overdispersion exists. But if $\alpha > 0$, then overdispersion exists and the Poisson model is rejected in favor of the negative binominal distribution.

Further problems with on-site collected data are associated with truncation of the sample to one trip, and also the more frequent users occur in the sample, which leads to endogenous stratification (Creel and Loomis, 1990; Englin and Shonkwiler, 1995). To correct the probability function for truncation, we replace *y* by *y-1* in the basic Poisson function (Parsons and Massey, 2003; Haab and McConnell, 2002). Then the function assumes the following form:

$$\Pr(Y = y \mid y > 0, \lambda) = \frac{e^{-\lambda}\lambda^{y-1}}{(y-1)!}$$

In practical applications, the influence of overdispersion, truncation and endogenous stratification needs to be tested.

1.b. Multi-site recreation demand model (Random utility model)

Random utility models stem from McFadden´s random utility framework (1984) that was rationalized by Hanemann (1984). Contrary to a single-site model which predicts the number of visits for one site, the random utility models (RUM) analyse the choice of the particular recreation site among many competing options. The choice among alternative recreation areas is dependent on the price of a visit and the characteristics of the area (Haab and McConnell, 2002; Freeman, 2003).

In terms of modeling choice between sites, the RUM actually works in a very similar fashion to the choice experiment approach, in that visitors´ choices over sites are modeled as being dependent on site attributes (one of which is price), plus an error term. The crucial difference is that the data is taken from actual choices, using information on which sites respondents have visited over some time period, how far/long it takes them to reach these sites, and which are the environmental attributes of the sites. As in the single-site travel cost model, distance and time costs are combined into an overall monetary travel cost, which is then included as one determinant of site choice in the econometric model.

The random utility model in the case of travel cost method may be described as follows: Every trip to natural site of interest i brings utility V_i. V_i is determined by a vector of m explanatory variables, which include travel costs to the site of interest tc_i and various forest site characteristics q_i :

$$V_i = \beta_{tc} tc_i + \sum_{k=1}^{m} \beta_{qk} q_{ki} + \varepsilon_i$$

Error term ε_i then captures every (random) effect unmeasured by the explanatory variables included in the equation - unobserved individual and site characteristics.

The visitor always has also a "status-quo" choice, which is not to choose any of the recreation sites offered for recreation and "stay at home". The status-quo option is associated with a utility of V_0 and may be expressed as a function of n socio-economic characteristics z of individual i:

$$V_0 = \alpha_0 + \sum_{l=1}^{n} \alpha_{zl} z_{lj} + \varepsilon_0$$

It is assumed that individual chooses the alternative yielding the highest expected utility (Parsons et al., 2000). Further we assume that ε is independent and identically distributed (IID) with an extreme value distribution (Haab and McConnell, 2002).

Most frequent specification of random utility models within environmental valuations are multinomial logit (MNL), nested logit (NL) or mixed logit (MXL), out of which application of MNL has been the most common (for example in Caulkins et al., 1985; Parsons et al., 2000). MNL has been popular mostly for simplicity of the estimation, which is based on logit probability for choosing any given alternative k in the choice set (i. e. a location to visit in travel cost RUM). The probability for choosing any given alternative k from the choice set using MNL is:

$$\Pr(choice_k) = \frac{\exp(X_k \beta)}{\sum_{i=1}^{C} \exp(X_i \beta)}$$

The main drawback of MNL is assumption of independence of irrelevant alternatives (IIA), which results from IID. IIA means that ratios of probabilities between each two alternatives in the choice set are not affected by changes in choice set (adding or deleting an alternative). It is likely to be violated particularly if several alternatives are similar.

Nested and mixed logit do not implicitly assume that IIA holds (Morey et al. 1993, Milon 1988). Nested logit is based on idea that the respondent sees some alternatives in the choice set as nested under a category and measure effect of the categories. The ratios of probabilities are then allowed to differ between subgroups, but are assumed to be the same within each group after a change in the choice set (IIA has to hold within groups, but not among groups). Examples of nested logit in recreation behaviour analysis are Carson et al. (2009) and Lew et al. (2009).

Mixed logit (also called Random parameters logit) is then a generalization of MNL model. It is theoretically more robust and in addition to IIA it accounts also for preference heterogeneity among population, which is second problem that may arise with simple MNL. Model specification is described e. g. by Haab and McConnell (2002). Mixed logit in recreation utility estimation was used for example by Train (1998).

At present recreational demand models represent one of the most sophisticated models of microeconomic modelling of consumer´s behaviour.

2. Hedonic pricing method

Hedonic pricing method stems from consumer theory first mentioned by Lancaster (1966) and expanded by Griliches (1971) and Rosen (1974). According to this theoretical approach, housing is considered a composite good the final price of which is not determined by the good as such, but by a particular combination of attributes that characterize housing as a market good. Market price of housing may be then disaggregated into a set of prices which refer to particular housing attributes. Under equilibrium, the value of each attribute perceived by consumer is then reflected in market clearing price of the good and is interpreted as the marginal (implicit) price of the attribute.

Many of the housing attributes may be treated as given at least in the short run, as it is practically impossible to adjust their level according to market demand. Equilibrium market price of housing is then formed mainly by the demand side and reflects subjective values perceived by consumers. To reach the equilibrium, it is also assumed that market subjects are rational and well-informed about the level of attributes of housing properties (other assumptions are discussed by Bateman et al., 2001, Bateman et al., 2004; Garrod and Willis, 1999; McConnell and Walls, 2005).

The hedonic pricing method consists of a statistical analysis of two phases. In the first phase, the hedonic price function is derived. The hedonic price function may be characterized by the following form (Markandya et al, 2002):

$$P = f(S_1,...,S_j, N_1,..., N_k, E_1,..., E_m)$$

where P is the market price of the property, which is a function of explanatory attributes of housing. The traditional hedonic variables are (Markandya et al, 2002):

Structural variables ($S_1, ... , S_j$):	number of rooms, extent of living area, type of heating, construction material etc.,
Neighborhood variables ($N_1,, ... , N_k$):	proximity to city center, transport facilities, crime etc.,
Environmental variables ($E_1, ... , E_m$):	proximity to urban open areas, air quality, noise level, flood risks etc.

Hedonic price function reflects specific conditions of supply and demand that exist at a particular property market, which has implications for transfers of the results to other markets (Day, 2001). The results of the first-stage model yield so called implicit price of the environmental attribute, which is based on the statistical relationship between the price P_h and the attribute E_h, and represents the isolated difference in property prices brought about by differences in the levels of the environmental attribute (e. g. number of trees in front of the house):

$$p_{(1,...,m)} = \frac{\partial P}{\partial E_{(1,...,m)}} ,$$

where p is the partial derivative of the hedonic price function P with respect to the particular environmental attribute (E_1 *to* E_m), and forms the implicit price function of the particular environmental attribute.

The implicit price function further allows to determine the welfare effect of marginal changes in the environmental attribute levels, which is done in the second step of the analysis. Implicit price represents one point on the demand curve of a particular household. The demand curve may be estimated using the implicit price function and the levels of socio-economic and demographic characteristics of the household. Only the second phase of the analysis yields estimates of the willingness to pay (WTP) of households for changes in level of environmental attributes that affect their living. Implicit prices for attributes that behave like normal goods tend to be lower than the WTP.

Hedonic pricing method has the potential to include into the estimation of greenery value – direct and indirect use values – practically all recreational, aesthetical and other ecosystem services that homebuyers consider when deciding about dwelling purchase or rent. Those involve particularly recreational and aesthetic services, but also microclimatic services generated in surroundings of the dwelling due to presence of greenery. However, the values of separate services are not usually differentiable from the aggregate value estimated for given green area. Because this technique could only capture those services that are directly linked to the property market, HPM does not enable to estimate non-use values – bequest or existence – that are an important part of the total economic value of urban ecosystem services.

Most frequent definitions of greenery open space amenities in hedonic price models in the neighborhood of a house are the following (Kaprová, 2014):

- Distance to nearest the urban greenery unit
- Area of the nearest urban greenery unit
- Joint influence of distance and area of the nearest urban greenery unit (use of interaction terms)
- Percentage of the area of greenery in given perimeter around the house/flat (length of perimeter varying from 50 to 500 m among studies)
- View on green area (binary, or % of view covered with greenery)

The traditional hedonic pricing model does not account for the spatial dimensions of the housing and the fact that the housing prices or some characteristics of the neighbouring buildings may be spatially correlated. Also, other sources of spatial correlation may be common omitted eplanatory variables and measurement errors (if the price expectations on the housing market are formed based on neighboring values, then we will observe that selling prices of houses affect the price of houses in their vicinity). Spatial dependence is widely observed in real estate data and lead to spurious results of traditional hedonic regression (that is usually estimated by ordinary least squares technique) and may affect the parameter estimates of the model. To correct for spatial autocorrelation, approaches originating in spatial econometrics and geographic analysis (Anselin, 1988; Anselin, 2006; LeSage and Pace, 2009) permeate to hedonic pricing modelling. Spatial lag model and spatial autoregressive error model are the two most widely used econometric models that allow to correct for this problem (e. g. Panduro and Thorsen, 2013). As Kaprová (2014) shows, also in the case of Prague reality market, there is evidence of spatial autocorrelation. An analysis that would account for its structure represents a desirable way of development of the further hedonic modelling studies of Prague property market (Ibid.).

3. Benefit transfer

Benefit transfer (BT) employs existing values as an approximation of the value of a new site. Value is derived from a 'study site' where the original study based on primary data was conducted, and is transferred to a 'policy site'. This method is important in the view of the fact that the estimates of benefits may be crucial for decision-making concerning recreational areas (or may constitute an essential input to cost-benefit analyses), but time and budget constraints often do not allow for performance of a primary study at the policy site.

The main techniques of benefit transfer include (Navrud and Ready, 2007):

1. Value transfer from original study to a new site with correction (e. g. correction for income level between the two sites)
2. Transfer of benefit function from the original study to a new site (enables to correct for characteristics the levels of which differ between the two sites)
3. Meta-analysis of previous studies (a complex method that yields a new benefit function, the source of which are a number of studies focusing on different sites; meta-analyses may enable to correct for a range of characteristics that differ between sites)

The validity of benefit transfer, particularly in an international setting, remains to large extent uncertain, is discussed and needs to be tested. Concerning recreation demand for natural areas in the Czech Republic, the dissertation thesis brings the first discussion on the validity of domestic and international transfer exercise available. Suggested dimension of thesis will then represent important insight if and how the Czech recreation demand fits into the context of foreign estimates.

3.a. Meta-analysis

In meta-analysis, the individual value estimates from different studies are treated as observations in a regression analysis. Meta-analysis, as the most complex means of benefit transfer methods, allows for synthesis of previous recreation demand research results, testing hypotheses with respect to the effects of particular determinants of value, and facilitates validity testing or testing for the potential publication bias.

The concept of meta-analysis is based on underlying utility theoretic model (Boyle et al., 1994, Smith et al., 2002). To disentangle variability of results among studies according to all mentioned factors, weak structural utility theoretic approach (WSUT) is applied in this thesis, as it is more frequent in most MA studies (Rosenberger and Loomis, 2000). As opposed to strong structural utility theoretic approach (SSUT) which is based solely on core economic variables that determine visitors´ demand for recreation, WSUT concept employs also study design variables (Bergstrom and Taylor, 2006) which may significantly affect the magnitude of the estimated values.

Core economic variables represent recreation site and user population characteristics and correspond to underlying utility theoretic model. Study design variables are used to widen the scope of the model so as to explain more heterogeneity across studies and to improve the predictive power. The model may be formalized as follows:

$$WTP_{ij} = SITE_{ij} + USER_{ij} + STUDY_{ij} + \varepsilon_{ij} ,$$

where WTP_{ij} is WTP estimate i from study j, $SITE_{ij}$ is a vector of recreation site characteristics, $USER_{ij}$ a vector of socio-economic variables describing particular user population and $STUDY_{ij}$ vector of methodologic variables characterizing study design. The *STUDY* vector also enables to widen the data set by including different valuation approaches such as in Shrestha and Loomis (2001), Zandersen and Tol (2009) or Kaprová and Melichar (2014). The random error term then captures residual unobserved variability of WTP.

Meta-analysis may be carried using studies within one evaluation technique only, or across methods, as in Shrestha, Loomis 2001; where Smith (2002) provides an insight into calibrating value estimates originating in different valuation methodologies (Marshallian vs. Hicksian surplus measures).

References

Adamowicz, W., J. Louviere, M. Williams (1994). Combining revealed and stated preference methods for valuing environmental amenities, *Journal of Environmental Economics and Management, 26 (3)*, p. 271-292.

Anselin, L. (1988). *Spatial econometrics: Methods and Models.* Dordrecht, The Netherlands: Kluwer Academic Publishers.

Anselin, L. (2006). Spatial econometrics. In Mills, T., and K. Patterson (eds.). *Palgrave Handbook of Econometrics: Volume 1, Economic Theory,* p. 901-969. Basingstoke: Palgrave Macmillan.

Bateman, I. J., B. H. Day, A. Lovett, I. Lake (2001). *The Effect of Road Traffic on Residential Property Values: A Lierature Review and Hedonic Pricing study.* Economic and Social Research Council, UEA Norwich.

Bateman, I. J., B. H. Day, I. Lake (2004). *The Valuation of Transport-Related Noise in Birmingham*. Centre for Social and Economic Research on the Global Environment, Centre for Environmental Risk, School of Environmental Science, University of East Anglia, UK.

Bergstrom, J. C. and L. O. Taylor (2006). Using meta-analysis for benefits transfer: Theory and practice. *Ecological Economics 60,* p. 351-360.

Boyle, K. J., G.L. Poe, J. C. Bergstrom (1994). What do we know about groundwater values? preliminary implications from a meta-analysis of contingent valuation studies, *American Journal of Agricultural Economics 76,* p. 1055–61.

Carson, R. T., W. M. Hanemann and T. C. Wegge (2009). A Nested Logit Model of Recreational Fishing Demand in Alaska. *Marine Resource Economics 24,* p. 101-129.

Caulkins, P. P., R. C. Bishop, N. W. Bouwes (1985). Omitted cross-price variables in the linear travel cost model: correcting common mis-perceptions. *Land Economics 61(2),* p. 182-187.

Creel, M. D., J. B. Loomis (1990). Theoretical and empirical advantages of truncated count data estimators for analysis of deer hunting in California. *American Journal of Agricultural Economics 72*, p. 434-441.

Czajkowski, M., M. Ščasný (2010). Study on benefit transfer in an international setting. How to improve welfare estimates in the case of the countries' income heterogeneity? *Ecological Economics 69/12*, p. 2409-2416.

Day, B. (2001). *The Theory of Hedonic Markets: Obtaining welfare measures for changes in environmental quality using hedonic market data*. Economics for the Environment Consultancy.

Englin, J., J. Shonkwiler, J. (1995). Estimating social welfare using count data models: an application to long-run recreation demand under conditions of endogenous stratification and truncation. *Review of Economics and Statistics 77*, p. 104-112.

Freeman, A. M. III. (2003). *The Measurement of Environmental and Resource Values: Theory and Methods.* Resources for the Future, Washington, DC.

Garrod, G. et K. G. Willis (1999*). Economic Valuation of the Environment - Methods and case studies.* Great Britain, Edward Elgar Publishing.

Griliches, Z., (1971). *Price Indexes and Quality Change.* Harvard University Press, Cambridge, MA.

Haab, T. and McConnell, K. E. (2002*). Valuing Environmental and Natural Resources: the econometrics of non-market valuation.* Cheltenham, Edward Elgar.

Hanemann, W. M. (1984). Welfare Evaluations in Contingent Valuation Experiments with Discrete Responses. *American Journal of Agriculture Economics 66*, p. 332-41.

Kaprová, K. (2014). Prague urban ecosystem services and their effect on property prices. Paper presented at Belpasso Summer School on Environmental and Resource Economics: Spatial context and valuing natural capital for conservation planning, August 31 - September 6 2014, Belpasso.

Kaprová, K., J. Melichar (2014). Review and meta-analysis of monetary values for non-market goods and services affected by climate change: land use, ecosystem, leisure. Deliverable No. D2.1 „Analysis of key determinants of costs and benefits of mitigation policy"of GLOBAL IQ - Impacts Quantification of global changes (Project no 266992). Chapter 1.

Lancaster, K.J. (1966). A New Approach to Consumer Theory. *Journal of Political Economy, 74*, p. 132-157.

LeSage, J., K. R. Pace (2009). *Introduction to Spatial Econometrics*. Taylor & Francis Group LLC., Stockholm.

Lew, D. K., D. M. Larson (2009). Valuing a Beach Day with a Repeated Nested Logit Model of Participation, Site Choice, and Stochastic Time Value. *Marine Resource Economics 23.*, p. 233-252.

Mäler, K. G. , J. R. Vincent, (eds) (2005). *Handbook of Environmental Economics, Volume 2*. North-Holland, Amsterdam.

Markandya, A., P. Harou, L.G. Bellù et V. Cistulli (2002). *Environmental Economics for Sustainable Growth - a handbook for practitioners*. Great Britain, Edward Elgar Publishing.

McConnell, V., M. Walls (2005). The Value of Open Space: Evidence from Studies of Non-market Benefits. Resources for the Future. On-line. URL: <http://www.rff.org/files/sharepoint/WorkImages/Download/RFF-REPORT-Open%20Spaces.pdf>. Citováno 27. 5. 2016.

Melichar, J. (2014). Measuring recreation benefits of forest quality change with contingent behavior model. *Journal of Landscape Management 2,* p. 10-15.

Milon, J. W. (1988). A nested demand shares model of artificial marine habitat choice by sport anglers, *Marine Resource Economics 5,* p. 191-213.

Morey, E. R., R. D. Rowe, M. Watson (1993). A repeated nested-logit model of Atlantic salmon fishing, *American Journal of Agricultural Economics 75*, p. 578-592.

National Research Council (2005). *Valuing Ecosystem Services: Toward Better Environmental Decision-Making*. The National Academies Press, Washington, DC.

Navrud, S. and R. Ready, eds. (2007). *Environmental value transfer: issues and methods.* Springer, 290 p.

Panduro, T., B. J. Thorsen (2013). Evaluating two model reduction approaches for large scale hedonic models sensitive to omitted variables and multicollinearity. *Letters in Spatial and Resource Sciences 7*, p. 85-102.

Parsons, G. R., D. M. Massey, T. Tomasi (2000). Familiar and Favorite Sites in a Random Utility Model of Beach Recreation. *Marine Resource Economics 14*, p. 299-315.

Parsons, G., D. M. Massey (2003). A Random Utility Model of Beach Recreation. In N. Hanley, D. Shaw, and E. Wright, eds., *The New Economics of Outdoor Recreation*. U.K.: Edward Elgar Publishing Limited, p. 241-267.

Phaneuf, D. J., V. K. Smith (2005). Recreation Demand Models. IN: Mäler, K. G. , J. R. incent, (eds). *Handbook of Environmental Economics, Volume 2*. North-Holland, Amsterdam.

Rosen, S., (1974). Hedonic prices and implicit markets: product differentiation in pure competition. *Journal of Political Economy 82,* p. 34–55.

Rosenberger, R., J. Loomis (2000). Panel stratification in meta-analysis of economic studies: an investigation of its effects in the recreation valuation literature. Journal of Agricultural and *Applied Economics 32 (3)*, p. 459–470.

Shrestha, R. K., Loomis, J. B. (2001). Testing a meta-analysis model for benefit transfer in international outdoor recreation. *Ecological Economics 39,* p. 67-83.

Smith, V. K., G. Van Houtven and S.K. Pattanayak (2002). Benefit transfer via preference calibration: “prudential algebra” for policy, *Land Economics 78 (1),* p. 132–52.

Train, K. E. (1998). Recreation Demand Models with Taste Differences Over People. *Land Economics 74(2),* p. 230-239.

Zandersen, M., and R. S. J. Tol (2009). A Meta-analysis of Forest Recreation Values in Europe. *Journal of Forest Economics 15*, p. 109-130.

Manuscripts - collection of works

I. Revealing preferences of Prague's homebuyers towards greenery amenities: the empirical evidence of distance-size effect

Melichar, J. & K. Kaprová (2013).
Landscape and Urban Planning 109(1): 56-66.

Abstract

The proximity principle of urban greenery and its positive effect on the prices of residential buildings is well documented in empirical literature. Application of hedonic price method in many urban and environmental settings has confirmed the proximity principle indicating residents´ positive preferences toward environmental amenities provided by green spaces. As proved in previous applications, the proximity effect lowers with increased distance from the dwelling, and the extent of the citizens´ demand for urban open space also differs with type and size of open space. The empirical evidence is relatively scarce with respect to combining both the distance to and the size of the nearest greenery. The majority of hedonic price studies on green space services have been conducted in the US and Western Europe, but the empirical evidence from the transforming economies of the former communist states of Central Europe is scarce. Similarly to many other European cities, urban sprawl has threatened green areas and agricultural land in Prague since the starting of the transformation process at the beginning of the 1990s.

Therefore, our intent is to contribute with two aspects: (i) trace the value of urban greenery amenities on the housing market in the newly transformed economy using a hedonic price model and (ii) capture the distance and size joint effect of green space on the property market by interaction effects. The study confirmed that proximity to greenery and its area are important determinants of housing prices in Prague, and benefits to residents differ with the type of greenery.

Keywords

Urban green spaces, Recreational services, Property market, Hedonic price method, Implicit price, Geographic information system

1. Introduction

Green areas constitute an important concept of urban solutions in the cities. Urban areas contain many forms of greenery from small lawnsand gardens over avenues of trees to large urban forests, recreational parks or protected areas. It is well known that urban greenery performs many social, spatial, technical and urban ecosystem services (UES) and as such has also great potential in contribution to the well-being of urban residents.

According to Bollund and Hunhammar (1999), urban open spaces provide many services that are directly used by residents. These include recreational services, where vegetation provides a setting of relaxation and relief from urban stresses and congestion. The scope and magnitude of recreational services may differ with greenery type. Potential to develop recreation opportunities are generally expected to play the more significant role the larger the greenery unit is (i. e. for example when comparing small plots of greenery among buildings with urban forest). Urban vegetation has also aesthetic value, due to which urban greenery forms a pleasant environment for living when located in residential areas, or may be even also used as architectural feature.

Greenery also provides ecosystem services that are less obvious to residents, but are of no less importance. Those may support recreational services, but urban residents tend to percept them rather indirectly, through overall pleasant environment for living in the city. As Costanza et al. (1997) state, main ecosystem services include the effect of greenery on urban microclima. Greenery absorbs carbon dioxide emissions, which are in the context of the city emitted mainly from urban transport. Further, presence of vegetation close to road network decreases secondary emissions of particulate matters and works as an acoustic screen between traffic and residential areas (Morancho, 2003). Another unquestionable factor is the effect on hydrological cycle, where green areas increase air humidity in predominantly hard surfaced area of cities, and through that reduce the intensity of urban heat island. Green areas also enable imbibition of water, which may have positive technical effects on sewerage system in terms of decreasing the risk of become clogged due to rains or flash floods. To these ecosystem services, also support of biodiversity should be added, as especially larger units of greenery play invaluable role in interconnection of urban environment and surrounding countryside, which is important for migration of species. Increased biodiversity may also support recreation services of urban greenery.

The magnitude of ecosystem services provided by particular unit of greenery may also differ with type, quality and area of urban green spaces. Microclimatic and hydrological services are generally expected to have positive relationship with quality and area of greenery. Poudyal et al. (2009) suggest similar relationship for biodiversity. Larger greenery units with higher ecological stability may provide habitats for various species and therefore considerably contribute to biodiversity enhancement of the area, while smaller units (for example avenues of trees) serve typically as migration facility without additional habitat provision. Urban greenery involves also protected areas, where the emphasis of management is put directly on biodiversity conservation. As such, these types of greenery should evince greater ecological stability and species richness than non-conserved areas.

In past decades, the evidence of above-mentioned positive effects provided by urban greenery has led to growing tendencies to integrate urban green areas into decision-making about spatial solution of cities as a legitimate part of urban planning. However, inclusion of urban ecosystem services into decision-making process is not straightforward, as these services do not have explicit prices reflected on existing market. In economic terminology, we speak about external benefits. The obvious consequence of external character of services is that the benefits associated with greenery are not fully taken into account in urban planning and decision-making about publicly owned urban green areas (Tyrvainen, 1997; Luttik, 2000).

The value of non-marketed services associated with urban greenery has then to be estimated indirectly on the basis of information from surrogate or hypothetical market. The most common empirical approach based on surrogate markets is hedonic price method (HPM) that reveals households' preferences towards UES from housing market. On the other hand, stated preference methods based on hypothetical markets such as contingent valuation or choice analysis use specially designed surveys that enable elicit households' preferences for open green spaces directly.

Vast amount of hedonic price studies on UES provided by green spaces has been managed in US and Western Europe but the empirical evidence from the transforming economies of the former communist states of Central Europe is relatively scarce. One example could be hedonic price study that was only aimed at assessing of recreational opportunities in urban forests in Prague (Melichar et al., 2009).

Similarly to many other European cities, urban sprawl has threatened green areas and arable land in Prague since the starting transformation process at the beginning of 1990s. Therefore, our intent is to contribute with the application of hedonic price method on the transforming housing market in the Czech Republic in order to investigate the positive effects of different type of urban vegetation – not only large urban forests but also less ecologically valuable land such arable land, or greenery spaces under protection regimes – on this market. In the legal setting of Czech Republic, the greenery is almost entirely provided to citizens through public budgets. As many effects of green areas do not come through markets, the decision-making about optimal quantity of greenery supplied comes to be heavily problematic. Concerning this, contribution of urban vegetation to the well-being of residents may become a fundamental guide-post for public bodies.

The central hypothesis is that residential property market in Prague positively reflects urban ecosystem services provided by large greenery spaces, i.e. there is presence of positive externalities. The type of positive externalities provided to residents may significantly differ with type of urban vegetation cover, area and other characteristics of greenery (Anderson and West, 2006; Kong et al., 2007). According to that, we compare three different types of greenery – large urban forests, arable land, and small protected areas – in Prague in terms of their proximity to the dwelling and greenery area, and we analyze also interactions between both measures. Moreover, we investigate the joint influence of all types of green spaces expressed as the relative coverage of greenery on cadastral area.

The second section reviews the literature focusing on the green open space valuation in an urban context. In the third section, bases of the theoretical foundations of the hedonic approach are described. The fourth section presents the study area, the fifths one then describe data and explains how the variables entering into the hedonic model are measured. The empirical models used in the hedonic regression including their results are presented in the sixths section. The seventh section provides discussion with respect to utilization of the results. The eighth section concludes.

2. Literature search

Applications on valuation of urban ecosystem services are relatively considerable in number and focus on a wide range of greenery types and associated services. As was outlined above, the magnitude of the value tends to differ according to type, quality and area of greenery and reflects also specific characteristics of greenery units. Most of the studies concentrate on the effects of large areas – urban parks, forests and greenbelts (Asabere and Huffmann, 2007; Anthon et al., 2004). Other studies pay specific attention to inclusion of protected areas into the model in contrast to ordinary urban vegetation. The evidence of differential in value of protected and unprotected vegetation is mixed – although urban parks equipped with trails may provide good opportunities for recreation (Sander and Polasky, 2009), protected areas may bring more environmental functions and therefore their implicit price may be higher (Lutzenhiser and Netusil, 2001).

Most of the previous research show that greenery has overall positive effect on property prices (Morancho, 2003; Poudyal et al., 2009; Crompton, 2001), though there exist some exemptions (Tyrvainen, 1997; Luttik, 2000). Positive effects of ecosystem services may be driven into negative when overweighted by some specific characteristic of the urban green area in the city, for example when it is associated with crime (Troy and Grove, 2008) or heavy recreation use (Tyrvainen, 1997).

Crompton (2001) reviewed 25 studies aimed at analysis of impact of parks on property prices, from which 20 reported significant positive impact of park, ranging from 10 to 20% of property values. The negative impacts were then caused mainly by methodological limitations of reported studies. Crompton also finds that the impacts vary considerably with characteristics of the park.

Lutzenhiser and Netusil (2001) focused on two types of open spaces – natural areas and urban parks. Their findings indicate that each type of greenery brings different effects on housing prices. While proximity to urban park decreases the price, natural parks have positive effect on the price. For both open spaces the residential prices increase with their size. Bolitzer and Netusil (2000) also conclude that the size of the open space has statistically significant positive effect on sales prices of housing.

In the Czech Republic, Melichar et al. (2009) conducted a hedonic analysis aimed at recreation functions of urban forest parks. 19 forest parks in Prague were covered in the study. Recreational aspects of forest parks were interlinked with equipment variables – number of benches and length of trails. 1 km increase in the distance from urban forest leads according to the results to 1.61% fall in the housing price.

Anderson and West (2006) analyzed the effect of several open spaces on property prices in Minneapolis-St. Paul metropolitan area. Significant positive effects were found for proximity to neighborhood parks and special parks (defined as national, state and regional parks, arboretums, nature centers, natural areas, and wildlife refuges). Although the estimated effects are relatively low, the analysis proved that special parks have greater effect on housing price (1% decrease in distance leads to 0.0252% increase in price) in comparison with neighborhood parks (0.0035% increase in sales price). Tyrväinen and Miettinen (2000) confirmed that increased amount of forested areas in the surroundings of apartment increases its price. According to their results, decreasing the distance to the forest by 1 km leads to 5.7% increase in price.

Asabere and Huffman (2007) used data set from Bexar County (Texas) to confirm the hypothesis that not only green belt, but also golf course, which represents an open space least rich in vegetation, has a positive effect on prices of houses in the neighborhood. Interestingly, the golf course adds to property prices 9%, which is more than the estimated effect of recreationally equipped greenbelt (5%).

Cho et al. (2008) analyzed benefits of green areas that differed by composition of tree layer. While proximity to a broad-leaved forest has according to results of their study positive impact on residential prices, proximity to coniferous or mixed forest decreases the prices. Garrod and Willis (1992) came with analogous conclusions.

As for analysis of smaller units of greenery, the study by Morancho (2003) suggests that the area of the park does not have any significant effect on price and the analysis is concluded with suggestion that in urban areas it might be appropriate to include rather smaller green areas than a few large urban parks. The distance to the nearest urban green space is nevertheless proved to be inversely related with housing price. However, Poudyal et al. (2009) have come to opposite results using data set from Virginia. Their study suggests that from recreational and aesthetic point of view one large continuous green area more important that the same area dispersed around the residential property.

Tyrvainen (1997) found that although the amount of forested area in a housing district affects property values positively, proximity to small forest parks has negative effect on prices. Mansfield et al. (2005) test hypothesis that trees on a parcel or in the neighborhood around it in North Carolina may serve as substitutes for living near large urban forests. The value of private forest is lower for houses with more vegetation on the housing plot, all else equal, so the authors conclude that proximity to private forest may be substituted by private greenery on the parcel. Irwin and Bockstael (2001) point out that measurement of greenery on the parcels adjacent to observed dwellings may be imprecise due to the fact that use of these areas is determined by homeowners, as opposed to other green areas in the city. All characteristics of privately owned greenery are then endogenous to housing value. Almost none of the studies conducted so far accounts for this problem, which may be the cause of underestimation or insignificance of estimates of small green areas.

As may be seen from previous research cited above, urban greenery amenities may be considered very site specific. It is necessary to address also the question whether different forms of greenery bring benefits of diverse magnitude. The studies reviewed above range in analyzed geographic areas from United States, Europe and China. The characteristics of housing market and homebuyers are also important factors that cause the results to vary among geographic areas. In Central Europe the empirical evidence is very scarce, which offers us a unique opportunity to contribute to worldwide estimates and see to which extent they differ from tendencies in other regions of the world.

Compared to previous hedonic price study realized on Prague's residential market (Melichar et al., 2009) which was aimed on urban forests only, this study widens the question on urban greenery benefits brought to residents by incorporating effects of three other types of urban open spaces – arable land, greenery under protection, and relative coverage of greenary – into the model. We also precisely address the isssues of greenery areas that directly threatened by housing development. The variable set was enriched by several important housing characteristics, which contribute to precision of the model. We also address methodological issue of variable construction – interaction effects capturing the joint influence of distance and size of greenery – mentioned by Kong et al. (2007). Moreover, final data set was widened by 3,500 observations, which is expected to bring more accurate results in terms of estimated implicit prices.

Although methods of environmental valuation are used to estimate effects of various environmental amenities and disamenities, in research practice it is common to aim separate studies on separate effects. In accordance to this trend, many reviewed studies do not contain other environmental characteristics of the city than presence of greenery (Anderson and West, 2006; Asabere and Huffmann, 2007; Donovan and Butry, 2010; Cho et al., 2007; Melichar et al., 2009). We account also for air quality, which is measured by composite index of four pollutants.

3. Analytical approach

Hedonic pricing method stems from consumer theory first mentioned by Lancaster (1966) and expanded by Griliches (1971) and Rosen (1974). According to this theoretical approach, housing is considered a composite good the final price of which is not determined by the good as such, but by a particular combination of attributes that characterize housing as a market good. Market price of housing may be then disaggregated into a set of prices which refer to particular housing attributes. Under equilibrium, the value of each attribute perceived by consumer is then reflected in market clearing price of the good and is interpreted as the marginal (implicit) price of the attribute. The application of the method is usually focused on valuation of environmental externalities experienced by households in a given area.

Many of the housing attributes may be treated as given at least in the short run, as it is practically impossible to adjust their level according to market demand. Equilibrium market price of housing is then formed mainly by the demand side and reflects subjective values perceived by consumers. To reach the equilibrium, it is also assumed that market subjects are rational and well-informed about the level of attributes of housing properties.

The model may then be characterized by the following form:

$$P_h = f_h(S_{h1},...,S_{hj},N_{h1},...,N_{hk},E_{h1},...,E_{hm})$$

where P_h is the market price of the property, which is a function of explanatory attributes of housing. The traditional hedonic variables are:

Structural variables ($S_{h1}, \ldots , S_{hj}$): number of rooms, extent of living area, type of heating, construction material etc.,

Neighborhood variables ($N_{h1},, \ldots , N_{hk}$): proximity to city center, transport facilities, crime etc.,

Environmental variables ($E_{h1}, \ldots , E_{hm}$): proximity to urban open areas, air quality, noise level, flood risks etc.

Hedonic pricing method has the potential to include into the estimation of greenery value – direct and indirect use values – practically all recreational, aesthetical and other ecosystem services that homebuyers consider when deciding about dwelling purchase or rent. Those involve particularly recreational and aesthetic services, but also microclimatic services generated in surroundings of the dwelling due to presence of greenery. However, the values of separate services are not usually differentiable from the aggregate value estimated for given green area. Because this technique could only capture those services that are directly linked to the property market, HPM does not enable to estimate non-use values – bequest or existence – that are an important part of the total economic value of UES.

3.1. Methodological issues

In spite of the fact that the model has been used in wide range of studies, some methodological issues have not yet been overcome. Among these, the choice of functional form may be mentioned. The economic theory does not provide much guidance about which functional form should be chosen. According to the law of diminishing marginal utility, it is possible to assume a nonlinear (concave) relationship between amenity attributes and housing price, which leads to frequent use of logarithmic (Poudyal et al., 2009; Sander and Polasky, 2009), quadratic (Troy and Grove, 2008) or Box-Cox transformations of the variables (Asabere and Huffman, 2007). However, Cropper et al. (1988) show that flexible Box-Cox models may fail when key explanatory variables are omitted. In such case simple linear model generates more accurate estimates of implicit prices.

Other practice is to analyze interact effects between variables, which may improve explanatory power of the model and enable more complex estimation with respect to how effects of greenery vary with changes in other attributes of given type of greenery (Mansfield et al., 2005) or other characteristics of housing (Anderson and West, 2006). According to Kong et al. (2007), many previous studies do not address the question of spatial pattern in using separate variables for distance and area of analyzed open space. Inclusion of these two types of variables for one type of open space leads to biased estimation, because the estimation then does not take into account the fact that two green spaces with the same area may be perceived differently when located in different distances from the dwelling. In other words, it is necessary to include also a variable which relates these two measures.

While Kong et al. (2007) constructed a size-distance index, more usual way to deal with this issue is to test inclusion of the two variables and their multiplication interaction effect. However, previous hedonic greenery research using interaction effects usually omits the area category (Anderson and West, 2006) or both base measures (Kong et al., 2007), which may bias the results as well when not tested for the significance of the variables in the model. We therefore clearly use both base measures and their interaction effect and test the stability of models estimated this way.

3. 2. Use of HPM in public management

Hedonic pricing method may serve for evaluation of public projects effects of which involve increases or decreases in quantity or quality of environmental housing amenities. It may be useful for quantification of benefits into cost-benefit analysis of projects aimed at enhancement or regeneration of urban green areas, as well as it has the potential to serve as a guide-post in decision-making about permissions to build up an open space in the city.

In cost-benefit analysis, output of hedonic pricing model as such can be directly used in case of relatively small project resulting in fundamental changes in urban greenery supply only on a local scale (Garrod and Willis, 1999).

Hidano (2002) suggests using HPM also over this conventional approach, in case of non-marginal projects, up to projects with vast and long-term effects on utility of residents. For small projects with local effects, partial equilibrium analysis is used and we analyze merely the effects on the property market. When the effects of given project are expected to cause changes in utility prevailing in the long time and to spread over more markets in the economy (for example when amenity of more pleasant environment attracts more inhabitants, which increases labor supply in the area), general equilibrium approach has to be adopted.. However, on which side of the borderline between „sufficiently small“ and „large“ projects the effects of the project lie has to be specified individually for each project.

4. Study site

Prague is the capital of the Czech Republic, which lies in Central Europe. With a population of approximately 1 million, the city constitutes the largest urban area in the country. The city center is located approximately in the middle. The housing market may be characterized by old luxurious apartments in the center, mixed housing development in circumjacent districts, which in some parts smoothly passes to newly developed family houses in the suburbs.

The city may be seen as relatively rich in urban greenery, which is dispersed in various forms, types, sizes and species composition all around the area. There exists a vast diversity among particular open spaces ranging from separate lawns to spacious urban parks or specially protected areas with considerable species richness. Prague as an urban complex is unique due to the fact that green areas and other open spaces are present from the suburbs to the city center, while in the center there can be found also features of naturally valuable areas.

In urban planning of Prague, increasing attention is paid to preservation and enhancement of green areas within the city. New urban plan which is being prepared includes creation of greenbelt on the agricultural lands around the city (with area of cca 2,000 ha). This evidence is in conflict with urban development pressures and raising problems with urban sprawl in the city. According to Czech office for surveying, mapping and cadaster urban development, in Prague the amount of built-up areas increases to the detriment of arable lands, permanent grasslands, gardens and orchards. From 1990 to 2008 totally 764 ha of these urban areas were developed, which is 1.5 % of the area of the city. The trend is expected to continue also in the future. In spatial planning of the city there have also been tendencies to seriously consider development of recreationally and environmentally most valuable areas, such as natural park Prokopske udoli.

Analysis of socioeconomic value attributed to green areas in Prague in this context provides a means to support ecological arguments in development planning of the city and may also outline the magnitude of benefits changes associated with vegetation cover transformations in individual areas.

5. Data

Data set used in hedonic price application consists of 8,568 apartment sales from 2005 to 2008 and was acquired from real estate catalogue operated by Czech company reality.cz (see http://www.reality.cz). These data included sales price, date of sale, structural variables and location of the observations. The rest of variables were generated by Geographical Information System (GIS), in software ArcGIS, according to data layers from City Development Authority Prague and Czech Statistical Office. Czech Statistical Office data served for completion and validation of structural variables stated in real estate catalogue. The other two data sources were used to generate environmental and neighborhood variables. All variables used in the regression analysis, including their brief definition, expected influence on the dependent variable and summary statistics, are summarized in Table 1.

GIS also served for validation of the spatial data location within residential building areas and for detection of duplicate observations. Spatial analysis detected 2,815 observations as wrong. Another 554 observations were removed due to incorrectly recorded data and in exploratory analysis as extreme values and observations. The final data set used in the analysis consists of 5,199 observations. Their geographic distribution over the city is depicted in Figure 1.

Variable PRICE is the selling price of apartment recorded by reality.cz in period of 2005-2008. This period is relatively stable regarding the fluctuations on the property market. Data have been transferred to 2008 price level using price index for housing in Prague produced by the Czech Statistical Office.

In regression model, we use structural variables that relate either to the apartment, or to the building in which it is situated. BAD_STATE dummy variable includes apartments that are described in real estate catalogue as „before reconstruction“ or „in bad state“. These apartments have not been maintained before sale and in most cases have to be reconstructed before inhabitation. AREA is the built-up area of apartment and AREA_BUILD represents area of the building in which the observation is situated. Other attribute related to the dwelling is INHABITANTS, which denote how many persons live in the building. APART_BUILD stands for apartments located in apartment building. BRICK_ROCK is a dummy variable indicating that the structure of the building is brick, rock or their combination. Apart from BAD_STATE, all structural variables were derived from GIS data layers the source of which is the Czech Statistical Office. Further, Euclidean distance to the city center was used in the analysis, which may serve as a proxy for accessibility possibilities. City center is represented by Saint Wenceslas Statue standing on Saint Wenceslas square.

To test the hypothesis that different forms of greenery contribute to property prices with different magnitude, we analyze effect of three types of open spaces: specially protected areas, urban forests and fields.

In Prague, there can be found 89 small-scale specially protected areas, which account for 9% of greenery area in Prague and 4% of total area of the city. They comprise 7 national nature reserves, 15 nature reserves and 67 national monuments. Specially protected areas cover a wide range of vegetation types: forest ecosystems, meadows, floodplain vegetation, rocks and quarries. The access to these areas is not restricted in any way, so the recreation function may be fully utilized by residents.

Urban forests represent greater complexes of urban greenery, with area ranging from 0.15 to 1,720 ha. Forest land accounts for 10% of the area of Prague. Geographical representation of large urban forests is depicted in Figure 2. All forests in the city are categorized as special purposes forests, which means that none of these forests serves for lumbering and is managed with respect to enhancement of recreation function. Part of forested areas are forest parks, and as such contain also maintained forest meadows and cultural lawns. Tree layer is formed mainly by broadleaved trees, mixed forests are also common.

Fields are seen as a type of vegetation with low diversity as opposed to the other two greenery features. They are expected to have minor contribution to urban ecosystem services, which should be reflected in the significance or magnitude of value estimates. However, agricultural land in the neighborhood of the dwelling may be seen as attractive by homeowners as it still represents an open space. Agricultural land is located mainly in the suburbs and represents also greater complexes of open space, with area of 0.15 to 1,310 ha.

In the regression models, each type of greenery is represented by distance to the nearest urban space of given type and its area. Distance is measured as Euclidean, which is consistent with previous research (Poudyal et al., 2009; Tyrvainen and Miettinen, 2000; Cho et al., 2008; Mansfield et al., 2005).

Apart from greenery variables, we account also for air quality in the surroundings of the apartment. Especially in wither time, urban air pollution is a serious problem due to damages on human health, building materials and vegetation. Natural services of UES can effectively mitigate and absorb air pollutants – PM_{10}, NO_X, SO_2 and O_3. Air quality is our model represented by air quality index, which includes effects of PM_{10}, SO_2, NO_2 and benzene. The index is methodically based on CITEAIR (Common Information to European Air) initiative and is derived from proportions of average yearly concentrations of partial pollutants to respective imission limit. The overall quality index is the average of partial indexes of each pollutant. The index ranges from 0.31 to 1.66, where the higher the number, the lower the air quality is. All environmental variables were coded from data layers provided by City Development Authority Prague.

6. Results

As outlined above, our intent is to find out the interconnection between the residential property market and urban ecosystem services that could influence the property prices particularly through recreational, aesthetical and microclimatic services. Therefore, we have constructed and econometrically estimated several hedonic price models.

We first analyze the effect of various types of greenery, as specified by previous studies (Lutzenhiser and Netusil, 2001; Asabere and Huffman, 2007). To test stability of estimates, we estimated firstly separate models for each type of open space, and then covered all greenery variables in one model. We test also significance of interaction effects between variables describing each type of greenery. As for specification of variables in regression models, logarithmic transformation of variables was tested, but in the end specification with linear price and distances to greenery proved to capture the highest portion of variability in price. However, we used logarithmic transformation on greenery area, following the assumption that intensity of price change due to increment of open space area declines with the acreage of the greenery. That means, residents tend to consider more increments in area of smaller greenery units than in vast open spaces, where additional increase in area may not be noticed at all.

We also found out that greenery has significant effect on property price only if the open space is sufficiently close to the dwelling. In the case of Prague, distance to nearest green area in the data set exceeds 7 km for urban forests and 4.5 km for specially protected areas and fields. With increasing distance also the complexity of other variables potentially influencing the price increases and the effect of proximity to urban space becomes intangible, as shown by models we estimated. Crompton (2001) found that large areas of urban greenery have substantial impact on property price up to 500 or 2,000 feet (152 - 609 meters). Mansfield et al. (2005) proved that overall effect of greenery is significant only to 3,200 m distance. We therefore assume the proximity to the three types of areas analyzed in this paper to have clear effect on property prices to 2,000 m only. This also leads to reduction of multicollinearity problem in the model to acceptable level (as measured by VIF). As Breusch-Pagan test rejected homoscedasticity of residuals, we estimated the models with White robust standard errors.

Table 2 shows results on three models which account for analyzed forms of greenery separately. All structural variables proved to be significant, with expected signs. Distance to all open spaces is inversely related to the price, although the effect of field is not significant. With every additional meter the property price decreases by 4 thousands CZK for specially protected areas and urban forests. The area of specially protected has negative impact on housing prices, which means people prefer to live near smaller units of these type of greenery.

Area of urban forests affects price only through distance to the forest, as may be seen from the significance of coefficients. With increasing distance the magnitude of positive effect of proximity to urban forest shrinks. Even within 2,000 meters people tend to consider the area of forest only if it is located sufficiently close to the dwelling. Distance to field does not show to be related to property price, indicating that residents are not willing to pay any extra money for location close to these forms of open space. The price then does not seem to reflect any recreational or environmental functions provided by this type of open space. As expected, air quality brings positive effects on property price – the lower the index of air quality, the higher the observed price, all else constant.

Model 4, which includes all types of greenery, brings similar results in terms of direction and significance of coefficients (see Table 3). In accordance with previous research, most important variables which influence property prices are structural variables. Whilst structural variables account for 56.62% of the variability in price, environmental variables add only a few percentage points to the explained variability. Analysis of variance inflation factors does not indicate any major problems with multicollinearity (Table 4). After omission of mutually related variables (interactions), which are by their definition expected to reach high values, neither of VIF values exceeds 5.

The model confirms that presence of fields has not any significant effect on price. When accounting for all types of greenery, the area of specially protected areas becomes insignificant and has effect on price through distance greenery only. The average decrease in price of 1,304 CZK for every additional meter to SPA declines with its acreage. Distance to forests is inversely related to the price, such as the area of forests. The interaction term denotes that for larger forests, the decline in price associated with distance to forest declines. The overall findings are in accordance to Morancho’s conclusion (Morancho, 2003) that the presence of smaller plots of greenery is sufficient for residents. However, it is necessary to point out that this conclusion refers only to larger greenery units, as we have not considered small dispersed greenery areas in the model.

Having proved positive effects of proximity to two different types of ecologically valuable urban spaces, we focus on estimation of specific effects of developing urban open spaces in Prague. As stated before, in Prague the evidence shows that mainly ecologically less valuable greenery units are being developed at present. Those include mainly arable land, permanent grasslands, orchards and gardens. While the separate effect of fields was not significant in previous models, we expect that with broadening the definition of areas threatened by development by grasslands, orchards and gardens the results will show that the overall effect of amenity of neighborhood with such types of open space becomes an important determinant of housing price. That also proves that housing development of undeveloped land brings negative effects to residents, although these types of open space do not belong to highly valued in terms of recreation and environmental facilities.

We cover all these types of open space with one variable GREEN_SEL, which is determined as percentage of area of these types over the area of cadastral territory, as derived from data layers of City Development Authority Prague. For this exercise, Prague is divided into 112 cadastral territories.

The results (see Table 5) suggest that every per cent of total area covered by those types of greenery adds 0.00213 per cent to the price. When a project leading to increase of selected greenery types over the area of cadastral territory by 1 percentage point is implemented, the price of apartment (computed at average price 5,018,006 CZK) will increase by 10,697 CZK.

7. Result's utilization and discussion

Although the definition of variable GREEN_SEL is rather aggregated when compared to usual measures of distance and area, it may be helpful for inclusion of estimates into decision-making. Measuring effects of distance or area of open space may not lead to straightforward estimation of aggregate benefits associated with realization of a project to enhance green open spaces in the city (say, when a new open space is to be developed). To be able to aggregate the effects with utilization of estimates measured by distance from a conducted study (either directly from policy site, or by using methods of benefit transfer), the decision-makers would have to find out for how many households and by how much the distance to nearest open space has decreased. Further, as our results suggest, the distance and area of nearest open space have effect on price up to certain distance only, which also complicates the aggregation.

However, simple measures as percentage of greenery on cadastral area defined within the city (which have to be sufficiently small to ensure variability) ease the utilization of estimates in practical decision-making. In our case, we can estimate the total increment to all apartments within given district in case of realization of project that would increase the amount of aggregate of selected types of greenery by 1 percentage point. For this exercise, we used logarithm of price to enable the implicit price to vary across districts of Prague.

Resulting estimates of implicit prices are found in Table 6. Implicit prices are used to compute increase in price of housing for all apartments in the district due to increase by 1 percentage point in area of GREEN_SEL. The procedure relies on assumption that construction of new urban greenery unit impacts only houses in some distance from the location of new greenery unit, which is here represented by one district. We can see that when taken into account all housing units in a district, increase by 1 percentage point leads to considerable increase in aggregate of housing prices – from 239 to 1,119 mill. CZK. When the magnitude of the change in supply of urban greenery is not considered to impact all housing units in a district, similar computation may be used for smaller cadastral units.

8. Conclusion

The proximity principle of urban open green spaces and its positive effect on the prices of residential buildings is well documented in empirical literature. Application of hedonic price method in many urban and environmental settings has confirmed the proximity principle indicating residents' preferences toward urban greenery amenities. As proved in previous applications, the proximity effect is lowering with increasing distance from the dwelling and the extent of citizens' demand for urban open space also differs with type and size of open space. The empirical evidence is relatively scarce with respect to combining two major green amenity effects, both the distance to and the size of the nearest greenery and either with respect to analysis of more greenery types.

Concerning these issues, the evidence from the Czech Republic and Central Europe is very scarce. This paper should fill in this gap, accounting for three different types of open space. In the legal setting of Czech Republic, the greenery is almost entirely provided to citizens through public budgets. As many effects of green areas do not come through markets, the decision-making about optimal quantity of greenery supplied comes to be heavily problematic. Concerning this, contribution of urban vegetation to the well-being of residents may become a fundamental guide-post for public bodies. To contribute to this topic, we take into account vegetation types the area of which has been for the most part subject to housing development in recent years.

Results show that green open spaces in urban areas constitute a considerable part of housing prices in Prague. Having accounted for separate effects of proximity, area and their interactions to avoid the problem of bias due to unobserved spatial pattern (Kong et al., 2007), we confirm that proximity to green open spaces and their area are important determinants of housing prices. The study proves that benefits to residents differ with type of greenery. Proximity to specially protected areas and urban forests brings expected significant positive effects on residential property prices. Fields as such were proved to be significant only when taken into consideration as a part of open spaces threatened by housing development. Although probably less rich in magnitude of ecosystem services, open spaces threatened by housing development are still relevant for residents. Every percentage point of these areas on cadastral territory increases the price of apartment by 10,697 CZK.

Acknowledgement

The research on this study was supported by the grant of the Czech Ministry of Transport CG712-111-520 Quantification of external costs of transport in the Czech Republic. Data about apartment sales was acquired from real estate catalogue operated by Czech company reality.cz (http://www.reality.cz). GIS data layers were provided by the City Development Authority Prague and the Czech Statistical Office. The financial and data support is gratefully acknowledged.

References

Anderson, S.T., West, S.E., 2006. Open space, residential property values, and spatial context. *Regional Science and Urban Economics 36,* 773–789.

Anthon, S., Thorsen, B. J., Helles, F., 2004. Urban-fringe afforestation projects and taxable hedonic values. *Urban Forestry & Urban Greening 3*, 79-91.

Asabere, P.K., Huffman, F.E., 2007. The Relative Impacts of Trails and Greenbelts on Home Price. *Journal of Real Estate Finance and Economics 38 (4),* 408-419.

Bolund, P., Hunhammar, S., 1999. Ecosystem services in urban areas. *Ecological Economics 29,* 293-301.

Bolitzer, B., Netusil, N. R., 2000. The impact of open spaces on property values in Portland, Oregon. *Journal of Environmental Management 59 (3),* 185–193.

Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskins, R.G., Sutton, P., Van den Belt, M., 1997. The value of the world's ecosystem services and natural capital. *Nature 387,* 253–260.

Crompton, J. L., 2001. *Parks and Economic Development.* Washington D. C.: American Planning Association.

Cropper, M. L., Leland, B. D., McConnell, K.E., 1988. On the Choice of Functional Form for Hedonic Price Functions. *Review of Economics and Statistics 70 (4),* 668–75.

Donovan, G.H., Butry, D.T., 2010. Trees in the city: Valuing street trees in Portland, Oregon. *Landscape and Urban Planning 94*, 77–83.

Garrod, G., Willis, K.G., 1992. Valuing Goods' Characteristics: An Application of the Hedonic Price Method to Environmental Attributes. *Journal of Environmental Management 34(1),* 59–76.

Garrod, G., Willis K. G., 1999. *Economic Valuation of the Environment - Methods and case studies,* Great Britain, Edward Elgar Publishing.

Griliches, Z., 1971. *Price Indexes and Quality Change. Harvard University Press*. Cambridge, MA.

Hidano, N., 2002. *The economic valuation of the environment and public policy: a hedonic approach*. Edward Elgar Publishing Ltd., Cheltenham, UK.

Cho, S., Poudyal, N.C., Roberts, R.K., 2008. Spatial analysis of the amenity value of green open space. *Ecological Economics 66,* 403-416.

Irwin, E.G., Bockstael, N.E., 2001. The Problem of Identifying Land Use Spillovers: Measuring the Effects of Open Space on Residential Property Values. *American Journal of Agricultural Economics 83,* 698–704.

Kong, F., Yin H.W., Nakagoshi N., 2007. Using GIS and landscape metrics in the hedonic price modeling of the amenity value of urban green space: A case study in Jinan City, China. *Landscape and Urban Planning 79,* 240–252.

Lancaster, K., 1966. A new approach to consumer theory. *Journal of Political Economy 74,* 132-57.

Luttik, J., 2000. The Value of Trees, Water and Open Space as Reflected by House Prices in the Netherlands. *Landscape and Urban Planning. 48*, 161-167.

Lutzenhiser, M., Netusil, N.R., 2001. The Effect of Open Spaces on a Home's Sale Price. *Contemporary Economic Policy 19 (3),* 291–98.

Mansfield, C., Pattanayak, S., McDow, W., McDonald, R., Halpin, P., 2005. Shades of Green: Measuring the value of urban forests in the housing market. *Journal of Forest Economics 11*, 177–199.

Melichar, J. Vojáček, O., Rieger, P., Jedlička, K., 2009. Measuring the Value of Urban Forest using the Hedonic Price Approach. *Regional studies 2*, 13–20.

Morancho, A.B., 2003. A hedonic valuation of urban green areas*, Landscape and urban planning 66*, 35-41.

Poudyal, N.C., Hodges, D.G., Tonn, T.C., Cho, S., 2009. Valuing diversity and spatial pattern of open space plots in urban neighborhoods. *Forest Policy and Economics 11*, 194–201.

Rosen, S., 1974. Hedonic prices and implicit markets: product differentiation in pure competition. *Journal of Political Economics 82*, 34-55.

Sander, H.A., Polasky, S., 2009. The value of views and open space: Estimates from a hedonic pricing model for Ramsey County, Minnesota, USA. *Land Use Policy 26*, 837–845.

Troy, A., Grove, J.M., 2008. Property values, parks, and crime: A hedonic analysis in Baltimore, MD. *Landscape and Urban Planning 87*, 233–245.

Tyrvainen, L., 1997. The Amenity Value of the Urban Forest: An Application of the Hedonic Pricing Method. *Landscape and Urban Planning. 37*, 211–22.

Tyrvainen, L., Miettinen, A., 2000. Property prices and urban forest amenities, *Journal of Environmental Economics and Management 39*, 205-223.

List of tables

Table 1 Definitions and descriptive statistics of variables entering the hedonic model, N=5,199

Variable	Description	Measure	Expected sign	Mean	Std. Dev.	Min	Max
PRICE	Sales price of apartments sold in years 2005-2008	CZK 2008	DV*	5,018,006	3,910,050	817,697	55,600,000
AREA	Built-up area of the flat	m^2	+	75.8319	36.2774	13	430
BAD_STATE	Bad state of apartment (reconstruction is necessary before living)	dummy	-	0.03808	0.19142	0	1
AREA_BUILD	Area of the building	m^2	+	476.214	561.779	2.33	4,588.7
INHABITANTS	Number of inhabitants in the building	number	-	20.6349	17.1336	0	92.7
DIST_CENTER	Distance to city center (Old-town square)	m	-	5,757.11	3,991.58	75.8161	19,057.02
APART_BUILD	Apartment is located in apartment house	dummy	-	0.71052	0.45356	0	1
BRICK_STONE	Building material is brick or stone	dummy	+	0.54299	0.4982	0	1
SPA_DIST	Distance to the nearest specially protected area	m	-	1,287.57	899.523	0	4,758.414
SPA_AREA	Area of the nearest specially protected area	m^2	+	226,185	370,730	1,590.56	1,448,013
FOREST_DIST	Distance to the nearest urban forest	m	-	1,504.76	1,219.75	0	7,123.17
FOREST_AREA	Area of the nearest urban forest	m^2	+	1,550,270	2,147,259	1,459.17	17,200,000
FIELD_DIST	Distance to the nearest field	m	-	1,587.51	1,310.5	0	4,627.877
FIELD_AREA	Area of the nearest field	m^2	+	299,429	724,020	1,475.81	13,100,000
GREEN_SEL	Percentage of selected greenery area (threatened by development) on cadastral territory area	%	+	14.91235	20.1493	0.53	88.89
AIR	Index of air quality	index	-	0.5981	0.1689	0.31	1.66

* Dependent variable

Table 2 Regression results for partial hedonic models (1-3)

	Model 1: SPA			Model 2: Urban forest			Model 3: Field		
Term	Coeff.	t-Ratio	Sig.	Coeff.	t-Ratio	Sig.	Coeff.	t-Ratio	Sig.
Intercept	2,992,128	2.16	*	-165,669.4	-0.14		-5,273,929	-4.65	**
ln(AREA)	5,113,868	34.33	**	5,402,471	32.82	**	4,259,604	27.55	**
BAD_STATE	-984,254	-6.1	**	-1,195,688	-6.87	**	-529,167	-4.25	**
ln(AREA_BUILD)	98,220.15	2.3	*	120,704.1	2.56	*	143,222.5	3.36	**
INHABITANTS	-16,744.5	-10.24	**	-17,315.45	-9.13	**	-10,724.3	-8.06	**
ln(DIST_CENTER)	-1,774,454	-16.33	**	-1,828,801	-15.3	**	-883,343	-9.62	**
APART_BUILD	-42,0062.9	-4.85	**	-443,722	-4.71	**	-520,560	-6.85	**
BRICK_STONE	411,909.3	4.62	**	462,714	4.66	**	705,511.9	8.79	**
SPA_DIST	-4,044.063	-6.94	**						
ln(SPA_AREA)	-309,657.4	-6.29	**						
SPA_DIST*ln(SPA_AREA)	346.4415	6.76	**						
FOREST_DIST				-4,010.967	-4.34	**			
ln(FOREST_AREA)				-87,488.7	-1.85				
FOREST_DIST*ln(FOREST_AREA)				289.4986	4.28	**			
FIELD_DIST							-319.458	-0.71	
ln(FIELD_AREA)							-45,752.1	-1.49	
FIELD_DIST*ln(FIELD_AREA)							22.71126	0.59	
AIR	-1,962,353	-7.83	**	-2299493	-7.30	**	-1,055,432	-6.39	**
dependent variable	PRICE			PRICE			PRICE		
N	4,086			3,595			3,299		
R^2	0.6140			0.6153			0.5651		
F (18; 5,180)	171.27			170.25			135.54		

Table 2 Regression results for partial hedonic models (1-3) - cont.

Prob > F	0.000	0.000	0.000

Robust estimation (White standard errors)

* Significant at 95% confidence level

** Significant at 99 % confidence level

Table 3 Regression results for full hedonic model (4)

Term	Coeff.	St. Error	t-Ratio	P-value	95% Confidence Interval		Sig.
Intercept	-3,707,255	1,130,580	-3.28	0.001	-5,924,117	-1,490,393	**
ln(AREA)	4,594,486	180,142.9	25.50	0.000	4,241,258	4,947,714	**
BAD_STATE	-650,080.5	128,307.5	-5.07	0.000	-901,668.3	-398,492.6	**
ln(AREA_BUILD)	139,536.3	48,346	2.89	0.004	44,738.55	234,334.1	**
INHABITANTS	-12,432.01	1,717.314	-7.24	0.000	-15,799.35	-9,064.668	**
ln(DIST_CENTER)	-1,009,759	100,732.8	-10.02	0.000	-1,207,278	-812,240.6	**
APART_BUILD	-561,071.4	85,475.41	-6.56	0.000	-728,673.2	-393,469.5	**
BRICK_STONE	664,486.6	90,953.43	7.31	0.000	486,143.4	842,829.9	**
SPA_DIST	-1,304.048	344.2676	-3.79	0.000	-1,979.095	-629.0019	**
ln(SPA_AREA)	-0.146225	0.103067	-1.42	0.156	-0.348320	0.055870	
SPA_DIST*ln(SPA_AREA)	120.0097	31.08737	3.86	0.000	59.05295	180.9664	**
FOREST_DIST	-2,960.691	939.1046	-3.15	0.002	-4,802.105	-1,119.277	**
ln(FOREST_AREA)	-122,672.7	44,102.33	-2.78	0.005	-209,149.4	-36,195.96	**
FOREST_DIST*ln(FOREST_AREA)	213.8779	69.21836	3.09	0.002	78.15322	349.6026	**
FIELD_DIST	-374.4675	491.3222	-0.76	0.446	-1,337.861	588.9264	
ln(FIELD_AREA)	-38,911.54	34,884.04	-1.12	0.265	-107,312.8	29,489.75	
FIELD_DIST*ln(FIELD_AREA)	30.79787	44.19361	0.70	0.486	-55.8578	117.4535	
AIR	-1,430,043	187,066.3	-7.64	0.000	-1,796,846	-1,063,240	**
Dependent variable	PRICE						
N	2,793						
R^2	0.5761						
F (18, 5180)	85.59						
Prob > F	0.000						

Table 3 Regression results for full hedonic model (4) - cont.

Robust estimation (White standard errors)

* Significant at 95% confidence level

** Significant at 99 % confidence level

Table 4 Variance inflation factors

Variable	VIF*	VIF**
ln(AREA)	1.04	1.03
BAD_STATE	1.03	1.03
ln(AREA_BUILD)	1.13	1.11
INHABITANTS	1.72	1.71
ln(DIST_CENTER)	4.19	3.92
APART_BUILD	1.34	1.33
BRICK_STONE	1.63	1.58
SPA_DIST	**23.42**	1.29
ln(SPA_AREA)	2.35	1.21
SPA_DIST*ln(SPA_AREA)	**24.36**	
FOREST_DIST	**130.96**	1.64
ln(FOREST_AREA)	3.05	1.25
FOREST_DIST*ln(FOREST_AREA)	**134.47**	
FIELD_DIST	**53.02**	3.16
ln(FIELD_AREA)	3.96	1.47
FIELD_DIST*ln(FIELD_AREA)	**42.03**	
AIR	1.48	1.43
Mean VIF	25.36	1.65

* Model with interaction terms

** Model without interaction terms

Table 5 Regression results for selected greenery model (5)

Term	Coeff.	St. Error	t-Ratio	P-value	95% Confidence Interval		Sig.
Intercept	13.7245	0.08656	158.55	0.000	13.55478	13.89417	**
ln(AREA)	0.91168	0.00949	96.06	0.000	0.8930748	0.9302857	**
BAD_STATE	-0.1588	0.01852	-8.57	0.000	-0.195062	-0.1224517	**
ln(AREA_BUILD)	0.02553	0.00459	5.56	0.000	0.0165252	0.0345286	**
INHABITANTS	-0.0024	0.00022	-11.29	0.000	-0.002862	-0.0020152	**
ln(DIST_CENTER)	-0.2779	0.00722	-38.52	0.000	-0.292067	-0.2637764	**
APART_BUILD	-0.0802	0.00912	-8.8	0.000	-0.098097	-0.062345	**
BRICK_STONE	0.04234	0.00861	4.92	0.000	0.0254685	0.0592073	**
GREEN_SEL	0.00213	0.00027	7.77	0.000	0.0015939	0.0026696	**
AIR	-0.1513	0.02483	-6.09	0.000	-0.200015	-0.1026551	**
dependent variable	ln(PRICE)						
N	5,199						
R^2	0.8055						
F (18; 5,180)	1,768.19						
Prob > F	0.000						

Robust estimation (White standard errors)

* Significant at 95% confidence level

** Significant at 99 % confidence level

Table 6 Implicit prices and aggregate results

District	Area of GREEN_SEL (ha)	Percentage of GREEN_SEL area	No. of apartments in district*	Average price**	Implicit price in CZK	Aggregated implicit price*** for 1 % point	for 1 ha****	for 1 m^2****
1	14	3.27	17,505	10,900,000	23,237	406,757,033	95,347,818	9,535
2	8	1.02	26,625	7,910,625	16,864	449,000,549	59,940,851	5,994
3	4	0.68	38,726	4,241,020	9,041	350,122,015	64,359,209	6,436
4	1,931	24.57	130,688	3,412,950	7,276	950,850,185	12,102,474	1,210
5	3,832	37.86	38,569	4,536,447	9,671	372,992,997	3,684,435	368
6	1,396	24.62	93,722	5,602,435	11,943	1119,347,238	19,741,973	1,974
7	152	10.43	21,666	5,178,964	11,041	239,203,808	16,442,853	1,644
8	1,362	36.29	50,808	3,693,115	7,873	400,010,498	10,660,283	1,066
9	4,551	42.78	58,733	3,382,891	7,212	423,561,665	3,981,891	398
10	4,271	50.89	74,201	4,124,739	8,793	652,458,193	7,773,705	777
Total	17,519	35.32	551,243	5,018,006	10,697	5,896,858,705	11,887,113	1,189

* According to Czech Statistical Office census

** Based on data

*** For all apartments within given district

**** With assumed linear increments for each ha/m^2

List of figures

Figure 1 Geographical localization of analyzed properties in Prague

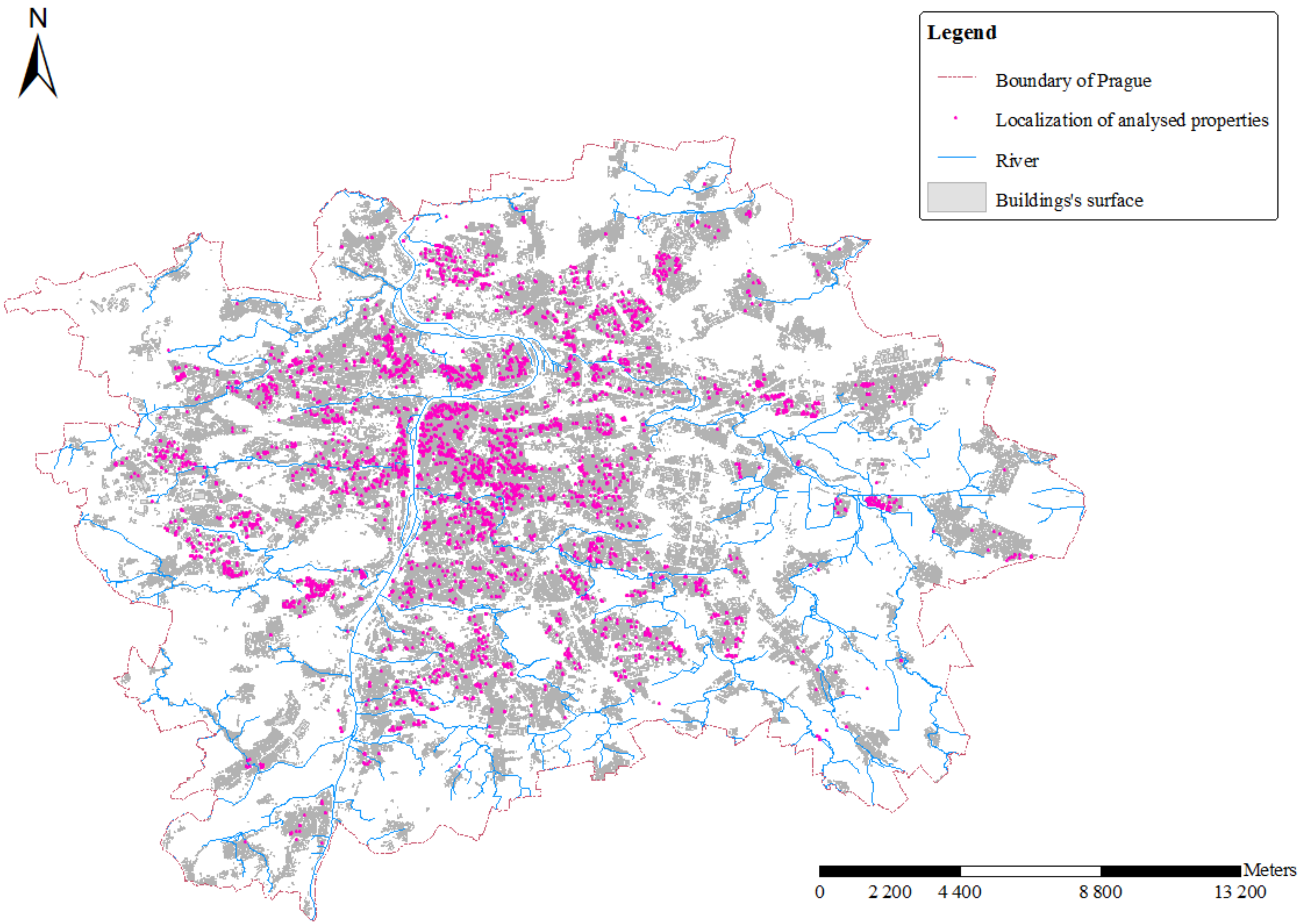
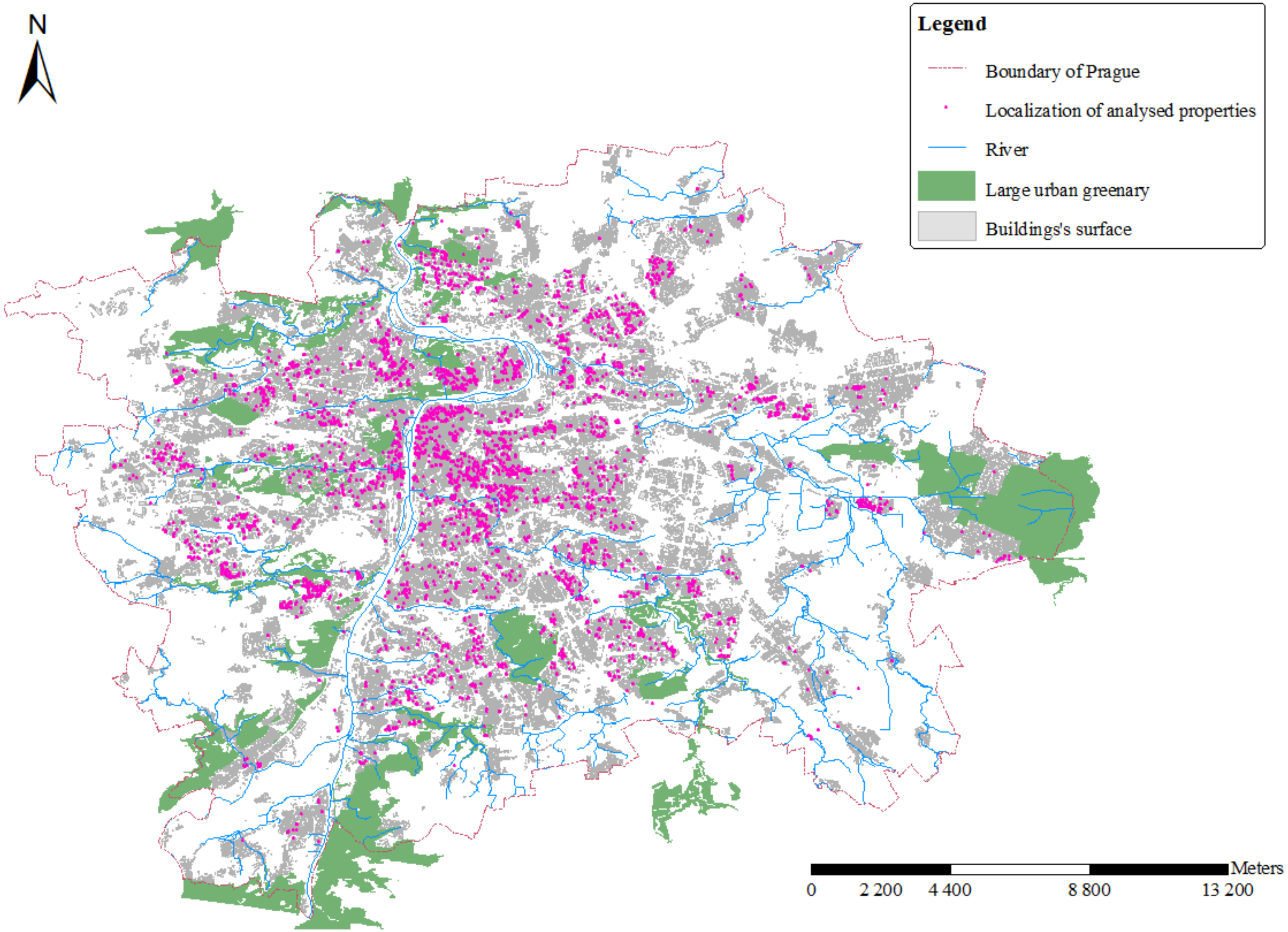


Figure 2 Geographical representation of large urban greenery in Prague



II. Definition of the recreation shadow price and its implications on recreation welfare estimation

Kaprová, K. (2015).
Journal of Landscape Management 6/1: 7-16.

Definition of the recreation shadow price and its implications on recreation welfare estimation

Kateřina Kaprová

Faculty of Humanities, Charles University in Prague

Abstract

The article presents the results of recreation demand analysis for the Šumava National Park, and focuses on a sensitivity analysis to the specification of the shadow price of recreation (travel cost). In the sensitivity analysis, I examine whether it matters to use calculated rather than theoretically correct perceived travel costs, and also discuss whether the travel costs stated by respondents are reliable.

Based on the results, the perceived costs directly stated by respondents may be considered unbiased and may be validly employed in the analysis of recreation demand and other travel-based models. The relative absolute error of respondents stating the travel cost is stable for close and far trips, and does not alter with trip frequency or socio-economic characteristics of the respondents.

To examine the effect of the specification on the recreation demand results, several recreation demand models are estimated, using truncated stratified negative binomial model. Regardless of the travel cost specification employed, the performance of the models is very similar. On the other hand, the effects on estimated consumer surplus are apparent for calculated travel cost specifications based on less precise estimation of travel distance and time. When relying on the results of existing simplified studies in decision-making, it is therefore necessary to reduce the bias caused by simplification of the study; in the Czech case, it is sufficient to consider an interval estimate of consumer surplus.

Key words: distance measurement, on-site, perceived travel costs, protected area, recreation demand, travel cost method

Introduction

Demand for outdoor recreation and underlying economic values of recreation areas are routinely estimated through various economic methods and models (Haab and McConnell, 2002, Freeman, 2003). Apart from choice modelling techniques, travel cost method (TCM) is applied very frequently. Having been developed cca 60 years ago, TCM has gone through important methodological development and exist in various forms: from average zonal visitation models to analysis on the level of individual recreationist, and from simple price-quantity relationship to modelling of probability of choice of recreation area.

All of the recreation demand models rely fundamentally on the „price“ (travel cost) definition, which enables to link the recreation use of the site to utility derived from the visit in terms of money. While the specification of travel costs may have very important effect on the estimates of welfare associated with recreation (Moons et al., 2001), there is still no consensus on the components of total travel cost (Birol et al., 2008), which vary among researchers, as well as their definition. In theory, the relevant cost that enter the demand for recreation is the travel cost perceived by the visitor; in practice, the use of objectively computed travel cost is predominant, in many cases using simplified assumptions on particular travel cost components.

Recreation demand results and recreation welfare estimates are, mainly in the US and western Europe, commonly used for decisionmaking about management of the site concerning future evolution of the site - determination of the size of the area accessible to the visitors, enhancing the environmental qualities of the site and equipping the site with paths or benches, or optimalisation of the visitation and setting entrance fees. Recreation welfare estimates are also often used in decision-making, or as a basis for cost-benefit analysis (CBA, e.g. Becker et al., 2010). In Central Europe and the Czech Republic, the application of the results into the practice has also become important, and the focus on the precision of the estimates is therefore essential.

The aim of the paper is to assess whether there is significant difference among particular subjectively perceived and objectively determined components of the total travel costs. As the behaviour and individual decisions of individuals about whether to visit the recreation site at all, which site to choose for recreation and how many trips to make to each of the sites, depend rather on subjective perception of the distance and cost, the recreation demand theory also supports using subjective measures of travel cost. However, the use of objective (GIS-based) measures has been more frequent in the past research (Parsons and Kang, 2010; Whitehead et al., 2010; Melichar, 2007; Melichar, 2014). Employing objective measures of travel cost, some of the researches implicitly assume that the two measures are of similar magnitude; others doubt the ability of respondents to estimate the travel distance and time properly.

Following the discussion and adapting it for the Czech environment, I examine in this paper:

- which (if any) means of GIS definition leads to travel distance and time estimates that are similar to subjectively perceived;
- whether the subjectively stated measures may be considered reliable;
- and finally, how serious is the bias in using simplified „objective“ approaches in defining the travel cost when compared to the travel cost the respondents take as relevant in their recreation decisions.

Recreation demand studies focusing on this topic are relatively scarce and deal typically with only some of these questions. Bateman et al. (1996) and Moons et al. (2001) have estimated the effects of different GIS specifications of distance and time on the recreation demand; nonetheless, both analyses are limited in the respect that the samples of these studies contain mainly respondents coming to the recreation site from short distances. These people may have large experience with travelling to the near recreation site in question and may be very well aware of the true distance and time needed to get to the recreation site. On the contrary, many recreationists that are coming to Czech outdoor recreation areas, and especially Šumava National Park, are over-night visitors, whose familiarity with the site and capability of a precise ex-ante estimation of distance and time spent travelling to the site may be very limited compared to one-day visitors living close to the site.

Liston-Heyes (1999) shows that even overnight visitors may estimate the distance and time spent travelling to the recreation site relatively well, but the analysis does not continue with the implications for recreation demand and welfare analysis. The amount and scope of the empirical evidence up to present is far from being generalisable, which specifically holds for larger recreation areas that are popular with overnight visitors coming mainly from larger cities (as is the case of Šumava National Park and other Czech outdoor recreational areas).

Data description

The analysis is based on an on-site survey conducted in the central part of Šumava National Park. The survey took part from May to October 2014 (covering both summer recreation peak and off-season periods), on 13 days covering both week-ends and working days, in several localities in central Šumava NP (Modrava, Antýgl, Rechle, Jezerní slať, Tříjezerní slať), with random sampling, from 9:00 to 17:00 each day. Face-to-face interviews in terrain were supplemented by not assisted data collection at 5 information points (Modrava, Kvilda, Horská Kvilda, Rokyta and Stožec).

In the questionnaire, socio-demographic information on the recreationists and characteristics of their trip to the site, including information on the travel, have been collected. Table 1 describes the variables used within the analysis below[2].

[2] In this study, I do not account for travel costs to a substitute site. Omitting a subsitute variable from the demand analysis may affect the elasticity of the estimated demand curve (Freeman, 1993); but in practice, the effect of substitute variable is not stable across studies, mainly in those studies using advanced models for on-site count data (using the same model as in this study, Martinez-Espineira and Amoako-Tuffour, 2008 find that substitute travel costs are not significant determinant of recreation demand). In this case, I explore the own-price elasticity, and I prefer not tointroduce another source of variation among the models in the form of substitute travel costs that would be calculated in a consistent way with the specification used in each of the models presented below.

Tab. 1 Definition of variables

Variable	Definition	Unit
Visits	No. of visits made by the respondent in previous 12 months, excluding winter recreation visits	visits
Hiking	Main activity of the respondent is hiking (0=no, 1=yes)	binary
Nights	No. of nights spent at the site	nights
Group_no	No. of people travelling with the respondent	persons
Hotel	Accomodation in hotel or guest house (0=no, 1=yes)	binary
Relatives	Accomodation at relatives´/friends´ house (0=no, 1=yes)	binary
Room	Accomodation in rented room/appartment/lodge (0=no, 1=yes)	binary
Camp	Accomodation in a camp/tent (0=no, 1=yes)	binary
Sex	Male=0, female=1	binary
Income	Net monthly income of the respondent	thousands CZK
Age	Age of the respondent	years
Outdoor	Not-assisted data collection=0,outdoor face-to-face data collection=1	binary

Table 2 defines various travel cost specifications that have been commonly used to model recreation demand so far: subjectively stated costs, and four specifications of computed travel costs ordered from the most precise to the least precise: based on centroid of the municipality district of the start and end of the journey[3], centroid of the municipality, and the edge of Šumava National Park.

GIS data for modelling the travel cost has been collected from Czech Office for Surveying, Mapping and Cadastre, Nature Conservation Agency of the Czech Republic, Road and Motorway Directorate of the Czech Republic and Šumava National Park. In the analysis, I combined the GIS data with the use of route planner www.mapy.cz, following the approach of Liston-Heyes (1999).

All travel cost specification are defined per person, as a sum of direct costs and time costs to get to and from the site. Accordingly to latest research (Whitehead et al., 2010; Parsons and Kang, 2010; Mitrica et al., 2013; Czajkowski et al., 2014), the opportunity cost of time is set in all cases as 33% of the recreationist´s hourly wage rate.

[3] Based on the results of pre-survey, the city district is the most desaggregated location of the trip origin that may be collected from the respondents – any of the pre-survey participants was not willing to share a more precise localisation of the respondent´s origin (street or even no. of house), even though the survey was completely anonymous.

Tab. 2 Travel cost specifications

<table>
<tr><th rowspan="2">Cost variable</th><th colspan="2">Direct cost of transport</th><th colspan="2">Opportunity cost of travelling time</th></tr>
<tr><th>Length</th><th>Per km rate</th><th>Travel time</th><th>Opportunity cost</th></tr>
<tr><td>Cost_perceived</td><td>Stated</td><td>Calculated using stated total direct cost</td><td>Stated</td><td rowspan="5">33% wage rate</td></tr>
<tr><td>Cost_obj1</td><td>Mapy.cz fastest route, using center of the part of municipality</td><td rowspan="4">2.51 (survey mean)</td><td rowspan="2">Mapy.cz, fastest route</td></tr>
<tr><td>Cost_obj2</td><td>Mapy.cz fastest route, using municipality center</td></tr>
<tr><td>Cost_obj3</td><td>GIS - euclidean distance using municipality center</td><td rowspan="2">Calculated using mean survey speed from mapy.cz (74 km/h)</td></tr>
<tr><td>Cost_obj4</td><td>GIS - euclidean distance using Šumava NP polygon</td></tr>
</table>

Out of the total 505 questionnaires collected in Šumava National Park, only 238 observations represent respondents coming by car and staying overnight in Šumava National Park, and exhibit no missing values in the explanatory variables used within the estimation. These observations are employed in the following analysis. The descriptive statistics of the sample are depicted in Table 3.

Tab. 3 Descriptive statistics of the sample (N=238)

Variable	Mean	Std. dev.	Min	Max
Visits	2.02	2.51	1	20
Cost_perceived	656.6	348.6	86.0	1 865.7
Cost_obj1	643.7	335.8	78.1	1 891.1
Cost_obj2	641.1	335.9	74.2	1 891.1
Cost_obj3	483.9	255.7	58.3	1 455.5
Cost_obj4	446.7	250.4	44.6	1 399.1
Hiking	0.67	0.47	0	1
Nights	5.39	2.99	1	15
Group_no	3.87	3.61	1	31
Hotel	0.55	0.50	0	1
Relatives	0.07	0.26	0	1
Room	0.18	0.39	0	1
Camp	0.11	0.31	0	1
Sex	0.46	0.50	0	1
Income	19.07	7.01	6.46	30.55
Age	41.63	12.78	15	76
Outdoor	0.58	0.49	0	1

Respondents make on average 2 visits to Šumava National Park per 12 months, ranging from 1 (present) visit to 20 visits. These trips last from 1 to 15 nights, on average 5 nights.

Respondents usually travel in groups, mean number of people in the group is 4. 67% of the sample are hikers. The most common type of accomodation is in hotel or guest house (55% of the sample); followed by renting a room, appartment or a lodge (18%) or staying in a camp or a tent (11%).

The socio-economic characteristics show that females form 46% of the sample, and the age distribution is from 15 to 76 years, where the average respondent is 42 years old. The average net monthly income of the respondents is 19 thousands CZK.

The distribution of the variables measuring travel costs as perceived and using fastest route (Cost_obj1 and Cost_obj2) is very similar; however, the use of simplified euclidean distance (straight line; Cost_obj3 and Cost_obj4) yields apparently lower travel costs than those stated by the respondents. On the other hand, there still exist a significant strong positive correlation among each two pairs of cost measures (Pearson correlation coefficients ranging from 0.78 to 0.99 are all statistically significant at α=0.01). Apparently, the closest to the magnitude of the costs which the respondents take as relevant in their recreation decisions is the Cost_obj1 specification, which is in line with the results of Zawacki and Marsinko (1999).

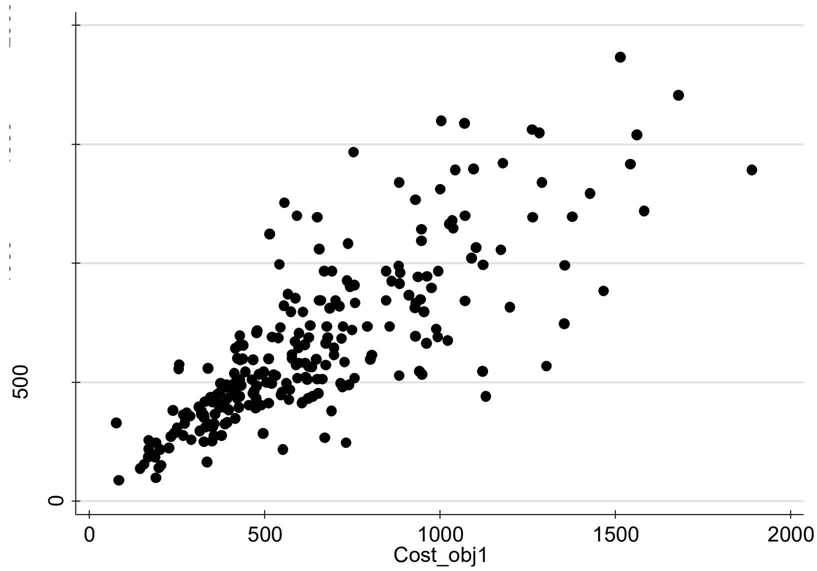
On the other hand, even in a sample where more than half of the respondents (51%) come from regional capital cities, it does not seem important at all to inspect the precise origin and end of the journey in terms of city district (Cost_obj2) – it is sufficient to know the city of origin (Cost_obj1).

Reliability of stated travel costs

Based on the economic theory, the perceived, not objectively computed, travel costs are related to the decision-making of visitors on how many times to visit a recreational area. However, up to present most studies employ computed travel costs, mostly due to the discussion on reliability of stated travel costs by respondents. Stated travel costs may be subject to rounding errors, simplification of the real distance by respondents, wrong estimation of the distance or time in case of no previous experience with travelling to the site etc. I therefore inspect the relationship between stated travel costs and the most precise measure of computed travel costs (Cost_obj1).

As seen in Table 3, the average difference between the two measures is not at all dramatic. However, when inspecting their relationship graphically, we may observe that the variability of the stated travel costs increases with the value of objective travel cost (Figure 1).

Fig. 1 Variability of stated travel cost with respect to objective travel cost



By the definition of travel cost in this study (Table 2), the variability may originate in three sources: the distance, time of travel, and the ratio of cost per km. Table 4 gives a statistical overview of the relationship of all three travel cost components.

Tab. 4 Statistical overview of travel cost components (stated vs. computed)

Statistics	Length (km)		Time (h)		Cost per km (CZK)	
	Stated	Computed	Stated	Computed	Stated	Computed
Mean	209.2	204.1	3.3	2.8	384.1	511.4
Std. dev.	94.5	94.1	1.7	1.1	245.0	235.8
Pearson corr.	0.94		0.81		0.55	
p-value	0.000		0.000		0.000	
Sign-rank test	3.50		7.90		-8.50	
p-value	0.00		0.00		0.00	

Inspecting the results of table 4, we may observe that the respondents tend to slightly overstate both the distance and time spent on the travel. The mean difference from the computed distances and times is very low, but the non-parametric Wilcoxon signed-rank test rejects the null hypothesis on the similarity of distribution, suggesting that the rankings of both specifications are different. Each of these travel cost components is highly correlated between the stated and the objective specification (Pearson correlation coefficients 0.94 and 0.81, respectively).

For distance and time, the relative absolute difference between stated and computed distance and time is calculated as follows:

$$Diff\_dist = \frac{|Dist\_obj1 - Dist\_stated|}{Dist\_obj1}$$

$$Diff\_time = \frac{|Time\_obj1 - Time\_stated|}{Length\_obj1}$$

where the computed distance and time represent those that have been used to calculate to the most precise measure of objective travel cost, Cost_obj1 (based on mapy.cz, fastest route). On average, the respondents have a relative absolute error of 10.8 % (median 8%) in estimating the distance, and by 18.4% (median 15.7%) in estimating the time.

Table 5 shows the regression results of respondents´ error in stating the true distance and time. In line with the previous results, we find no relation of the error and the distance or time. That suggests that Czech respondents show no tendency to misperceive the distance and time spent on the trip that would increase for visitors living farther away from the study site (unlike the results of Moons et al., 2001). The error of respondents in stating the true distance and time of travel is not related to previous experience with the site and practically to any socio-economic variables. The only significant variables in the model for distance difference are age (Age) and number of people in the group of travellers (Group_no). However, even in their whole sample range, they may account only for a very small relative difference in stated distance (0.06 for Age and 0.09 for Group_no).This is also confirmed by the values of F-test, which for both models does not reject the null hypothesis of the full models being superior to the model with constant only (at α=0.05).To conclude, if we accept mapy.cz fastest route measures of distance and time as a good representation of actual trips, we may claim that respondents are relatively successful in estimating the true distance and duration of their trip to Šumava National Park.

Tab. 5 Regression results of respondents´ error

Variable/ model	**Diff_distance**		**Diff_time**	
	Parameter	*Std. Err.*	*Parameter*	*Std. Err.*
Distance	0.000	0.000	-	-
Time	-	-	-0.004	0.009
Visits_no	-0.002	0.002	-0.001	0.004
Hiking	-0.060	0.037	-0.027	0.046
Cycling	-0.022	0.039	0.024	0.047
Group_no	-0.003**	0.001	-0.001	0.003
Children	0.012	0.015	0.009	0.020
Sex	0.005	0.017	-0.009	0.019
Income	0.000	0.000	0.000	0.000
Age	-0.001*	0.000	0.000	0.001
Prague	-0.007	0.016	-0.020	0.021
Outdoor	0.004	0.016	-0.002	0.019
Constant	0.215***	0.066	0.251***	0.078
N	233		233	
F(11, 221)	1.61		0.59	
Prob > F	0.098		0.839	
R-squared	0.057		0.034	

*Statistical significance of parameters: *** α=0.01; ** α=0.05; * α=0.1*

Estimated using Hubert-White robust standard errors

The main cause of the differences between perceived and objective travel cost measures is therefore not the error introduced by the respondent, but the definition of cost per km per person (correlation 0.55), which has a large variability of the stated specification (in fact, reflecting the real fuel consumption of the respective car, and the number of people that share the cost of fuel in each car), while the objective measure relies on a constant per km rate, and a constant average number of people in the car, not allowing for the variations among journeys of each respondent.

For this analysis, the main difference between perceived and objective travel cost measures is not caused by wrong estimation of the length or time duration of the journey by respondents, which is the main concern of demand analysts due to which perceived cost have been so rarely used in recreation demand analyses. More important than the objection to the use of perceived costs as unreliable due to rounding errors, simplification of the real distance by the respondents etc., is the error potentially introduced by researcher in case of not allowing for the variability of cost per km based on real characteristics of the trip.

Recreation demand analysis - results and discussion

To model the recreation demand and inspect the sensitivity of the consumer surplus with respect to the specification of the travel cost variable, I employ a single-site individual travel cost model (Haab and McConnell 2002, Parsons 2003). In this demand model, the quantity demanded by the recreationist is represented by the number of trips done to the recreation site within past 12 months, while the shadow price of the visit is given by different specifications of travel costs. For each travel cost definition, a different recreation demand functions is estimated, using a common set of other explanatory variables describing the trip, the recreationist and type of data collection.

The estimation is based on truncated stratified negative binomial model (Hilbe and Martinez-Espineira, 2005) first presented by Englin and Shonkwiler (1995)[4]. The density of the negative binomial distribution truncated at zero for the count y is (Englin and Shonkwiler, 1995; Cameron and Trivedi, 1998):

$$\Pr(Y|x) = \frac{y_i \Gamma\left(y_i + \frac{1}{\alpha}\right) \alpha^{y_i} \lambda_i^{y_i - 1} [1 + \alpha\lambda_i]^{-(y_i + \frac{1}{\alpha})}}{\Gamma(y_i + 1)\Gamma(\frac{1}{\alpha})}$$

where:

λ_i......is the expected visitation rate, modeled as a function of explanatory variables in the recreation demand model,
$\lambda_i = \exp(x_i\beta)$,

[4] I have explored also the use of generalized negative binomial model (Englin and Shonkwiller, 1995; Hilbe and Martinez-Espineira, 2005), which allows the overdispersion parameter α to vary with the socio-economic characteristics of the respondent. However, none of the socio-economic characteristics plays a significantrole in explaining the overdispersion, and also based on the likelihood-ratio test, the model is not superior to the truncated negative binomial model employed in this study.

y_i......is the real number of trips realised by the respondent,

α ......is the dispersion parameter that expresses the unobserved heterogeneity among the observations, and

Γ ......is gamma function.

The model accounts for the data problems of on-site collected sample related to:

- non-negative integer character of the dependent variable (number of visits in the past 12 months),
- truncation (observing only people with at least one visit, which disables to include the potential recreationists in the analysis),
- overdispersion (specific distribution of the dependent variable with variance exceeding the mean value), and
- endogenous stratification (higher probability of people who more often visit the site to be included in the sample).

The estimation results are shown in Table 6. The table consists of five models, estimated for each of the travel costs specifications considered in the study. The models are estimated via maximum likelihood techniques. Statistical significance of the dispersion parameter α justifies the use of negative binomial distribution for modelling the data.

In all models, the cost variable is statistically significant at α=0.01 and works in the expected direction, irrespective of its precise definition. All models exhibit almost identical fit statistics. Also, the use of any of travel cost specification does not alter the effects of any other explanatory variable on the predicted number of trips to Šumava National Park.

Tab. 6 Recreation demand estimates

Variable /Model	Model 1 Cost_perceived		Model 2 Cost_obj1		Model 3 Cost_obj2		Model 4 Cost_obj3		Model 5 Cost_obj4	
	Parameter	*Std. Err.*	*Parameter*	*Std. Err.*	*Parameter*	*Std. Err.*	*Parameter*	*Std. Err.*	*Parameter*	*Std. Err.*
Cost	-0.002***	0.000	-0.003***	0.000	-0.003***	0.000	-0.003***	0.001	-0.003***	0.001
Hiking	-0.620***	0.227	-0.488**	0.222	-0.474**	0.222	-0.570**	0.223	-0.522**	0.224
Nights	0.056*	0.034	0.050	0.033	0.050	0.033	0.045	0.034	0.048	0.034
Group_no	-0.032	0.029	-0.032	0.029	-0.032	0.029	-0.032	0.029	-0.028	0.029
Hotel	-1.923***	0.301	-2.174***	0.297	-2.154***	0.295	-2.011***	0.294	-2.051***	0.297
Relatives	-1.108**	0.435	-1.152***	0.426	-1.154***	0.424	-1.010**	0.427	-0.919**	0.433
Room	-2.276***	0.382	-2.575***	0.382	-2.571***	0.380	-2.440***	0.379	-2.484***	0.383
Camp	-1.036***	0.372	-1.247***	0.367	-1.215***	0.365	-1.163***	0.367	-1.189***	0.370
Sex	-0.464**	0.226	-0.436**	0.222	-0.439**	0.221	-0.464**	0.222	-0.470**	0.224
Income	-0.001	0.017	0.011	0.017	0.010	0.017	0.004	0.017	0.000	0.017
Age	-0.002	0.009	0.001	0.008	0.001	0.008	0.000	0.009	0.001	0.009
Outdoor	-0.263	0.241	-0.328	0.238	-0.335	0.237	-0.343	0.238	-0.330	0.239
Constant	1.719	1.751	2.220**	1.079	2.243**	1.052	2.252*	1.155	2.097*	1.217
Alpha	6.20***		3.10***		2.93***		3.40***		3.81***	
N	238		238		238		238		238	
Log-likelihood	-263.09		-258.15		-258.02		-259.39		-258.96	
Wald chi2	106.3***		115.9***		116.8***		115.5***		115.1***	
Pseudo R2	0.211		0.226		0.226		0.222		0.223	
AIC	2.32		2.28		2.28		2.29		2.29	
BIC	-1 231.3		-1 231.3		-1 231.3		-1 231.3		-1 231.3	

*Statistical significance of parameters: *** α=0.01; ** α=0.05; * α=0.1; Pseudo R2 refers to McFadden´s Pseudo R^2 (Greene, 1993)*

Focusing on the effect of the other explanatory variables, we may observe that hikers make fewer trips to the site than cyclists and other recreationists; the same holds for people staying in hotels and guesthouses, at their friends or relatives houses, rent a room or stay in a camp. Women visit Šumava national park less often per year than men; nonetheless, the rest of socio-demographic variables is not statistically significant even at α=0.1, which means that visit frequency does not depend on income nor age. The quantity of visits demanded also does not change between the two subsamples of data based on different data collection techniques.

Sensitivity analysis of consumer surplus estimates

Table 7 lists the estimates of welfare associated with 1 visit to Šumava National Park based on different travel cost specifications, together with 95% confidence intervals for the welfare estimates. The estimates are obtained by integrating the area under the demand curve:

Tab. 7 Consumer surplus estimates (in CZK 2014)

Welfare measure/ Cost specification		Model 1 Cost_perceived	Model 2 Cost_obj1	Model 3 Cost_obj2	Model 4 Cost_obj3	Model 5 Cost_obj4
CS/visit		439.4	387.8	386.4	301.0	294.1
95% Conf. Int.	Lower bound	322.9	294.3	293.3	226.3	221.8
	Upper bound	687.1	568.4	566.2	449.4	436.2

The point estimates of consumer surplus vary by 145 CZK per visit, exhibiting a downward bias related to the level of simplification of the travel cost variable. However, all the 95% confidence intervals of the objective estimates of costs contain or are very close to the point estimate of CS/visit using perceived costs model.

Conclusion

The Šumava National Park is a large-sized recreational area to which many visitors come from a long distance (205 km on average) from large municipalities (51% from regional capitals, 28% from Prague). Despite of these facts, the perceptions of recreationists concerning the travel distance and time are relatively close to the reality and thus may be considered reliable.

As opposed to previous findings (Moons et al., 2001), there is no evidence that the error of respondents in stating the true distance or time compared to the most precise objective measure would change with the length of the journey or familiarity with the site, and it does not relate to the socio-demographic variables either. That enables to rely on perceived travel costs, which are supported by the recreation demand theory, also in practical analyses of recreation demand and other travel-based techniques analysed in the Czech Republic.

The recreation welfare associated with 1 visit to Šumava National Park is estimated at 439.4 CZK (24.4 EUR[5]) using theoretically correct perceived travel cost, and at 387.8 CZK (21.5 EUR) using the most precise measure of objective travel cost.

The use of simplified travel cost based on euclidean distance underestimates the true distance to the site by 145 CZK (8.1 EUR) per visit. Nonetheless, the divergence is not so dramatic as in previous studies (e.g. Moons et al., 2001), and the definition of travel cost variable does not affect the fit of the recreation demand model or the effect of the other recreation demand determinants.

The recommendation for further analyses dealing with travels in the Czech Republic is that when the researcher cannot avoid simplifications in travel cost measurement, e.g. using euclidean distance, not only the point estimate of recreation utility should be reported, but also the distribution of the estimate.

[5] Converted using GDP PPP exchange rate to EUR level of year 2014.

In recreation demand modelling, the result is particularly important for prediction of latent visitation to the site from different parts of the country (mainly through zonal travel cost model), where the objective measure of distance is the only one known to the researcher when predicting the visitation with inclusion of potential users to the recreation site. The issue is also crucial for the estimation of random utility models of recreation demand[6]. In these models, the choice among several tens or even hundreds of recreation sites is modelled, and it is largely impossible to inspect the theoretically correct perceived travel cost associated with a potential visit to all of these sites in a questionnaire without fatiguing the respondent. Also, computation of the most precise objective measures of travel costs for a large set of recreational areas in random utility model (e.g. Parsons and Kang, 2010) comes at a considerable time and money cost to the researcher; I therefore hope to have shed some light on the trade-off one is making using simplified approaches in estimating the distance and time (e.g.Melichar et al., 2008; Whitehead et al., 2010).

Further, for the use of recreation utility estimates that are based on simplified travel cost calculations in decision-making or for cost-benefit analysis, care must be taken to account for the potential downwards bias of the estimate. In the case of Šumava National Park as a large Czech recreational area, it is sufficient to employ the interval estimate of welfare, where the upper bound of 95% confidence interval is already very close to the point estimate of the model estimated using theoretically sound perceived travel costs.

Acknowledgement

The work on this paper was supported by the funds of the Grant Agency of Charles University, under project GAUK no. 1544314 „Specification of distance, time and time cost in recreation demand models“. The support is gratefully acknowledged.

[6] For the categorisation of travel cost models, see for example Freeman (2003), Parsons (2003) or Melichar (2007).

References

Bateman, I. J., G. D. Garrod, J. S. Brainard, A. A. Lovett (1996). A GIS approach to measurement issues in the travel cost method. *Journal of Agricultural Economics, 47(2),* 191-205.

Becker, N., M. Inbar, O. Bahat, O.Y. Choresh (2010). Cost benefit analysis of conservation efforts to preserve an endangered species: The Griffon Vulture (Gyps fulvus) in Israel. *Journal of Bioeconomics 12*, 55–70.

Birol, E., P. Koundouri, Y. Kountouris (2008). Using economic valuation techniques to inform water resources management: A survey and critical appraisal of available techniques and an application. *Environment & Policy 48*, 135-155.

Cameron, A. C., P. K. Trivedi (1998). *Regression Analysis of Count Data*, Cambridge: Cambridge University Press.

Czajkowski, M., M. Giergiczny, J. Kronenberg, P. Tryjanowski (2014). The economic value of a white stork nesting colony: a case of 'stork village' in Poland. *Tourism Management, 40,* 352-360.

Englin, J, J. Shonkwiler (1995). Estimating social welfare using count data models: an application to long-run recreation demand under conditions of endogenous stratification and truncation, *Review of Economics and Statistics, 77,* 104-112.

Freeman, A.M. (1993). *The measurement of environmental and resource values, theory and methods*, Washington, D.C.: Resources for the future.

Greene, W. H. (1993). *Econometric Analysis, 2nd edition*. Englewood Cliffs: Prentice Hall.

Haab, T. and McConnell, K. E. (2002). *Valuing Environmental and Natural Resources: the econometrics of non-market valuation*, Cheltenham: Edward Elgar.

Hilbe, J. and R. Martinez-Espineira (2005). *NBSTRAT: Stata module to estimate Negative Binomial with Endogenous Stratification*. Statistical Software Components S456414, Boston College Department of Economics.

Liston-Heyes, C. (1999). Stated vs. computed travel data: a note for TCM practitioners. *Tourism Management, 20,* 149-152.

Martinez-Espineira, R. M., J. A. Tuffour (2008). Recreation Demand Analysis under Truncation, Overdispersion, and Endogenous Stratification: An Application to Gros Morne National Park. *Journal of Environmental Management, 88(4),* 1320-1332.

Melichar, J. (2007). *Aplikace metody cestovních nákladů v oblasti Jizerských hor.* Disertační práce, Praha: Vysoká škola ekonomická v Praze.

Melichar, J., J. Urban, V. Máca (2008). Peněžní hodnocení rekreačních a estetických funkcí lesních ekosystémů v České republice. Redakčně upravená závěrečná zpráva projektu výzkumu a vývoje č. 1R56014. COŽP UK, 176 p.

Melichar, J. (2014): Measuring recreation benefits of forest quality change with contingent behavior model. *Journal of Landscape Management, 5(2),* 10-15.

Mitrica, E., B. Mitrica, A. Stanculescu (2013). Economic analysis of nature preservation investments: the zonal travel cost approach applied for Harghita County of Romania. *Journal of Environmental and Ecological Statistics, 21(1),* p. 83-93.

Moons, E., J. Loomis, S. Proost, K. Eggermont, a M. Hermy (2001). Travel cost and time measurement in travel cost models. Working Papers Series No. 2001-22, Katholieke Universiteit Leuven, Center for Economic Studies.

Parsons, G. R. (2003). The Travel Cost Method. In Champ, P. A., Boyle, K. J., Brown, T. C. (eds.). *A Primer on Nonmarket Valuation*, London: Kluwer Academic Publishers.

Parsons, G. R., A. K. Kang (2010). Compensatory restoration in a random utility model of recreation demand. *Contemporary Econmic Policy, 28(4)*, 453-463.

Whitehead, J. C., D. J. Phaneuf, C. F. Dumas, J. Herstine, J. Hill, B. Buerger (2010). Convergent validity of revealed and stated recreation behavior with quality change: a comparison of multiple and sigle site demands. *Environmental and Resource Economics, 45*, 91-112.

Zawacki, W. and A. Marsinko (1999). Using geographic information systems with travel cost models: A case study. *Proceedings of the 2000 Northeastern Recreation Research Symposium*. Bolton Landing: USDA Forest Service General Technical Report NE-269, 287-292.

Author´s contact address

Ing. Kateřina Kaprová

Charles University, Faculty of Humanities

U Kříže 8, 158 00 Prague 5

+420 220 199 466, katerina.kaprova@czp.cuni.cz

III. Recreation values and the value of recreation demand modelling: The case of the Šumava NP

Kaprová, K. (2015).
Journal of Landscape Management 6/2: 38-48.

Recreation values and the value of recreation demand modelling: The case of the Šumava NP

Kateřina Kaprová

Faculty of Humanities, Charles University in Prague

Abstract

The article focuses at recreation demand modelling and the estimation of a single site travel cost model for the Šumava National Park. Particular theoretical and practical steps of the application and issues concerning the method are discussed and comprehensively revealed also to non-economists: from the definition of travel cost, sampling, modelling, estimation of recreation value and further use of the results in decisionmaking and policy assessment.

The final output of the article is the estimate of recreation value for the Šumava National Park in monetary terms. The consumer surplus associated with one average trip for an average visitor to the Šumava National Park is estimated at 399 CZK (23.2 EUR); yearly estimate of recreation surplus for an average visitor mounts to 773 CZK (44.9 EUR).

Key words: environmental valuation, nonmarket benefits, protected area, travel cost method, welfare analysis

Introduction

The Šumava National Park represents an important and exceptionally extensive recreation area. It covers 680.6 square kilometers, and being surounded by additional 996.2 square kilometers of the Šumava Protected Landscape Area, the two sites form the largest specially protected complex of land in the Czech Republic. Šumava, often described as „green roof of Europe“, offers an impressive variety of landscapes: from spruce and beech virgin forests, mountain forests and meadows to unique large-scale peat bogs, wild streams and glacial lakes. It is no wonder that the popularity among outdoor recreationists and the pressure on the recreational use of the area grow in time - yearly visits are roughly estimated at 2 millions visitors by the park management, and the most exposed localities experience a daily load of several thousands recreationists in the high season. Such an area has undoubtedly large potential to deliver significant non-market services and associated benefits to its visitors. But how to assess them?

While we know exactly how much it costs yearly to preserve and maintain the national park (and through that, to secure the provision of its services to the society), the effects of this effort are not directly available in comparable monetary terms. Recreation services are not connected to a direct value that would be evident from the market. The assessment of the benefits associated with recreation requires an analysis of a surrogate market, and estimation of the relationship between demanded quantity of visits, the shadow price of the visit (travel cost) and other quantitative and qualitative determinants of visitation.

This article reveals theoretical and practical steps of the analaysis and discusses the issues of the method, so that the results become more transparent also for non-economicsts in the expert public. The specific aim of the article is disentanglement of the factors that affect the visitation of the Šumava NP. The final output of the analysis is the estimate of non-market recreation use value associated with a visit to the area.

While the previous work on the topic (Kaprová, 2015) has focused on the definition, specification and precision of the shadow price of recreation, this analysis investigates the recreation welfare based on an extended and representative set of recreationists. In the article, I also discuss the possibilities of the model to derive information for the management of the protected area, and compare these with the usual focus of the other recreation demand models and their applications.

Data description

The analysis is based on a dataset originating in an on-site survey that was conducted in the central part of the Šumava NP in 2014 and focuses on summer and off-season activities. The survey took part from May to October, to cover summer recreation peak and off-season periods as well, both on week-ends and working days. The analysis is limited to visitors of the age of 15+ years. Part of the survey has been conducted using a face-to-face PAPI (pen and paper interviews) questionnaires on five localities in the outdoors of the central part: namely Modrava, Antýgl, Rechle, Jezerní slať and Tříjezerní slať. Face-to-face outdoor interviews have been done on the basis of random sampling and therefore represent well the population of visitors in the central part of the Šumava NP. The survey has been very successful in data generation, since the questionnaire was (with the help of several rounds of pre-testing that took part in May 2014 on the collection points of the final survey) designed to last 6 minutes on average. Due to that, the rejection rate was very favourable: less than 15%.

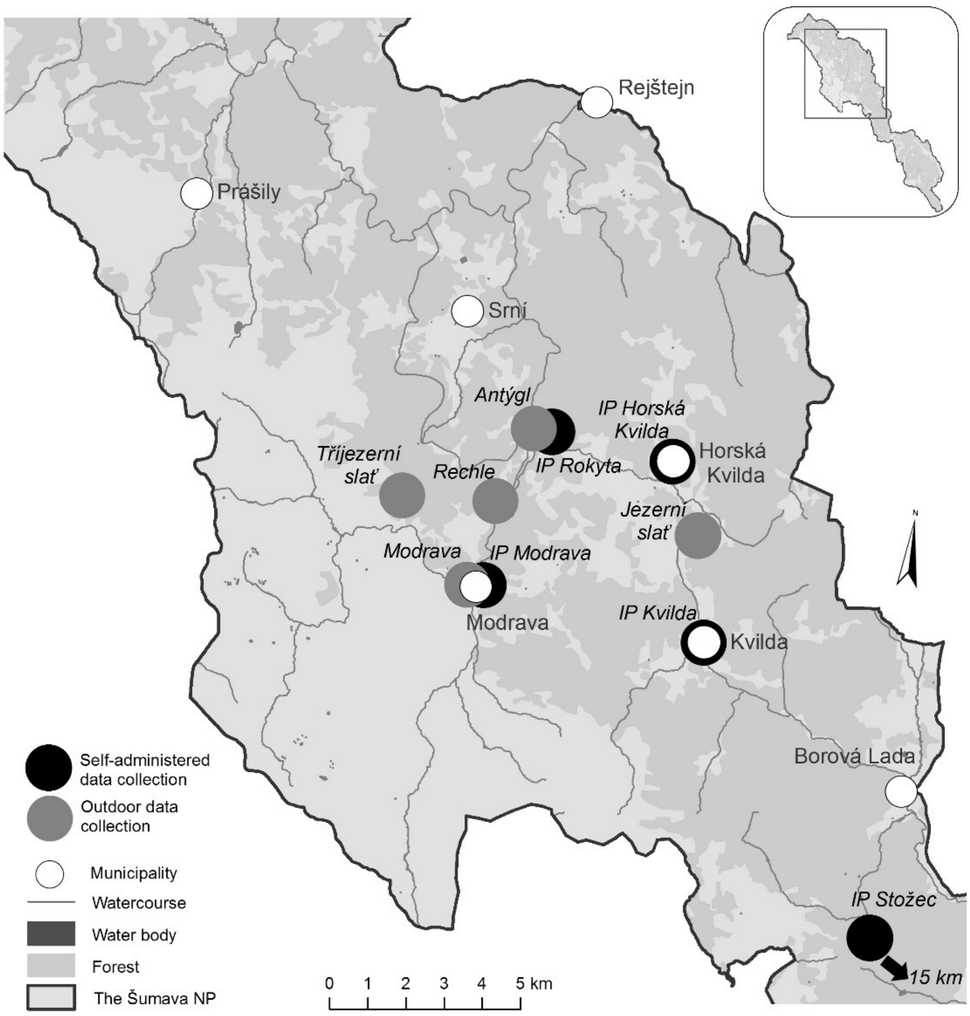
The outdoor survey has been supplemented by not assisted data collection at 5 information points (IP): Modrava, Kvilda, Horská Kvilda, Rokyta and Stožec. This part of the survey has also been successful and generated as much as 52.3% of the total sample used in the analysis. However, it must be noted that not assisted data collection does not allow the researcher to control for the representativeness of the sample regarding the general visitor population of the Šumava NP, and it is possible that data collected in this way suffer from a self-selection bias[7]. It is therefore necessary to inspect the differences between both subsamples and also to account

[7] Recreationists who are more interested in the national park are more willing to share their view on the park and have higher propensity to participate in self-assisted pen-and-paper or online surveys (Braver and Curtis Bay 1992; Beckendorff et al. 2007, Khazaal et al. 2014). In most instances, this leads to biased data, as the decision to participate in the survey may reflect some inherent bias in the characteristics of the participants, and the uncontrolled sample may not well represent the entire population of recreationists of the park.

for the possible divergences in the analysis[8].

The distribution of the data collection localities, both face-to-face and not assisted, is depicted in figure 1 (IP Stožec is located to the southeast of the central part of the Šumava NP). The relevant information on the visitors, their characteristics and recreation behavior have been supplemented by a geographic analysis, using the data from Czech Office for Surveying, Mapping and Cadastre, Nature Conservation Agency of the Czech Republic, Road and Motorway Directorate of the Czech Republic and the Šumava National Park.

Fig. 1 Location of data collection points



[8] In fact, also the first part of the sample – the data collected outdoors - may possibly suffer from one type of bias, regardless of the fact that it is collected in a representative way. Since the data are collected on a selection of days, the recreationists that come to the site more often and for a longer time have higher probability to be sampled than those who visit the site less often. This bias is called ´endogenous stratification´, occurs due to oversampling of frequent visitors, and is related to all surveys that are coducted on-site (for more detailed information, see for example Braun Kohlová et al., 2015 or Parsons, 2003). In recreation demand modelling, it is possible to correct for the bias by using a type of model that incorporates a probability that the recreationist will be sampled, based on the information on the number of his/her trips. The corrected model is used also in the subsequent analysis.

Unlike many other recreation areas in the Czech Republic, the Šumava NP is a typical site for trips that take several days. The factor contributing to this is mainly the large area of the park, which, together with the abundance of places of interest that concern various fields of interest, and also by rather remoted location by the south-western border, make the park ideal for spending at least a weekend there during one trip. This pattern is evident also in the dataset, where only 8.6 % of the visitors have come for a day trip (i. e. do not spend a night in Šumava); while an average overnight visitor spends a whole week in the Šumava NP (see further the descriptive analysis). For the insufficient number of observations of day visitors and the fact that the two types of visits are not generally advised to be covered under one demand curve, as the factors influencing the demand may differ for both (Ward and Beal, 2001), the analysis is limited to overnight visitors only. For similar reasons, the demand model for winter recreation should be also separate, as the recreation activities differ from the summer and off-season period.

Table 1 describes the variables that are employed further in the recreation demand analysis.

Tab. 1 Definition of variables

Variable	Definition	Unit
Visits	No. of visits made by the respondent in previous 12 months, excluding winter recreation visits	visits
Travel_cost	Travel cost to the Šumava National Park (two-way, per visitor)	CZK
TC_outdoor_int	Interaction variable: Travel_cost*Outdoor	CZK
Nights	No. of nights spent at the site	nights
Distribution	No. of visited areas within the park during the present visit	areas
Hiking	Main activity of the respondent is hiking (0=no, 1=yes)	binary
Group_no	No. of people travelling with the respondent	persons
Hotel	Accomodation in hotel or guest house (0=no, 1=yes)	binary
Cottage	Accomodation at a cottage	binary
Room	Accomodation in rented room/appartment/lodge (0=no, 1=yes)	binary
Relatives	Accomodation at relatives´/friends´ house (0=no, 1=yes)	binary
Camp	Accomodation in a camp/tent (0=no, 1=yes)	binary
Substitute_tc	Travel cost to nearest substitute site (NP or PLA)	CZK
Sex	Male=0, female=1	binary
Income	Net monthly income of the respondent	thousands CZK
Age	Age of the respondent	years
Outdoor	Not-assisted data collection=0,outdoor face-to-face data collection=1	binary

The specification of the travel cost, i. e. the shadow price of recreation, may impact the resulting welfare estimates, as shown for example by Kaprová (2015) or Hynes et al. (2004). In the analysis of travel cost, I combined the GIS data with the use of route planner www.mapy.cz, following the approach of Liston-Heyes (1999). All travel cost specification are defined per person, as a sum of direct costs and time costs to get to and from the site (Smith et al., 1983; Hanley and Spash, 1995; Parsons, 2003)[9]:

$$Travel\ cost =$$
$$2 * \left(\frac{(dist * dir\_cost\_km)}{no\_trav} + \frac{t\_time * yn\_inc * oc\_rate}{ywh}\right)$$

where:

dist .... one-way shortest route distance in kilometers from the center of the municipality district of origin („home“ or other destination specified as a start of the journey by the respondent) to the center of the municipality district where the journey in the Šumava NP ended

dir_cost_km average direct cost per kilometer based on the survey (2.51 CZK per km); all respondents considered only direct fuel cost (none included also the indirect costs as deterioration/amortization of the car or car insurance)

no_trav ..... number of travellers in the respective car (on average 2.8)

t_time .... one-way travel time in hours, estimated using shortest route analysis

yn_inc .... yearly net income (= monthly net income stated by the respondent*12)

oc_rate...... opportunity cost of time (accordingly to latest research - Mitrica et al., 2013; Czajkowski et al., 2014, - the opportunity cost of time is set in all cases as 33% of the recreationist´s hourly wage rate)

ywh .... yearly working hours (1816; assuming each working day has 8 hours, that there were 252 working days in year 2014, accounting for an average yearly amount of 25 days of paid holiday)

For those travelling by public transport (13.7% of the final sample), the direct travel cost and time has been inquired from the respondents, and has been compared against the server www.jizdnirady.cz, on the basis of the second fastest connection from the origin to the destination that operates from Friday 3 pm to Saturday 12 am on the week before the interview took part.

Trips covering more destinations than the Šumava NP, business trips and trips the main aim of which (as stated by the respondent) was to visit relatives or friends, have been omitted from the analysis. In these cases, we cannot attribute all the travel cost to the recreation in the park

[9] Parsons (2003) suggests to incur also equipment cost, which may be relatively expensive for some receration activities (such as mountaineering). However in practice, the equipment cost is almost always excluded (Ibid.), as it is not related only to the analysed trip of the respondent. The equipment is re-used by the respondent for several years; and for one additional trip, the respondent may treat it as sunk cost (similarly to the indirect car transport cost - see further in the text). Also, the most ´specific´ recreation activities in the central Šumava mentioned by the recreationists, apart from most common hiking and biking, were ´mushrooming´ and ´birdwatching´, where the equipment costs are negligible.

(Phaneuf and Smith, 2006) - a large portion of the travel cost associated with these trips may be incurred for different purposes.

Tab. 2 Descriptive statistics of the pooled sample (N=329)

Variable	Mean	Std. dev.	Min	Max
Visits	2.06	2.72	1	21
Travel_cost	665.8	371.8	78.1	1957.6
Nights	5.71	3.40	1	30
Distribution	3.88	1.88	1	10
Hiking	0.70	0.46	0	1
Group_no	4.02	3.77	1	31
Hotel	0.50	0.50	0	1
Cottage	0.04	0.20	0	1
Room	0.20	0.40	0	1
Camp	0.12	0.32	0	1
Relatives	0.06	0.24	0	1
Substitute_tc	42.49	30.18	0	154.0
Sex	0.54	0.50	0	1
Income	18.38	7.23	6.46	30.55
Age	41.07	13.23	15	80
Outdoor	0.48	0.50	0	1

Table 2 depicts the descriptive statistics of the sample. On average, an overnight visitor makes 2 visits per year to the Šumava NP, ranging from 1 (present) visit to 21 visits. To get to the site and back home, the respondent pays on average 666 CZK (including the direct cost and the opportunity cost of his/her time), the median value is 588 CZK. The average trip lasts 6 nights (i. e. one week; the median value is equal), and the duration of trip ranges from 1 to 30 nights.

To monitor the geographic distribution of the recreatinosts´ trips in the Šumava NP, the areas within the park visited during the trip have been inquired: Železná Ruda, Prášilsko, Srní-Povydří, Modrava-Kvilda-Horská Kvilda, Borová Lada-Knížecí plains, Stožecko, Schwarzenberg channel-Plešné lake). On average, the recreationist visits 4 areas (with equal median value).

Respondents usually travel in groups, mean number of people in the group is 4 (3.6% travelled alone). 70% of the sample are hikers. The most common type of accomodation is in hotel or guest house (50% of the sample); followed by renting a room, appartment or a lodge (20%) or staying in a camp or a tent (12%). 4% have stayed in a cottage.

The socio-economic characteristics show that 54% of the sample are women, and the age distribution is from 15 to 80 years, where the average respondent is 41 years old (median value is 40). The average (and median) net monthly income of the respondents is 18.4 thousands CZK.

As denoted earlier in the text, 48% of the sample has been collected outdoors by the means of face-to-face interviews; the rest in information points through not-assisted data collection. To inspect how the characteristics of visitors differ when collected in a representative way compared to a self-selected sample, table 3 shows the same descriptive statistics for both subsamples.

Tab. 3 Descriptive statistics by sampling type (N=329)

Variable	Mean		Std. dev.		Min		Max	
	Outdoor	IC	Outdoor	IC	Outdoor	IC	Outdoor	IC
Visits	1.94	2.17	2.56	2.85	1	1	20	21
Travel_cost	651.2	679.0	361.1	381.8	84.7	78.1	1957.6	1929.6
Nights	4.42	6.88	2.73	3.54	1	1	15	30
Distribution	3.68	4.07	1.95	1.80	1	1	10	10
Hiking	0.67	0.72	0.47	0.45	0	0	1	1
Group_no	3.49	4.49	3.01	4.30	1	1	31	30
Hotel	0.57	0.43	0.50	0.50	0	0	1	1
Cottage	0.05	0.03	0.22	0.18	0	0	1	1
Room	0.13	0.26	0.34	0.44	0	0	1	1
Camp	0.14	0.10	0.35	0.30	0	0	1	1
Relatives	0.06	0.06	0.23	0.25	0	0	1	1
Substitute_tc	48.84	36.70	32.61	26.57	0	0	154.0	133.1
Sex	0.38	0.69	0.49	0.46	0	0	1	1
Income	19.38	17.47	7.24	7.13	6.46	6.46	30.55	30.55
Age	44.36	38.06	13.07	12.68	15	15	76	80

When comparing both subsamples, we may observe that the average value and distribution of almost all explanatory variables are similar. The most important difference is that the self-selected subsample is more dominated by women. The values of the other two socio-demographic variables, the net monthly income and age, are slightly lower in the self-selected subsample. The range is, however, almost equal in both subsamples, and also the distribution of all the recreation-related variables do not differ dramatically.

Model

To model the recreation demand, I employ a micro-economic single-site individual travel cost model (Haab and McConnell, 2002; Parsons, 2003). In this demand model, the quantity demanded by the recreationist is represented by the number of trips done to the recreation site within past 12 months, while the shadow price of the visit is given by travel costs (including direct costs and opportunity cost of time spent travelling to and from the site). The estimation is based on truncated stratified negative binomial model (Hilbe and Martinez-Espineira, 2005), which accounts for several data problems of on-site collected sample, including endogenous stratification.

The density of the negative binomial distribution truncated at zero for the count y is (Englin and Shonkwiler, 1995; Cameron and Trivedi, 1998):

$$\Pr(Y|x) = \frac{y_i \Gamma\left(y_i + \frac{1}{\alpha}\right) \alpha^{y_i} \lambda_i^{y_i - 1} [1 + \alpha\lambda_i]^{-(y_i + \frac{1}{\alpha})}}{\Gamma(y_i + 1)\Gamma(\frac{1}{\alpha})}$$

where:

λ_i......is the expected visitation rate, modeled as a function of explanatory variables in the recreation demand model, $\lambda_i = \exp(x_i\beta)$,

y_i......is the real number of trips realised by the respondent,

α ......is the dispersion parameter that expresses the unobserved heterogeneity among the observations, and

Γ ......is gamma function.

Results

Table 4 shows the results of the recreation demand modelling. The models are estimated via maximum likelihood technique.

Tab. 4 Recreation demand models

Variable /Model	Model 1 Pooled		Model 2 Sampling type	
	Parameter	*Std. Err.*	*Parameter*	*Std. Err.*
Travel_cost	-0.001***	0.000	-0.001**	0.000
TC_outdoor_int			-0.002***	0.001
Nights	0.024	0.029	0.022	0.028
Distribution	0.004	0.052	0.004	0.051
Hiking	-0.576***	0.201	-0.555***	0.198
Group_no	-0.022	0.025	-0.018	0.024
Hotel	-1.046***	0.334	-1.017***	0.329
Cottage	1.534***	0.425	1.595***	0.414
Room	-0.793**	0.354	-0.802**	0.348
Camp	-0.322	0.387	-0.274	0.379
Relatives	-0.251	0.443	-0.202	0.441
Substitute_tc	0.007**	0.003	0.007**	0.003
Sex	-0.445**	0.197	-0.41**	0.194
Income	-0.004	0.014	-0.003	0.014
Age	0.003	0.007	0.004	0.007
Outdoor	-0.520***	0.209	0.423	0.376
Alpha	8.58***		4.29***	
N	329		329	
Log-likelihood	-368.63		-364.08	
Wald chi2	131.5***		143.9***	
Pseudo R2	0.214		0.224	
AIC	2.34		2.32	
BIC	-1 814.2		-1 808.4	

*Statistical significance of parameters: *** α=0.01; ** α=0.05; * α=0.1;*
Pseudo R^2 refers to McFadden´s Pseudo R^2 (Greene, 1993)

The pooled model (Model 1) is estimated for the full set of data, irrespective of the data collection method. The significance of the Outdoor variable means that the results for the two data collection methods may be different; this also means that the representativity of the data may be an issue in determining the true price-quantity relationship.

Model 2 corrects for the possible bias by employing an interaction variable of travel cost with data collection type (TC_travel_int). In this model, the interaction variable is statistically significant at α=0.05, which confirms that the predicted number of visits, as well as the predicted recreation welfare, differ between the subsamples. The Outdoor variable itself becomes insignificant after the correction of the model, denoting that the effect of the data collection on the modelling results works only through the travel cost variable and no further corrections are needed.

The results show that the number of nights spent at the site, the geographic distribution in the area of the national park and number of people in the group do not significantly affect the demand for recreation trips. Hikers make fewer trips to the Šumava NP than recreationists engaging in other activities. The same holds for people staying in hotels or who rent a room; on the other hand, people staing in a cottage (mostly their own) come far more often. The other types of accomodation (in camp or at their relatives´) do not affect the demanded quantity of visits.

Closeness of a substitute site is important for the demand modelling, indicating that the lower the travel cost to a substitute recreation site i. e., the nearest other national park or protected landscape area), the fewer visits the respondent makes to the Šumava NP. Among the socio-economic characteristics, only sex is statistically significant - women yearly visit the national park less often than men. Both models exhibit very similar values of fit statistics.

Tab. 5 Welfare estimates (in CZK)

Welfare measure/ Cost specification		Model 1 Pooled	Model 2 Sampling type	
			Outdoor	IC
CS/visit		755.6	399.4	1 324.2
95% Conf. Int.	Lower bound	527.3	231.2	715.8
	Upper bound	1 332.1	1 465.0	8 810.6
CS/year		1 554.8	773.4	2 871.6
95% Conf. Int.	Lower bound	1 085.1	447.7	1 552.3
	Upper bound	2 741.1	2 836.7	19 106.7

The recreation welfare associated with 1 visit is defined as the integral under the estimated demand curve. As shown in Table 5, using the pooled sample, one trip to Šumava NP would be associated with a consumer surplus of 756 CZK (43.8 EUR[10]). After the correction for the non-representative part of the sample collected at information points, the correct recreation welfare estimate is only almost half of it: 399 CZK (23.2 EUR). Should the sampling be based solely on the equally large, but non-representative data collection, the resulting consumer surplus estimate is overestimated more than three times (1324 CZK, 76.8 EUR), and also the confidence intervals spread out more. The results document the importance of correct sampling in the analyses of outdoor recreationists, where the statistical information on the whole ´population´ of visitors are not available.

[10] All EUR values stated in the text have been converted from the original currency and year level using GDP PPP exchange rate to EUR level of year 2014.

Discussion

When compared to the previous results for the Šumava NP that were based on a smaller experimental sample (Kaprová, 2015), the resulting recreation welfare estimate is of very similar magnitude (439 CZK, i. e. 24.4 EUR using perceived travel cost, and 388 CZK, i. e. 21.5 EUR using objective travel cost of the same definition as in this analysis). Other recreation welfare estimates for protected sites in the Czech Republic are available only for Jizerské Mountains, where the average consumer surplus per visit is 1-3 thousands CZK (71-220 EUR), depending on the model applied (Melichar, 2007). Examples from abroad include the protected Hoge Veluwe Forest in the Netherlands, the recreation value of which has been estimated at 11.7 EUR per trip (Hein, 2011) or value of forest recreation in Poland, where the estimated consumer surplus is 26.7 EUR per trip (Bartczak et al., 2008). While the recreation values for particular sites naturally differ due to dissimilarities in the site characteristics, attributes of the visitor population and modelling techniques used (Zandersen and Tol, 2009), it may be concluded that the estimated recreation value of the Šumava NP fits well into the bounds of other outdoor recreation welfare estimates in Europe.

The results of the estimated recreation demand model may serve for evaluation of management and policy issues concerning the Šumava NP. In general, travel cost method may address three classes of policy issues (Ward and Loomis, 1986):

a) estimation of the value of availability of a single recreation site for recreation (existing or new; i. e. also the value lost if the existing site is closed for public or destroyed),

b) assessment of the benefit/loss associated with an environmental change at the recreation site,

c) assessment of the effects of pricing in the recreation site (setting up entrance fees etc.).

The single site model employed within this analysis may contribute to only two of these issues: for the estimation of the total recreation value of a site and for the prediction of the change in visitation and in recreation welfare that are associated with a change in travel cost (which includes setting an entrance fee or changes in fuel costs[11]). The results represent a valuable input into optimization techniques (Alpízar, 2006), which confront the recreation demand with the supply side of recreation in protected areas and find the solutions for setting an „optimal fee" that maximizes social benefits from the visitation to the protected area given the expensiveness of the maintenance of the area. The model may be also used for a prediction of

[11] The theoretical model assumes that the recreationist is indifferent about which component of travel cost is changed – whether it is an entrance fee or fuel cost. It might be discussed, mainly in countries with low tradition on pricing nature (such as the Czech Republic), that the reality is potentially different. While people are used to changes in fuel cost and may in reality behave ´according to the model´ if a scenario of a fuel cost increase is evaluated, the real recreation behavior may differ totally from the model if the evaluated price change is the setting of an entrance fee - due to protest reactions in case that most of the visitors do not agree with paying a fee for visiting the park.

However, there is a tradition of pricing of points of recreational interests in several nature reserves and a national park (Adršpach-Teplice Rocks, Rejvíz, Soos, Prachov Rocks or Pravčice Gate), which work relatively well with the public. Also, the preliminary results of the survey in the Šumava NP in 2014 show that most of the visitors agree to contribute to the maintenance of inquired points of interest (Šumava bogs) and do not object to the eventuality of setting (a small) entrance fee. It seems then that the protest reactions are not likely to divert the real behavior in the Šumava NP from the modelled one in the case of the evaluation of an entrance fee scenario.

how efficient will the regulation of visitation through pricing be in areas where the decrease of visitor load is necessary due to conservation purposes, and to predict the revenue that may contribute to financing the maintenance costs. Overally, once the optimization model is developed, itmay contribute to the potential discussions on setting entrance fees in natural areas and their effects on the visitor population.

What the single-site model itself cannot address is the evaluation of a change in the environmental quality of the recreation site - the environmental quality is constant in the model for all recreationists, because they respond about their recreation behavior of the same time period. To evaluate environmental quality change under a specific scenario, the single-site model (revealing the real recreation behavior in the past) may be extended in the same survey by an analysis of hypothetical behavior based on the presentation of the scenario to the respondents, yielding a contingent behavior model (Melichar, 2014). More flexible way is to conduct an application of a random utility travel cost model or a system of recreation demands for several areas (Parsons, 2003), which cover more recreation sites. This approach allows to properly address the substitution effects among a system of recreation sites, and also to assess the effect of the environmental quality change at a recreation site on potential recreationists (not only actual ones that are covered by a single-site demand model), as the data for these models are usually collected off-site.

To evaluate the shifts in recreation demand due to external factors such as weather, neither of the above mentioned cross-section models is appropriate, and models based on time series or panel data have to be employed (see for example WTO and ETC, 2008). However, the seasonal recreation demand for a recreation site may be disentangled using a single-site model (Bartczak et al., 2012).

The recreation benefits of visitors based on the single site travel cost model presented here may serve as a direct input into cost-benefit analyses (CBA) concerning the Šumava NP (and are also utilisable in CBAs in grant applications). Recreation welfare represents a very important non-market benefit associated with nature - regarding the magnitude of benefits, it may be even the most important one (Bartczak et al., 2008). As such, it should not be omitted from the CBA. In the opposite case, when the CBA is based solely on more accessible market values, the CBA would bring unoptimal results from the perspective of the society, where the projects that improve visitors´ well-being might be improperly identified as undesirable (i. e. with unfavourable benefit/cost ratio).

However, to sum the recreation benefits over the visitor population, the essential knowledge is the number of visitors in the park per year. While some expert judgements exist, they are practically not backed up by continuous visitor monitoring results; and the uncertainty on the number of affected visitors transfers into the results of the CBA. Also, the problematics of the generalization of the results of particular visitor monitoring methods over a larger area is very complex (typically, the monitoring covers only a path and do not yield the number of unique visitors, but number of passings, where the unique visitor may be counted multiple times) and needs further attention in the research (Braun Kohlová et al., 2015).

The results of recreation demand modelling may also be employed to demonstrate that the effort to preserve and maintain the national park (together with the associated cost) contribute to the well-being of visitors in comparable monetary terms. In this respect, it is necessary to emphasize that recreation is only one of the ecosystem services provided by the national park and the recreation use value, however important, is only one component of the total economic value of the park. The recreation demand itself does not aspire to reveal the other components of the total economic value, i. e. direct use values for marketed products such as forest fruit, mushrooms, timber or clean water, and non-use values, such as option value, bequest value or existence value. Also, as quoted before, the model covers overnight visitors (not one-day visitors, and not residents, both of which certainly also yield benefits from spending free time in the park), and do not cover winter activities.

Conclusion

The article has focused on the travel cost methodology and the application of the single-site travel cost model to the Šumava NP. The aim has been to discuss the steps and issues of the method to increase the transparency of the results also to non-economists among managers and policymakers. For each issue, the discussion has focused on the explanation of the state-of-the art practices.

The recreation demand model for the Šumava NP shows that the characteristics of the visit account for the differences among the quantity of trips demanded by particular visitors; the visitation is not much responsive to the socio-demographic characteristics of the visitors. The availability of a substitute recreation site close to the visitor´s place of residence plays an important role in the model. Within the analysis, it has been also demonstrated that it is very important to account for the representativeness of the sample.

The consumer surplus associated with an average trip of an average visitor to the Šumava NP is estimated at 399 CZK (23.2 EUR); yearly estimate of recreation surplus for an average visitor mounts to 773 CZK (44.9 EUR). The results of a single-site model may be employed within the estimation of the total value of availability of the site for recreation, optimalization, prediction of the changes in the demand driven by a potential pricing policy. They may also serve as an input into a cost-benefit analysis or for demonstration of the nonmarket recreation value of the park against the known maintenance and management cost.

Acknowledgement

I would like to thank the employees of the information points, who willingly adverted the survey to the recreationists. The work on this paper was supported by the Grant Agency of the Charles University under the project GA UK no. 1544314. The support is gratefully acknowledged.

References

Alpízar, F. (2006). The pricing of protected areas in nature-based tourism: A local perspective. *Ecological Economics, 56(2)*, p. 294-307.

Bartczak, A., H. Lindhjem, S. Navrud, M. Zandersen, T. Zylicz (2008). Valuing forest recreation on the national level in a transition economy: The case of Poland. *Forest Policy and Economics 10, 7-8*, p. 467-472.

Bartczak, A., J. Englin, A. Pang (2012). When are forests visits valued the most? An analysis of the seasonal demand for forest recreation in Poland. *Environmental and Resource Economics, 52(2),* p. 249-264.

Benckendorff, P., G. Moscardo, L. Murphy (2007). Contrasting online and onsite sampling methods: Results of visitor responses to a destination survey. *2007 TTRA Annual Conference Proceedings*, p. 13-22.

Braun Kohlová, M., J. Melichar, K. Kaprová (2017). *Metodika monitoringu návštěvnosti v přírodních oblastech*. Prague: Charles University Environment Center.

Cameron, A. C., P. K. Trivedi (1998). *Regression Analysis of Count Data*, Cambridge: Cambridge University Press.

Czajkowski, M., M. Giergiczny, J. Kronenberg, P. Tryjanowski (2014). The economic value of a white stork nesting colony: a case of 'stork village' in Poland. *Tourism Management, 40,* 352-360.

Englin, J, J. Shonkwiler (1995). Estimating social welfare using count data models: an application to long-run recreation demand under conditions of endogenous stratification and truncation, *Review of Economics and Statistics, 77,* 104-112.

Greene, W. H. (1993). *Econometric Analysis, 2nd edition*. Englewood Cliffs: Prentice Hall.

Haab, T. and McConnell, K. E. (2002). *Valuing Environmental and Natural Resources: the econometrics of non-market valuation*, Cheltenham: Edward Elgar.

Hanley, N., C. L Spash, (1995). *Cost-Benefit Analysis and the Environment.* Edward Elgar Publishing, Cheltenham.

Hein, L. (2011). Economic benefits generated by protected areas: the case of the Hoge Veluwe Forest, the Netherlands. *Ecology and Society 16(2)*, p. 13. [online] URL: <http://www.ecologyandsociety.org/vol16/iss2/art13>, accessed on 1/10/2015.

Hilbe, J. and R. Martinez-Espineira (2005). *NBSTRAT: Stata module to estimate Negative Binomial with Endogenous Stratification*. Statistical Software Components S456414, Boston College Department of Economics.

Hynes, S., N. Hanley, C. O'Donoghue (2004). Measuring the opportunity cost of time in recreation demand modelling: An application to a random utility model of whitewater kayaking in Ireland. Working Paper No. 0087, Economics, National University of Galway.

Kaprová, K. (2015). Definition of the recreation shadow price and its implications on recreation welfare estimation. *Journal of Landscape Management, 1,* p. 7-16.

Khazaal, Y., M. van Singer, A. Chatton, S. Achab, D. Zullino, S. Rothen, R. Khan, J. Bilieux, G. Thorens (2014). Does self-selection affect samples´ representativeness in online surveys? An investigation in online video game research. *Journal of Medical Internet Research 16(7)*, e164. doi: 10.2196/jmir.2759

Liston-Heyes, C. (1999). Stated vs. computed travel data: a note for TCM practitioners. *Tourism Management, 20,* 149-152.

Melichar, J. (2007). *Aplikace metody cestovních nákladů v oblasti Jizerských hor.* Dissertation thesis. Prague: University of Economics, 150 p.

Melichar, J. (2014). Measuring recreation benefits of forest quality change with contingent behavior model. *Journal of Landscape Management, 2,* p. 10-15.

Mitrica, E., B. Mitrica, A. Stanculescu (2013). Economic analysis of nature preservation investments: the zonal travel cost approach applied for Harghita County of Romania. *Journal of Environmental and Ecological Statistics, 21(1),* p. 83-93.

Parsons, G. R. (2003). The Travel Cost Method. In Champ, P. A., Boyle, K. J., Brown, T. C. (eds.). *A Primer on Nonmarket Valuation*, London: Kluwer Academic Publishers.

Phaneuf, D. J. and V. K. Smith (2006). Recreation Demand Models. In: K. G. Mäler and J. R. Vincent, eds. *Handbook of Environmental Economics*, vol. 2, chapter 15, p. 671-761. Elsevier.

Smith, V. K., W. H. Desvousges and M. P. McGivney (1983). The Opportunity Cost of Travel Time in Recreation Demand Models. *Land Economics, 59(3)*, p. 259-277.

Ward, F. A., J.B. Loomis (1986): The travel cost model as an environmental policy assessment tool: A review of literature. *Western Journal of Agricultural Economics, 11(2)*, p. 164-178.

Ward, F., D. Beal (2001). *Valuing nature with travel cost models: A manual.* Cheltenham, United Kingdom: Edward Elgar, 255 p. ISBN 1-84064-078-2.

World Tourism Organization and European Travel Commission (2008). *Handbook on tourism forecasting methodologies.* Madrid: WTO, 101 p.

Zandersen, M., and R. S. J. Tol (2009). A Meta-analysis of Forest Recreation Values in Europe. *Journal of Forest Economics, 15*, p. 109-130.

Author´s contact address

Ing. Kateřina Kaprová

Charles University, Faculty of Humanities

U Kříže 8, 158 00 Prague 5

+420 220 199 466, katerina.kaprova@czp.cuni.

IV. Recreation demand for large natural areas in the Czech Republic

Kaprová, K., J. Melichar.
[manuscript draft for Leisure Sciences: An Interdisciplinary Journal]

Recreation demand for large natural areas in the Czech Republic

Kateřina Kaprová[1], Jan Melichar[1]

Charles University Environment Centre[1], José Martího 407/2, 162 00 Prague 6, Czech Republic

Abstract

The article aims at modelling of recreation demand for large-scale natural areas in the Czech Republic using a discrete choice model based on McFadden´s random utility framework. Our application encompasses 27 natural areas, including national parks and large protected landscape areas. The analysis is based on a cross-sectional micro data set gathered off-site from Czech population that is supplemented with data on travel cost and environmental variables describing each natural site that were calculated using GIS analysis.

The results show that Czech visitors choose rather larger natural recreation areas for their trips, and that they prefer broadleaved forests over coniferous and mixed forests. Protected areas are more probably chosen for a trip to nature than other natural sites. The average value of access to one of the 27 large natural areas is estimated at 10 CZK / 0.6 EUR 2017 per one-day trip per person from Czech population (71.3 CZK / 4 EUR 2017 for actual visitor) and 39.5 CZK / 2.2 EUR 2017 per overnight trip (98.3 CZK / 5.6 EUR 2017 for actual visitor).

Key words: environmental valuation, recreation value, travel cost method, random utility model, welfare analysis, natural area

Introduction

Natural areas provide a wide variety of essential ecosystem services to the human society. The knowledge on these services (such as provision of food, timber and other materials, sequestration of carbon, protection of groundwater reservoirs, recreational and aesthetic function, provision of habitat for species) and their levels should play an important role in the management of natural areas, as the management may affect and support the provision of these functions. For example, the management of the forests in the Czech Republic is affected by the classification of forests by the Forest Act (no. 289/1995 Coll.) into several categories according to the prevailing function of forests, including production forests, protective forests and forests with important non-wood-producing functions. The non-productive functions of natural areas are very imporant also for designation and management of protected areas, which generally provide enhanced non-production functions, but the production function (e. g. of timber) is restricted. This study focuses on recreational services, which represent an important non-production benefit provided by the natural areas.

Natural areas, including large-scale specially protected areas and other large forested areas in the Czech Republic have been very popular for recreational use. The recreation value of the natural areas in the Czech Republic is not directly known, as it represents a non-market service that is not traded on a market, unlike e. g. timber. There is very limited scientific evidence on the recreational preferences of Czech citizens for the natural areas and associated recreation values of natural areas, which accounts only for Czech natural recreation sites: the Jizerské Mountains Protected Landscape Area (Melichar, 2007 and 2014), Bohemian Paradise Geopark (Špaček and Antoušková, 2013), the Šumava National Park (Kaprová, 2015) and Eastern Ore mountains (Vojáček and Louda, 2017).

Also in Central and Eastern Europe, the evidence is limited to studies in Poland (Bartczak et al., 2008a, b; 2010; 2012), Hungary (Mitrica et al., 2013) and Romania (Dumitras and Dragoi, 2006; Dumitras et al., 2012). Consequently, also the existing works focusing on a synthesis of recreation values of open spaces in Europe (e. g. Zandersen and Tol, 2009 or Schägner et al., 2018) are based solely or mostly on research results on natural areas in Western, Northern and Southern Europe.

This study analyses the recreation demand for large natural areas in the Czech Republic using a discrete choice model based on McFadden´s random utility framework. The set of natural sites in the Czech Republic is very diverse and may represent mountainous areas, grasslands or forest areas, with different terrain, levels of urbanisation and availability of visitor infrastructure. Our application encompasses 27 natural recreational areas, including 4 national parks, 20 large protected landscape areas and 3 other large recreational mountainous forested areas in the Czech Republic.

The main interest of the analysis is to determine which environmental attributes of recreation sites (such as structure of land cover, type or structure of vegetation or forest type) drive the demand for outdoor recreation. Employing the recreation demand model, we further disentangle the implicit recreation values that visitors associate with recreation in particular natural sites.

Methodology

The methodology of recreation demand is based on the neo-classical microeconomic theory of demand. Analogically to the conventional demand theory, the demand for recreation links the quantity of recreation demanded (the visitation rate at a particular recreation site) with the price of recreation (travel costs). Travel costs are employed a shadow price of recreation. They reflect the real travel expenses (e.g. on fuel when travelling by car) and also the opportunity costs of time that the visitor need to spend on journey to the recreation site. Travel cost models are based on real behaviour of visitors, where actual choices of visitors over chosen time period are observed.

To model the recreational behavior, we use a travel cost model based on a random utility framework. Random utility models stem from McFadden´s framework (McFadden, 1974) that was rationalized by Hanemann (1984). Random utility modelling of recreation demand focuses at estimation of the probability that the visitor chooses one recreation site among other substitute areas (Freeman, 2003). The term „random utility“ refers to the fact that the indirect utility from choosing an alternative is composed of two parts: the deterministic part that is explicitly modelled, and a random part. The randomness enters into the model through the model error, which accounts for the part of the preferences that are known to the individual (recreationists), but unknown (random) to the analyst. The other part of the preferences that is known to the analyst refers to the modelled part of the expected indirect utility function. The error is assumed to have a generalized extreme value distribition (McFadden, 1978; Parsons and Massey, 2002).

Most frequent specification of random utility models within environmental valuations are multinomial logit (MNL), nested logit (NL) or mixed logit (MXL), out of which application of MNL has been the most common (for example Caulkins et al., 1986; Parsons et al., 2000). All of these models are estimated by maximum likelihood. MNL has been popular mostly for simplicity of the estimation, which is based on logit probability for choosing any given alternative in the choice set (i. e. a location to visit in travel cost RUM). It is assumed that individual chooses the alternative yielding the highest expected utility (Parsons et al., 2000).

For the first version of the manuscript presented in the thesis, we apply a nested logit model (Parsons and Massey, 2002). The design of the nesting structure represents an important step in the analysis and may have a considerable impact on welfare measures (Parsons and Massey, 2003). We design a simple 2-level nesting structure. In the first nest, the recreationist decides whether to participate in recreation (i. e. choose any of the natural sites of the choice set for recreation), or whether he/she prefers to stay at home and visits none of the areas (the latter option is status quo alternative). In the second nest, the recreationist decides which recreational area he/she prefers to visit, based on the characteristics of the natural areas.

The probability of individual n choosing any given alternative (site) j from the choice set is set as (Englisch, 2010):

$$\Pr(choice_{nj}) = \frac{e^{sV_{nj}}}{\sum_j e^{sV_{nj}}} ,$$

where the site utilities V_{nj} are defined by a set of site characteristics and travel cost x_{nj} multiplied by preference parameters β, and s represents a scale parameter from the upper-level participation nest (to stay at home and focus on alternative activities or to set on a trip to a natural area). The probabilities for the upper-level nest may be expressed separately from the site-choice probabilities, which allows for summarizing each of D choice occasions of the visitor into a single expression, so that the annual trip demand is given by (Ibid.):

$$T_n = D \frac{\left(\sum_j e^{sV_{nj}}\right)^{\left(\frac{1}{s}\right)}}{e^{V_0} + \left(\sum_j e^{sV_{nj}}\right)^{\left(\frac{1}{s}\right)}},$$

where V_0 is the utility associated with a status quo alternative („staying at home“ option) and depends on the socio-econimic and demographic variables of the respondents, and the number of choice occasions D is set accordingly to the dataset. In the analysis, we estimate the β parameters using observed data on recreation in large-scale natural areas.

Data

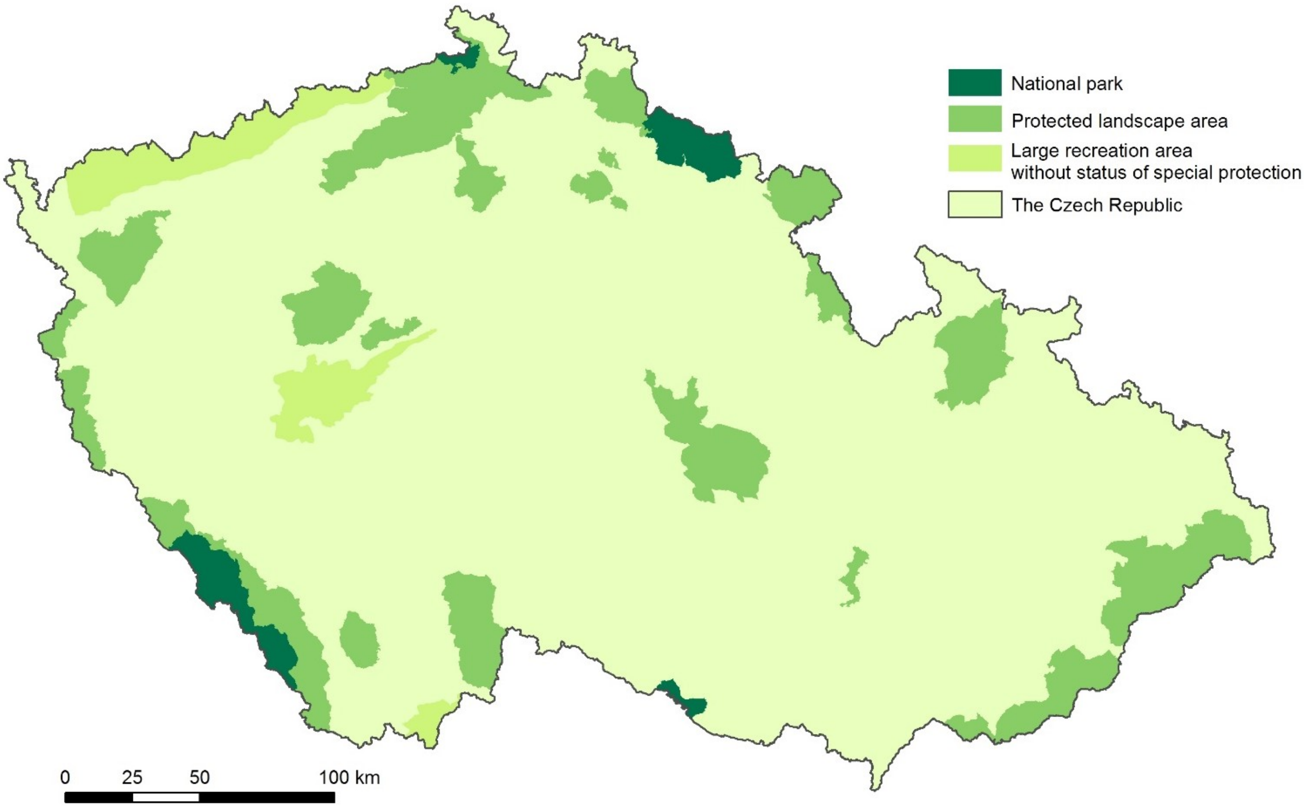
The analysis is based on a cross-sectional micro data set obtained within the scope of project funded by the Ministry of Agriculture of the Czech Republic „Monetary valuation of recreational and aesthetical function of forest in the Czech Republic“. The project was solved by the Charles University Environment Center during 2005 and 2007. The final data set consists of 857 observations gathered off-site from Czech population in year 2007, where the respective recreational season the respodents reported on was April to October 2006. Data were collected by SC&C, s. r. o. - agency that focuses on marketing and sociologic surveys. We employed stratified quota sampling on region, magnitude of the municipality, sex, age and education.

Personal interviews were based on pen-and-paper questionnaires, and the average length of the interview was of 35 minutes (minimum 10, maximum 98 minutes). The response rate was of 51%. Within the survey, information on numbers of short visits (i. e. without spending a night at the natural recreation site) made by respondents to large recreational areas during last year has been inspected. The main set of recreational areas involves 4 national parks, 20 landscape protected areas and 3 large recreational areas without status of special protection (Krušné mountains, Novohradské mountains and Brdy). Respondents stated that they visited also other recreational areas, but these were not common in the dataset (frequented by <2% of respondents for each area and trip type - one-day or overnight).

At present, there is one change concerning Brdy mountains - at the beginning of year 2016, part of the Brdy area was designated as a protected landscape area. Following recommendations by Parsons (2003) to group sites similar in characteristics including trip cost, the Šumava National Park and the Šumava Protected Landscape Area are treated as one natural recreation site in the analysis. Also the findings from the survey by Kaprová (2015a, b - see chapters II and III of the thesis) prove that most of the visitors of the Šumava National Park did not actually distinguish whether the locations of their visit were in NP part or in PLA part of Šumava, which supports the grouping of the two parts.

Figure 1 shows the location of the recreational areas involved in the choice set. Table 1 summarizes the total number of visits per year for the whole sample.

Figure 1: Recreational areas involved in the analysis



Source: ČÚZK (2014), AOPK (2014)

Table 1: Natural recreational areas involved in the analysis and numbers of trips to the areas in the sample

Natural area	No. of visits in sample		No. of actual visitors in sample	
	1-day	**Overnight**	**1-day**	**Overnight**
Beskydy	*250*	*57*	82	37
Bílé Karpaty	*63*	*7*	23	7
Blanský les	*18*	*2*	3	2
Brdy	*155*	*21*	48	8
Broumovsko	*11*	*7*	8	7
České středohoří	*77*	*19*	20	9
České Švýcarsko	*84*	*13*	32	13
Český kras	*55*	*12*	27	5
Český les	*11*	*7*	4	7
Český ráj	*241*	*52*	59	27
Jeseníky	*160*	*50*	65	40
Jizerské hory	*59*	*33*	28	22
Kokořínsko	*53*	*10*	39	8
Krkonoše	*170*	*80*	59	43
Krušné hory	*63*	*17*	20	11
Křivoklátsko	*66*	*21*	39	8
Labské pískovce	*51*	*11*	22	7
Lužické hory	*28*	*7*	12	5
Moravský kras	*72*	*16*	45	15
Novohradské hory	*3*	*9*	3	9
Orlické hory	*91*	*21*	34	14
Podyjí	*65*	*21*	31	20
Slavkovský les	*53*	*5*	10	3
Šumava	*76*	*81*	40	69
Třeboňsko	*35*	*38*	21	30
Žďárské vrchy	*134*	*62*	35	17
Železné hory	*91*	*9*	15	7
Average per 1 area	*82.8*	*25.0*	*30.5*	*16.7*
Sum per all areas	**2 235**	**688**	**440**[1]	**314**[1]

[1] *Total no. of visitors with at least 1 trip to any of the areas*

For one-day visits, the most popular large-scale natural areas are Beskydy PLA in Moravia, Český ráj PLA and Brdy near Prague, and Krkonoše NP in the northeast of the country. Also Jeseníky PLA and Žďárské vrchy PLA are very popular. Overnight visitors often choose mountainous natural areas located by the Czech borders for their trips - the most trips in the sample have been made to Krkonoše NP and Šumava NP. On the other hand, some areas were not much frequented by the visitors - Novohradské mountains, Broumovsko PLA and Český les PLA fall within this category.

The sample of 857 respondents made on average 25 overnight trips per year to a natural recreational area. Per year, a respondent made on average 0.8 overnight trips in total, which accounted for 0.03 overnight trips to one recreational area out of the choice set. As expected, the one-day trips were more frequent among the sample: the whole sample made on average 83 one-day trips to a recreational area. Per year, a respondent made on average 2.6 one-day trips to the large recreational areas in the choice set in total, which accounted for 0.1 trip per person to a specific recreational area.

These numbers document well some of the drawbacks of off-site collected recreation data over on-site recreation surveys (as Kaprová, 2015b)[12]: as they include both users and non-users (the latter may also be regarded as potential users) of the recreational areas, typically only a small portion of the total sample had an experience with recreation in a natural area from the choice set. The number of observations for the second nest of the model, where the respondent chooses over different natural areas the one to visit, given the characteristics of the sites and the travel costs, is therefore not large. On the other hand, in the single-site travel cost models that are based on on-site surveys, only the actual users are sampled, but we completely lose the information on the potential users.

The data have been supplemented with natural characteristics describing the particular recreational areas, employing geographic data analysis on CORINE Land Cover categories for year 2006 by the European Environment Agency (ETC/LC, 2006). We have planned to employ recreational equipment data such as availability of walking, cycling and marked tourist paths, and abundance of other recreation equipment (benches, tourist shelters and playgrounds, information signboards etc.). For forested areas, The Forest Management Institute offers data on forest paths (including transport paths for timber), that up to some extent coincide with tourist paths but do not cover all of them. Other data on tourist paths and recreational equipment are available typically only for national parks, which keep these data suitably in a digital GIS form. Private tourist data providers (for example mapy.cz, seznam.cz or Czech Tourist Club) do not provide data in analysable digital form for similar purposes in such extent. Data by a voluntary open data platform Openstreetmaps, exhibit missing data on tourist paths compared to data sources mentioned above, and problems with attribute description of paths further hinder the trail availability analysis needed. Not disposing with a comparable data source for all areas, we do not include the data on recreational infrastructure in the recreation demand analysis.

The Forest Management Institute also disposes of data on detailed structure of the forests in the Czech Republic, such as tree species composition, age, health state and other characteristics. However, there is not any comparably detailed source of data that would describe the other types of land cover (pastures, wetlands or water bodies and streams), so we stick to the basic categories of forest cover, distinguishing the prevailing the forest type.

---

[12] The random utility models may also be based on on-site collected data, which increase the proportion of actual users of recreation sites in the sample. On-site collection represents a choice-based sampling, because the sample is dependent on the choice that the people have made, and has to be corrected in the estimation process so that it does not cause inconsistencies in parameter estimates (the procedure is shown in Parsons and Massey, 2002).

Data on the travel cost have been collected using an objective measure of distance and time, using a simplified Euclidean approach (see Kaprová, 2015a). Distance and time costs were combined into an overall monetary travel cost (two-ways), which was then included as one determinant of site choice in the econometric model. Travel costs are individual-specific and site-specific. Through the observed travel costs, it is possible to derive the willingness to pay for visit and visitor´s utility from recreation in the natural site. Since trip costs are included as one of the characteristics of the trip, the model implicitly captures trade-offs between money and levels of natural characteristics (Parsons and Massey, 2002).

The previous research has shown that the factors that affect the recreation demand may differ among types of visit or among recreational uses (Parsons, 2003). Usually, the demand curves represent either one-day trips or overnight visits to the natural area, which may originate in a different „market" of visitors - most one-day visitors generate frequently from the surroundings of the natural site, while overnight visitors encompass broader geographical areas. One-day visits have been more frequently analysed as they are much less biased by potential multipurpose trips than overnight visits (Ibid.). In this study, we estimate two models separately for the type of visit (1-day trip or overnight visits), and we omit the multipurpose trips from the sample. As the vast majority of the sample stated that the main purpose of their visits were general recreational activities such as hiking or mountain biking, we also distinguish between the probability of visit of these two groups of users in each model.

Table 2 lists the variables used within modelling, including the descriptive statistics. The variables are listed as they appear in the models and their nests. The variables describing the natural state of the recreational area explain the choice of the trip to the respective area in the lower nest of the model(1 out of 27 areas); and the descriptive statistics stated below in Table 2 are calculated over the 27 areas. These are of interest in the analysis, as they enable to predict which characteristics of the natural sites the visitors in the Czech Republic prefer. The variables explaining the upper nest - i. e. whether the respondent travels to one of the sites or does not visit any site and focus on other activities (with this status quo option, a no-trip utility is associated) - are explained with the socio-economic conditions of the respondent and are calculated accross respondents and the characteristics of their last trip. Two variables that explain the characteristics of the last one-day or overnight trip made by the respondent are specific to the type of trip: the duration of the last one-day trip is measured in hours, whileas the one of overnight trip in days.

Table 2: Definition of variables and descriptive statistics

Variables	Explanation	Mean	Median	St.dev.	Min	Max
One-day trips	No. of one-day trips per year	2.6	1	5.7	0	102
Overnight trips	No. of overnight trips per year	0.8	0	2.0	0	25
Trip utility (both models)						
TC	Travel cost (in hundreds CZK 2007)	4.5	3.9	2.8	0	33.0
TC_subst	Travel cost to a substitute site (in hundreds CZK 2007)	0.9	0.8	0.5	0	6.6
Artif_%	% of artificial surfaces	2.8	2.5	2.0	0	9.4
Pasture_%	% of pastures	11.1	8.2	7.1	0.3	25.6
Forest_br	Prevailing forest type is broadleaved (binary)	0.1	0	0.3	0	1
Forest_con	Prevailing forest type is coniferous (binary)	0.7	1	0.5	0	1
Forest_snat_%	% of forests and seminatural areas	63.0	62.4	14.2	38.2	89.1
Wat_body	Water body present (binary)	0.6	1	0.5	0	1
Ln_area	Natural logarithm of area (ha)	10.5	10.7	0.8	9.0	12.0
NP	The natural area is a national park (binary)	0.15	0	0.4	0	1
PLA	The natural area is a protected landscape area (binary)	0.74	1	0.4	0	1
Individual specific variables - socio-economic (both models)						
University	Respondent has an university degree	0.1	0	0.3	0	1
Fulltime	Respondent works fulltime	0.5	1	0.5	0	1
Family_no	No. of family members	2.6	3	1.2	1	6
Family_1	1 family member (binary)	0.2	0	0.4	0	1
Age	Age (years)	43.9	45	14.8	18	80
Income	Income of the respondent (in thousands CZK 2007)	11.9	11.5	6.2	2	40
Individual specific variables on the last trip (short trip model)						
Hours	How many hours the last trip took	5.3	6	5.0	0	18
Hiking	Most important activity at the last one-day trip was hiking (binary)	0.2	0	0.4	0	1
Individual specific variables on the last trip (overnight trip model)						
Days_avg	Average no. of days spent at overnight trips by the respondent	3.4	0	6.5	0	70
Hiking	Most important activity at the last overnight trip was hiking (binary)	0.1	0	0.2	0	1

Out of the total sample of 857 respondents, 440 (51%) have visited at least one site during a 1-day trip, and 314 (36%) have visited at least one site overnight in the period of interest. For a person in the sample, the average no. of 1-day trips per year to any natural area was 2.6; and the average no. of overnight trips per year was 0.8 (both including non-visitors in the sample), ranging to 102 1-day visits and 25 overnight visits for the most frequent visitor for any natural area. For a visiting person, the average no. of trips to the natural recreation sites was 5.1 for 1-day trips and 2.2 for overnight trips. An average overnight trip lasted 4.2 days.

The shadow price of the actual visits with an average of 450 CZK (both ways) is significantly higher than the average travel cost of respondents to the nearest substitute site (90 CZK). This would support the hypothesis that the nearest large-scale natural recreational area need not represent the most preferred one for the recreational use and the visitors to natural areas are willing to travel longer and pay more for the recreation in the area which they found more suitable for recreation in terms of its characteristics.

As Parsons (2003) points out, the real substitution patterns between sites may be complicated if we consider a decreasing marginal utility of visitation. In recreational context that could mean that after one realized visit to the area (where this particular area was the one bringing the highest level of expected utility of all opportunities), on another occasion of choosing an area for recreation, the recreationists would prefer this particular area significantly less than the others than in the previous occasion, even if the characteristics of the recreational areas and the levels of travel costs did not change. The model applied does not allow for modelling of such tastes for variety of recreational experiences.

Modelling results

The nested logit model employs socio-demographic characteristics of the respondent for modelling the choice in the first nest of the model, where the respondent decides whether to participate in recreation in large-scale natural areas at all or whether to stay at home. The second nest of the modelled decisionmaking process of the visitor (which of the large-scale natural recreation sites to choose for visit) is explained by environmental and recreational characteristics of the natural sites.

The analysis is done using GAUSS software, version 9.0, using a full information maximum likelihood approach which jointly estimates all parameters of the likelihood function. For the analysis, we work with a software code designed by Massey (2002) which was also employed in Parsons and Massey (2002). The underlying model in the second nest is a multinomial logit[13].

Table 3 and 4 show the results of the modelling, using a set of 857 observations, for both types of trips: one-day and overnight.

[13] The correct statistical term is actually conditional logit (McFadden, 1974), because the choice of sites is explained by the attributes of the alternatives (recreation sites); not by the characteristics of the individual recreationists. Individual characteristics of respondents could only influence the choices of recreation sites (in the second nest) if interacted with the site-specific characteristics. A bit confusingly, the environmental valuation literature (e. g. Parsons and Massey, 2003) usually employs the term „multinomial“.

Table 3: Nested RUM results - 1-day visits

Variable	Parameter[1]	Std. err.	Est./s.e.	Prob.
Short-trip utility				
TC	-1.108***	0.021	-51.678	0.000
Artif_%	-0.064***	0.023	-2.748	0.006
Pasture_%	-0.0001	0.004	-0.018	0.985
Forest_br	0.488***	0.159	3.067	0.002
Forest_con	0.656***	0.065	10.048	0.000
Forest_snat_%	0.016***	0.003	6.185	0.000
Wat_body	0.432***	0.061	7.109	0.000
Ln_area	0.113***	0.043	2.620	0.009
NP	0.955***	0.078	12.301	0.000
PLA	0.228***	0.063	3.621	0.000
Individual specific variables				
Constant	9.686***	0.417	23.222	0.000
TC_subst	0.385***	0.039	9.944	0.000
University	-0.609***	0.060	-10.130	0.000
Fulltime	-0.119***	0.046	-2.613	0.009
Family_no	0.103***	0.025	4.088	0.000
Family_1	-0.509***	0.078	-6.526	0.000
Age	0.005***	0.001	3.390	0.001
Income	-0.041***	0.003	-11.894	0.000
Hours	-0.134***	0.005	-28.582	0.000
Hiking	-0.356***	0.045	-7.885	0.000
Mean log-likelihood	-19.15			
No. of cases	857			

[1] *We report significance as follows: *** p<0.01, ** p<0.05, * p<0.1..*

Table 4: Nested RUM results - overnight visits

Variable	Parameter[1]	Std. err.	Est./s.e.	Prob.
Short-trip utility				
TC	-0.353***	0.023	-15.661	0.000
Artif_%	-0.020	0.044	-0.458	0.647
Pasture_%	-0.038***	0.009	-4.135	0.000
Forest_br	0.950***	0.320	2.966	0.003
Forest_con	0.952***	0.138	6.908	0.000
Forest_snat_%	-0.0004	0.005	-0.089	0.929
Wat_body	0.144	0.105	1.375	0.169
Ln_area	0.476***	0.084	5.657	0.000
NP	1.439***	0.119	12.137	0.000
PLA	0.350***	0.108	3.245	0.001
Individual specific variables				
Constant	13.858***	0.782	17.716	0.000
TC_subst	0.388***	0.070	5.560	0.000
University	-0.384***	0.114	-3.357	0.001
Fulltime	0.263***	0.081	3.226	0.001
Family_no	-0.218***	0.041	-5.367	0.000
Family_1	-0.777***	0.140	-5.532	0.000
Age	0.005*	0.003	1.821	0.069
Income	-0.028***	0.006	-5.032	0.000
Days_avg	-	-	-	-
Hiking	-1.221***	0.082	-14.983	0.000
Mean log-likelihood	-6.41			
No. of cases	857			

[1] *We report significance as follows: *** p<0.01, ** p<0.05, * p<0.1..*

For both models, most of the variables in each nest of the random utility model are successful in explaining the choice of the respondents. As expected, the travel cost is in both cases negatively related to the probability of visiting the particular site. The coefficient is significant even at 1% significance level. Most of the variables describing the natural sites that are used to model the trip utility are also highly significant determinants of the choice.

The preference for a short one-day visit to the area grows with increasing proportion of natural areas in the recreation site, such as forests and seminatural areas, and are indifferent about the presence of pastures in the natural area that they choose for their visit. For overnight trips that last on average 3.4 days (see Table 2), the visitors prefer forests over natural sites with the presence of pastures and other types of semi-natural areas.

Both types of visitors in the Czech Republic have a significant preference for natural areas where the dominant forest is coniferous or broadleaved (over the omitted category of mixed forest). For one-day visitors, there is a slightly stronger preference for forests dominated by coniferous trees (more than by 30% higher than for broadleaved forest sites). The present dataset does not allow for further precision of the forest characteristics using e.g. age categories, but it is known from the results of other Czech studies that the age of forest stand, as well as the forest management that would enhance diversity in the vertical distribution of tree canopies, affects the preference in context of recreation. Braun Kohlová and Melichar (2017) prove that in the areas reclaimed after the brown coal mining in the Sokolov mining area, the preferences for the mature spruce forest stand and mature broadleaved natural succession are the highest among the types of forest stands that are typically grown during the reclamation process; these two stands are not significantly different in the stated preference from each other. Melichar et al. (2018) show that in Podkomorské forests near Brno, the recreationists favour broadleaved forests which combine diverse age categories in one forest stand and have medium permeability of the view, with presence of undergrowth; the second most preferred forest stand were young managed broadleaved forests with high permeability of the view and no undergrowth. The lowest preference of visitors found was for clear-cuts.

Both types of visitors, one-day and overnight, choose rather larger natural areas for their trips. This results is in accordance with Kaprová and Melichar (2014) synthesis of the European recreation values of forests, which show that the recreation values grow with increasing area of the natural recreation sites. It is evident that the preferences of Czech population depend a lot on the duration of trips that are represented in the sample, where the larger area of the recreation site plays much larger role for overnight trips (Table 4). For one-day trips, the area is also important, but the coefficient is cca 4 times lower than for overnight trips (Table 3).

National parks are generally more probably chosen for a trip than protected landscape areas, and the unprotected sites have the lowest probability of visitation. This holds both for one-day and overnight visitors, but the importance of the protection status is higher for overnight trips (Tables 3 and 4).

The presence of a water body in the natural area enhances the probability of a visit to this area only for one-day visitors. The probability of visit due to the water bodies may relate to any recreational use of water bodies in natural areas, as the recreational uses of water bodies are not distinguished in more detail for the analysis for each trip - and may range from enhanced aesthetical experience during hiking or cycling to swimming, fishing and other activities in and around the ponds and lakes (provided that they are not restricted due to protection).

The effects of presence and levels of recreational equipment on the recreation demand for Czech large recreational areas was not tested due to lack of comparable data for all sites. The European evidence however suggests that it plays a significant role for the prediction of levels of visitation - Schägner et al. (2016) shows that the both the length of trails and length of small roads that enhance the accessibility of the area is positively related to the average visitation per hectare in European national parks.

The percentage of artificial areas in the recreational area affects negatively the choice of the natural recreational area for one-day trips, but has no effect for overnight trips. This result may also be intuitive. For overnight visitors, the presence of artificial areas plays two competing roles: it may be correlated with the availability of the accommodation, which is necessary for to stay in the area overnight (for most visitors); on the other hand, it decreases the size of natural areas available for the recreation. For one-day visitors, the second motive evidently prevails, whereas the availability of accommodation and other services present in villages and other urban areas in the natural area is not important.

The individual specific variables explaining the decision of visitors to participate in a trip to nature and not to stay at home (the upper nest of the model) are almost all significantly related to the probability of choice in both models (Tables 3 and 4). Respondents that live alone or have a university degree or are hikers are more likely to stay at home than to go on a one-day or overnight trip to large recreational areas than the rest of the sample. For larger families, the probability of taking a trip with a one-day duration, is higher than staying at home compared to families with lower number of family members (Table 3); on the other hand, larger families will more probably than smaller families stay at home than go on an overnight trip to a large-scale natural recreational area (Table 4). Respondents that work fulltime less probably choose a one-day trip than the status quo,but more probably choose an overnight trip compared to the respondents with other job status.

The probability of going out on a trip grows with age and decreases with income of the respondents (suggesting that recreation in domestic large-scale natural areas is an inferior good and with growing income tends to be replaced with other activities, or perhaps with visits to abroad, with growing income). Visitors that spend longer time within a one-day trip at the site take generally less trips per year (as the probability of the respondent taking a trip decreases).

Recreation value estimates

The recreation welfare estimates of the random utility model represent the value of access to the site. The recreation value represent the average willingness to pay of person from the population to avoid the loss of the respective site. These values are associated with one person from the whole affected population, including potential users (i. e. people that do not visit the particular area). The value of access is calculated as the loss of the expected maximum utility in case the particular natural site disappears from the choice set (i. e. closes for recreation - Parsons and Massey, 2002):

$$W_{close} = \{E_{close} - E_{base}\}/\beta_{tc}$$

where W_{close} is the per-trip welfare loss of an individual due to the closure of the site, E_{base} is the expected maximum utility an individual can attain when choosing among all alternatives (visit to a particular natural site and staying at home) and E_{close} is the expected maximum utility an individual can attain when choosing among all alternatives except the particular site (Ibid.). β_{tc} is the travel cost parameter from the recreation demand model (Table 3, resp. Table 4). Since trip costs are included as one of the characteristics of the trip, the model implicitly captures trade-offs between money and levels of natural characteristics (Parsons and Massey, 2002). The negative of β_{tc} measures the individual´s marginal utility of income, and is used to convert the expected utility difference into monetary terms.

The estimates of recreational use values associated with one-day and overnight trips to the particular areas in our choice set are summarized in Table 5. The measures of WTP per person per trip for avoidance of loss of access to the particular sites in Table 5 were estimated directly from the models. The respondents have been quota-sampled to match the composition of Czech adult population, and the values therefore reflect those of the general adult population of the Czech Republic (including users and non-users). The range of values among sites is intuitive in the sense that for sites with low probability of visitation, the WTP to avoid the loss of the site is low, and vice versa.

Using the sample characteristics on average duration of visits in the sample and no. of visits per season to the particular sites, we recalculate these values into values per the whole season and per 1 day of visit (Table 5). We may observe that the CS per season for overnight trips in is actually lower than the value per trip for all areas, because the average respondent makes less than 1 overnight trip per year (on average, 0.8 - see Table 5).

While the values reported by RUM travel cost studies usually report the recreation values associated with a person from the whole population, including non-users, we calculate also the average recreation values associated per visit, season and visit-day (the last only for overnight trips) for the subsample of visitors that actually visited the respective large-scale natural recreational area (Table 6). These values are comparable to the estimates from the single-site studies (see further the Discussion section).

*Table 5: Average recreation values associated per person per visit, per person per season and per person per visit-day for an average person from Czech population (including potential visitors) in CZK 2017**

Natural area	Overnight trips			1-day trips	
	CS/visit	CS/season	CS/day	CS/visit	CS/season
Beskydy	79.9	64.1	18.9	24.8	64.6
Bílé Karpaty	12.3	9.9	2.9	5.5	14.3
Blanský les	21.3	17.1	5.0	3.9	10.1
Brdy	65.0	52.2	15.4	26.6	69.5
Broumovsko	20.3	16.3	4.8	3.0	7.9
České středohoří	20.2	16.2	4.8	6.6	17.3
České Švýcarsko	21.6	17.3	5.1	11.3	29.5
Český kras	33.2	26.6	7.8	8.8	22.8
Český les	23.7	19.0	5.6	5.7	14.9
Český ráj	38.1	30.6	9.0	13.7	35.7
Jeseníky	49.1	39.4	11.6	10.0	26.0
Jizerské hory	41.4	33.2	9.8	12.3	32.0
Kokořínsko	20.7	16.6	4.9	7.3	19.0
Krkonoše	94.6	75.9	22.3	16.4	42.7
Krušné hory	34.0	27.3	8.0	8.4	21.9
Křivoklátsko	34.0	27.3	8.0	13.4	34.8
Labské pískovce	29.1	23.4	6.9	10.0	26.0
Lužické hory	20.2	16.2	4.8	6.5	16.9
Moravský kras	26.6	21.4	6.3	11.3	29.6
Novohradské hory	17.3	13.9	4.1	2.1	5.4
Orlické hory	18.8	15.1	4.4	9.0	23.5
Podyjí	16.6	13.3	3.9	4.6	11.9
Slavkovský les	22.3	17.9	5.3	8.6	22.5
Šumava	154.0	123.6	36.4	14.7	38.3
Třeboňsko	47.1	37.8	11.1	7.9	20.6
Žďárské vrchy	53.2	42.7	12.6	16.3	42.4
Železné hory	51.5	41.3	12.2	17.4	5.4
Average per site	***39.5***	***31.7***	***9.3***	***10.0***	***26.1***
No. of visits/year			0.8		2.6
No. of days/visit			3.4		1

** Transferred from CZK 2007 using EU HICP deflator.*

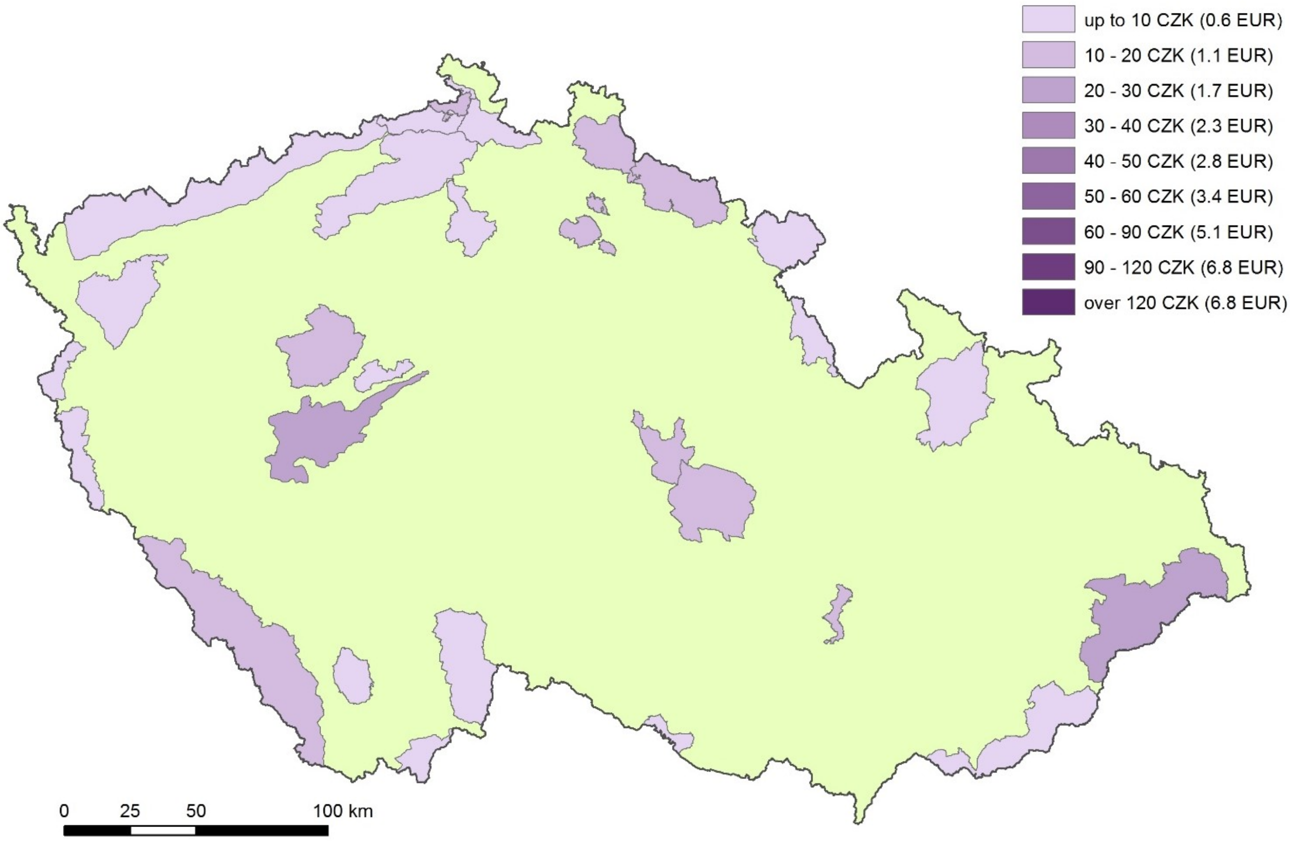
Table 6: Average recreation values associated per person per visit, per person per season and per person per visit-day for actual visitors of the particular areas (in CZK 2017)*

Natural area	Overnight trips			1-day trips	
	CS/visit	CS/season	CS/day	CS/visit	CS/season
Beskydy	337.1	738.7	79.6	160.7	816.1
Bílé Karpaty	67.3	147.4	15.9	53.4	271.5
Blanský les	27.5	60.2	6.5	8.1	40.9
Brdy	181.7	398.1	42.9	143.6	729.6
Broumovsko	46.4	101.7	11.0	28.9	146.8
České středohoří	23.3	51.1	5.5	7.6	38.5
České Švýcarsko	24.6	54.0	5.8	67.6	343.5
Český kras	54.0	118.4	12.8	40.2	204.1
Český les	128.8	282.1	30.4	126.4	642.0
Český ráj	89.7	196.6	21.2	65.6	333.3
Jeseníky	132.5	290.4	31.3	58.8	298.7
Jizerské hory	108.7	238.2	25.7	63.4	322.0
Kokořínsko	55.6	121.9	13.1	30.4	154.4
Krkonoše	96.7	211.8	22.8	56.1	284.8
Krušné hory	195.6	428.7	46.2	74.0	376.1
Křivoklátsko	88.4	193.6	20.9	59.1	300.0
Labské pískovce	68.2	149.5	16.1	113.5	576.5
Lužické hory	49.2	107.7	11.6	73.4	373.0
Moravský kras	63.6	139.3	15.0	73.6	373.6
Novohradské hory	25.8	56.6	6.1	2.6	13.5
Orlické hory	65.3	143.0	15.4	76.0	385.8
Podyjí	51.2	112.3	12.1	23.8	120.8
Slavkovský les	156.4	342.6	36.9	175.6	892.0
Šumava	145.7	319.3	34.4	45.2	229.4
Třeboňsko	158.9	348.2	37.5	100.5	510.7
Žďárské vrchy	117.4	257.3	27.7	92.3	468.7
Železné hory	93.6	205.0	22.1	104.9	532.9
Average per site	***98.3***	***215.3***	***23.2***	***71.3***	***362.2***
No. of visits/year			2.2		5.1
No. of days/visit			9.3		1

* *Transferred from CZK 2007 using EU HICP deflator.*

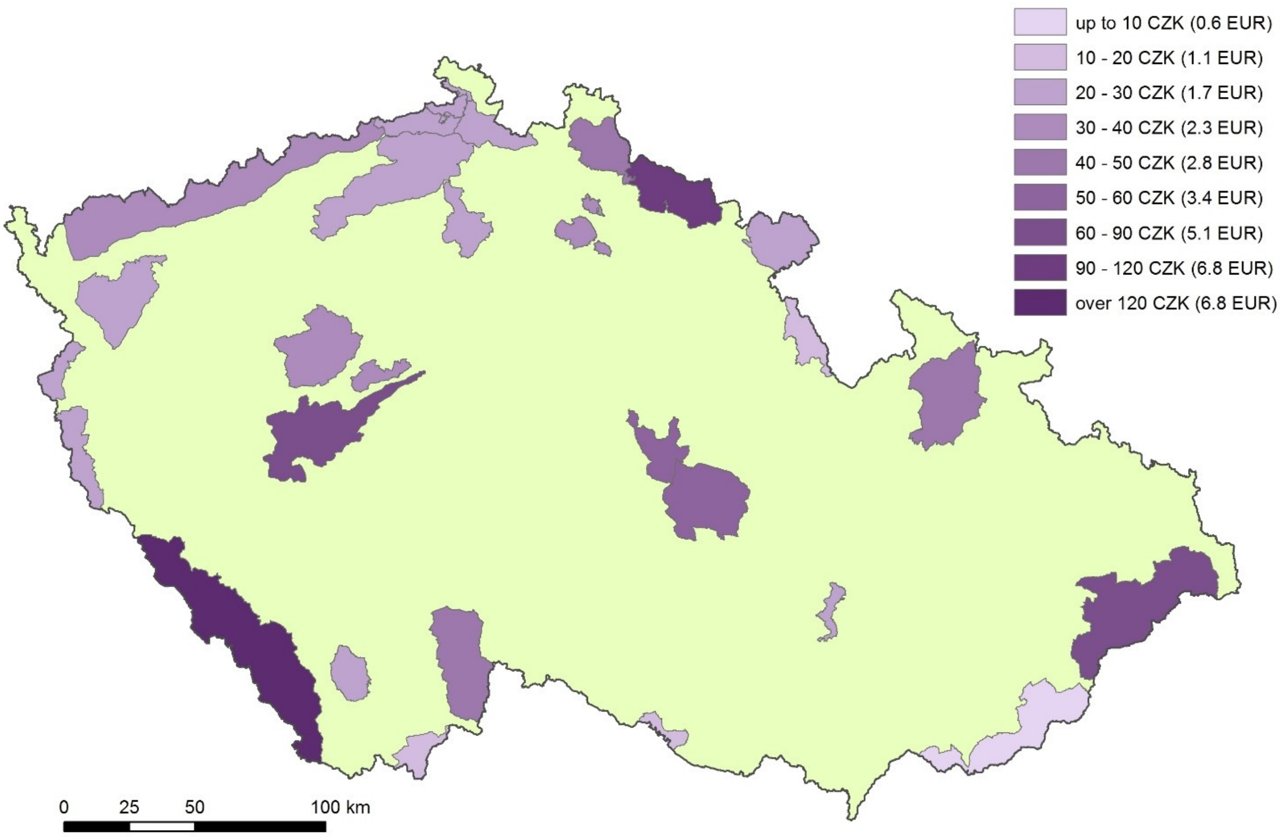
The figures 2 and 3 depict the geographical distribution of the recreation sites together with their per trip recreation values associated with an average person from the Czech population described above (Table 5). The values are depicted both in CZK and EUR, where the employed PPP exchange rate by EUROSTAT and year 2017 is of 0.056652 EUR/CZK.

Figure 2: CS per person per trip - one-day visits



Source: own analysis (values based on Table 5), ČÚZK (2014), AOPK (2014)

Figure 3: CS per person per trip - overnight visits



Source: own analysis (values based on Table 5), ČÚZK (2014), AOPK (2014)

Discussion

The analysis presented above is based on an off-site collected data representing the Czech population and its preferences for recreation in large-scale natural recreational areas.

The analysis was based on a simple nested logistic regression which relies on independence of irrelevant alternatives assumption in the second nest of the model. We do not account for preference heterogenity among the respondents in the model. We suppose that in the case of using a more sophisticated model - a mixed logistic regression (also called a random parameter logit), the structure of substitution among areas would be better accounted for and because of that, these models might yield lower recreation values than the presented model (as seen for example in Parsons, 2003).

The use of random utility framework in context of recreation demand modelling has its specifics compared to the use of these models in choice modelling of stated preferences. The recreationists do not face a single choice occasion at the time - on the contrary, he/she encounters many choice occasions over the modelled season. We would expect that visits to a single site are associated with declining marginal utility, which would force the recreationists to visit a variety of the sites during the season. A more general model would be more appropriate to account for this substitution pattern over sites (Parsons and Massey, 2002). In this analysis, following Parsons and Massey (2002), we treat each trip of the respondent as independent across the choice obsevations of the respondent. The probable impact on the modelling is higher efficiency, because the estimator does not account for the correlation between yearly recreation site choices of the same individual (which is realistic to exist).

However, there are several characteristics of the random utility framework that make RUM superior to the single-site models (Kaprová, 2015b; Melichar, 2007). The single-site model typically accounts only for the nearest substitution site available, the travel cost to which may enter the recreation demand equation as a determinant. On the contrary, the random utility model allows to introduce a wide range of available substitutes of the particular natural recreation sites and to model the substitution pattern among the set of sites. That has important impacts on the magnitude of the estimated recreation welfare, which is defined as the WTP for access to the respective site; if one of the sites is not accessible, there are still 26 alternative large recreational areas, several of which may be good substitutes.

As far as we know, none of the previous meta-analytic works focusing on travel recreation demand succeeded in collecting enough data on RUM estimates that would allow to compare the estimates of individual TCM and RUM statistically, in a meta-regression model. Zandersen and Tol (2009) and Shrestha and Loomis (2003) compare only individual TCM with zonal travel cost model studies, and Kaprová and Melichar (2018 - see chapter V of this thesis), dispose only with 3 RUM studies in the sample (Font, 2000; Termansen et al., 2008; Bestard and Font, 2010), which account only for 27 out of 288 recreation value estimates in the full sample - thus the RUM variable drops out of their model due to collinearity. Other more general meta-analyses (e. g. Schägner et al., 2018; Chiabai et al., 2011; or Ojea et al., 2009, 2010, 2011) due to incorporation of more environmental valuation techniques (as CVM or CE) do not allow at all for modelling of the methodological effects in such detail.

Another distinction between the two discussed travel cost modelling approaches (RUM and single-site model) that is essential for the employment of the modelling results concerns the presence of environmental characteristics of the site in the model as explanatory variables. In a traditional cross-section single site models of recreation demand, the environmental characteristics of the area in question are fixed for all recreationists that visit the natural area at the same time, and therefore cannot enter the model. Including multiple diverse sites into a choice set in the random utility model allows to explicitly model the effects of the environmental characteristics of the sites on the visitors´ demand for recreation. That also enables to model the effect of the change in environmental characteristics on the visitation level (including the potential visitors) and on the recreation welfare. These two tasks are not available in pure single-site travel cost analyses, and become feasible only if the single-site travel cost data are supplemented with stated preference into a contingent behaviour study (for example Melichar, 2007).

The magnitude of estimated recreation values for the natural areas in this study using the random utility framework may be directly compared to the recreation values estimated in primary single site models in the Czech Republic. Kaprová (2015b) estimated the recreation value for Šumava National Park at 417 CZK (23.6 EUR) 2017 [14], with seasonal value per visitor of 807 CZK (45.7 EUR) 2017. All the trips in the sample are overnight. The corresponding RUM estimate of value is 146 CZK (8.3 EUR) 2017 per trip, 319 CZK (18.1 EUR) 2017 per season (Table 6).

Melichar (2007) estimates the value of recreation in Jizerské mountains at 1 277 to 3 960 CZK 2017 (72.3 to 224.3 EUR 2017) per trip based on the model employed (2 517 CZK / 142.6 EUR 2017 on average). Most of the sample are one-day trips. The RUM model yields much lower values of 63 CZK (3.6 EUR) 2017 per one-day visit, and 109 CZK (6.2) 2017 per overnight trip to this natural area (Table 6).

Špaček and Antoušková (2013) estimate the value of Bohemian Paradise Geopark at 530 CZK 2017 per visit (20.1 EUR 2017) using a linear model. 33% of the sample accounted for one-day visits, the rest for overnight trips. The corresponding RUM estimate for overnight trips is 90 CZK (3.6 EUR) 2017.

The choice experiment study on Eastern Ore mountains by Vojáček and Louda (2017) values marginal changes in attributes of the landscape and does not provide recreation values per trip. Corresponding RUM value estimate for an overnight visit to Ore mountains by our study (Krušné hory in Table 6) is 196 CZK (7.8 EUR) 2017. The study by Vojáček and Louda (2017) however presents insights into recreational preferences of visitors over the landscape of Eastern Ore mountains. Based on their results, visitors prefer flowering meadows over meadows with farm animals (which decrease the value of a weekend long recreation trip by 383 CZK 2017 / 14.6 EUR 2017 compared to flowering meadows); the lowest preference was stated for overgrown meadows (-579 CZK 2017 / 22 EUR 2017, compared to flowering meadows). Also, presence of natural streams over artificial streams was preferred by visitors, enhancing the value of a weekend long recreational experience by 629 CZK 2017 (23.9 EUR 2017).

Conclusion

The article presents and discusses the results of a random utility recreation demand model for large natural areas in the Czech Republic. The application is based on cross-sectional microeconomic data set gathered off-site from Czech population and information on past visits of respondents to 27 large natural recreation areas. We model one-day and overnight trips separately. Most of the variables in both nests of the random utility model (participation in a trip

[14] All values stated in this chapter are recalculated from the original price level (e. g. Kaprová, 2015b: CZK 2014; Melichar, 2007: CZK 2007; Špaček and Antoušková, 2012: CZK 2012; Vojáček and Louda, 2017: 2013) to CZK 2017 and EUR 2017 using EU HICP deflator and PPP exchange rate by EUROSTAT.

to a recreational area, and participation in the status quo alternative - visiting none of the areas) are successful in explaining the choice of the respondents.

Both models (one-day and overnight trips) reveal a similar structure of preferences of the recreationists. Both types of visitors choose rather larger recreation areas for their trips, and prefer broadleaved forests at the natural recreation site over coniferous and mixed forests. In both models, the respondents are sensitive to presence of artificial areas in the natural recreation site, which have negative effect on their preference for visitation at the site. National parks are generally more probably chosen for a trip than protected landscape areas, and the unprotected sites have the lowest probability of visitation; this holds both for one-day and overnight visits.

The recreation values for a person from Czech population (including non-users) range from 2.1 to 26.6 CZK (0.1to 1.5 EUR) 2017 for one-day trips, with an average of 10 CZK (0.6 EUR) 2017 per trip. The highest values are associated with recreation at sites of Brdy and Beskydy PLA, other recreation values at the higher end of the scale are associated with Železné hory PLA, Krkonoše NP, Žďárské vrchy, Český ráj PLA or Křivoklátsko PLA.

For overnight trips, the WTP for access to an average site is of 39.5 CZK (2.2 EUR) 2017, and ranges between 12.3 and 154 CZK (0.7 and 8.7 EUR) 2017. The highest recreation values are associated with recreation at sites of Šumava NP and PLA, Krkonoše NP, Beskydy PLA.

Acknowledgement

The data collection was supported by the grant of the Czech Ministry of the Agriculture: 1R56014 - Monetary valuation of recreational and aesthetical function of forest in the CR within the program “Krajina a Budoucnost”. The further work on the analysis was supported by the projects no. TD020049 and TD03000093 financed by the Czech Technological Agency. The support is gratefully acknowledged.

References

Bartczak, A., Czajkowski, M., Giergiczny, M., Zylicz, T., Checko, E., Navrud, S., Englin, J., Pang, A. (2010): *Report on national and local forest sites survey.* POLFOREX.

Bartczak, A., H. Lindhjem, S. Navrud, M. Zandersen, T. Zylicz (2008a): Valuing forest recreation on the national level in a transition economy: The case of Poland. *Forest Policy and Economics 10 (7-8)*, p. 467-472.

Bartczak, A., H. Lindhjem, S. Navrud, M. Zandersen, T. Zylicz (2008b): *Valuing forest recreation on the national level in a transition economy: The case of Poland.* Munich Personal RePeC Archive paper no. 11483.

Bartczak, A., J. Englin, A. Pang (2012): When are forest visits valued the most? An analysis of the seasonal demand for forest recreation in Poland. *Environmental and Resource Economics 52*, p. 249-264.

Bestard, A. B., A. R. Font (2010): Estimating the aggregate value of forest recreation in a regional context. *Journal of Forest Economics 16*, p. 205-216.

Braun Kohlová, M., J. Melichar (2017): Environmental preferences for forest growth in post-mining landscape. *Journal of Landscape Management 2017/1*, p. 14-19.

Caulkins, P. P., R. C. Bishop, N. W. Bouwes (1985): Omitted cross-price variables in the linear travel cost model: correcting common mis-perceptions. *Land Economics 61(2)*, p. 182-187.

Dumitras D. E., S. Dragoi (2006): Estimation of the recreation values of romanian parks by travel cost methods. *Buletin USAMV-CN 63/2006*.

Dumitras, D. E., M. Ilea, I. M. Jitea, F. H. Arion (2012): The recreation value of Piatra Craiului National Park: A combined travel cost and contingent valuation survey. *Bulletin UASVM Horticulture 69 (2)*, p. 116-121.

Englisch, E. P. (2010). Discrete choice, recreation demand, and consumer surplus. Dissertation thesis. Faculty of the Graduate School of Cornell University, 89 p.

ETC/LC (European Topic Centre On Land Cover) (1994): *CORINE Land Cover Technical Guide.* Office for Official Publications of European Communities, Luxembourg. 163 p.

Font, A. R. (2000): Mass Tourism and the Demand for Protected Natural Areas: A Travel Cost Approach. *Journal of Environmental Economics and Management 39*, p. 97-116.

Forest Act no. 289/1995 Coll. / Zákon č. 289/1995 Sb. ze dne 3. listopadu 1995 o lesích a o změně a doplnění některých zákonů (lesní zákon)

Freeman, A. M. III. (2003): *The Measurement of Environmental and Resource Values: Theory and Methods.* Resources for the Future, Washington, DC.

Hanemann, W. M. (1984): Welfare Evaluations in Contingent Valuation Experiments with Discrete Responses. *American Journal of Agriculture Economics 66*, p. 332-341.

Chiabai, A., Ch. M. Travisi, A. Markandya, H. Ding, P. A. L. D. Nunes (2011): Economic assesment of forest ecosystem services losses: cost of policy inaction. *Environmental and Resource Economics 50*, p. 405-445.

Kaprová and Melichar (2018) - see chapter V of this thesis

Kaprová, K. (2015a): Definition of the recreation shadow price and its implications on recreation welfare estimation. *Journal of Landscape Management 6/1*, p. 7-16.

Kaprová, K. (2015b): Recreation values and the value of recreation demand modelling: The case of the Šumava NP. *Journal of Landscape Management 6/2,* p. 38-48.

Kaprová, K., J. Melichar (2014): *Review and meta-analysis of monetary values for non-market goods and services affected by climate change: land use, ecosystem, leisure.* Deliverable No. D2.1 „Analysis of key determinants of costs and benefits of mitigation policy"of GLOBAL IQ - Impacts Quantification of global changes (Project no 266992). Chapter 1.

Massey, D. M. (2002): *Heterogeneous Preferences in a Random Utility Model of Recreation Demand: An Application to Beach Use.* PhD Dissertation, University of Delaware.

McFadden, D. (1974): Conditional logit analysis of qualitative choice behavior. In: P. Zarembka (eds.), *Frontiers in econometrics*, p. 105-135. Academic Press, New York.

McFadden, D. (1978): Modeling the Choice of Residential Location. In A. Karlqvist, L, Lundqvist, F. Snickars and J. Weibull, eds. (1978): *Spatial Interaction Theory and Planning Models*. North-Holland, Amsterdam, p. 75-96.

Melichar, J. (2007): *Aplikace metody cestovních nákladů v oblasti Jizerských hor.* Disertační práce, Praha: Vysoká škola ekonomická v Praze.

Melichar, J. (2014): Measuring recreation benefits of forest quality change with contingent behavior model. *Journal of Landscape Management 5(2),* 10-15.

Melichar, J., D. Zahradník, V. Zatloukal, P. Pavelčík, K. Kaprová, J. Halfar, M. Roubalová, J. Beranová, M. Banaš (2018): *Vyhodnocení funkčního potenciálu lesů v oblasti záměru vyhlášení „Lesnického parku Podkomorské lesy" včetně návrhu optimálního nastavení jeho polyfunkčního využití".* Final report of project no. 5/2017 by the Grant Agency of the State Forests Enterprise. Prague: COŽP UK, Monitoring návštěvnosti s. r. o., IFER - Institute for Forest Ecosystem Research, s. r. o.

Mitrica, E., B. Mitrica, A. Stanculescu (2013): Economic analysis of nature preservation investments: the zonal travel cost approach applied for Harghita County of Romania. *Journal of Environmental and Ecological Statistics 21(1),* p. 83-93.

Ojea, E., M. L. Loureiro (2011): Identifying the scope effect on a meta-analysis of biodiversity valuation studies. *Resource and Energy Economics 33*, p. 706-724.

Ojea, E., P. A. L. D. Nunes, M. L. Loureiro (2009): *Mapping of forest biodiversity values: a plural perspective.* Fondazine Eni Enrico Mattei 04.2009.

Ojea, E., P. A. L. D. Nunes, M. L. Loureiro (2010): Mapping biodiversity indicators and assessing biodiversity values in global forests. *Environmental and Resource Economics 47(3)*, p. 329-347.

Parsons, G. (2003). Random Utility Model for Travel Cost Analyses. In P. Champ, K. Boyle & T. Brown, eds. (2003): *A Primer on Non-Market Valuation*. The Netherlands, Kluwer Academic Publishers, p. 269-329.

Parsons, G. and Massey, D. M. (2003): A Random Utility Model of Beach Recreation. In N. Hanley, D. Shaw, and E. Wright, eds. (2003): *The New Economics of Outdoor Recreation.* U.K., Edward Elgar Publishing Limited, p. 241-267.

Parsons, G. R. and D. M. Massey (2002): Site choice models. In: Haab, T. , T. McConnell (2002): *Valuing Environmental and Natural Resources*. Edward Elgar, eds., p. 190-244.

Parsons, G. R., D. M. Massey and T. Tomasi (2000): Familiar and Favorite Sites in a Random Utility Model of Beach Recreation. *Marine Resource Economics 14*, p. 299-315.

Shrestha, R. K., J. B. Loomis (2003): Meta-analytic benefit transfer of outdoor recreation economic values: testing out-of-sample convergent validity. *Environmental and Resource Economics 25 (1)*, p. 79–100.

Schägner, J. P., L. Brander, J. Maes, M. L. Paraccini, V. Hartje (2016): Mapping recreational visits and values of European National Parks by combining statistical modelling and unit value transfer. *Journal for Nature Conservation 31*, p. 71-84.

Schägner, J. P., L. Brander, M. L. Paracchini, J. Maes, F. Gollnow, B. Bertzky (2018): Spatial dimensions of recreational ecosystems service values: A review of meta-analyses and a combination of meta-analytic value-transfer and GIS. *Ecosystem Services 31(C)*, p. 395-409.

Špaček, J., M. Antoušková (2013): Individual single-site travel cost model for Czech Paradise geopark. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis LXI (7)*, p. 28512858.

Termansen, M., Zandersen, M., C. J. McClean (2008): Spatial substitution patterns in forest recreation. *Regional Science and Urban Economics 38*, 81-97.

Vojáček, O., J. Louda (2017): Economic Value of Ecosystem Services in The Eastern Ore Mountains. *Ekonomie a management 3*, p. 5-18.

Zandersen, M., and R. S. J. Tol (2009): A Meta-analysis of Forest Recreation Values in Europe. *Journal of Forest Economics 15*, p. 109-130.

V. Meta-analysis of recreation values attributed to forested areas in Europe and the validity of meta-analytic value transfer in Central and Eastern Europe

Kaprová, K., J. Melichar
[manuscript draft for Ecosystem Services/Journal of Forest Economics]

Meta-analysis of recreation values attributed to forested areas in Europe and the validity of meta-analytic value transfer in Central and Eastern Europe

Kateřina Kaprová[1], Jan Melichar[1]

Charles University Environment Centre[1], José Martího 407/2, 162 00 Prague 6, Czech Republic

Abstract

The contribution synthesises recreation demand values attributed to natural areas in Europe. We derive a measure of central tendency of European estimates from the published recreation studies in the past 35 years that were based on primary (individual) data. Since the estimates are substantially heterogeneous across the primary studies, we further disentangle factors of variability in reported values of consumer surplus per visitor per trip. A meta-analytic model is the core of the current analysis.

The scope of this study is twofold: i) to disentangle the environmental and methodological variables on the value, and ii) to derive a model appropriate for a benefit transfer of forest recreation values in Europe. Our sample encompasses a significant portion of recreation values associated with recreation sites in the post-transition area of Central and Eastern Europe. In this area, the preferences for recreation in open spaces may differ from those of the Northern, Western and Southern European populations on which most of the previous meta-analytic works that incorporate forest recreation values are typically based.

One of the key results from our meta-analysis of European forest recreation values is that higher recreation values are associated with remote forests in sparsely populated mountainous areas, consisting of broadleaved forests. Protected sites are not associated with significantly different recreation values than other natural sites. We find that the out of sample prediction from Northern, Western and Southern recreation sites to those located in Central and Eastern Europe systematically overpredicts the recreation values in all quartiles of CS per trip.

Keywords: value transfer, meta-analysis, recreation demand, recreation, open space

Introduction

The valuation of non-market goods and services provided by the environment to the society represents a very interesting and quickly developing area of environmental economics. Over decades, a large body of primary research has been devoted to enhance the ways of measuring these benefits and to give more accuracy to the estimated environmental values. In response to that, a substantial number of applied research studies on various ecosystems and different aspects of environmental values associated with the goods and services provided by nature has emerged.

The primary estimates of European recreation values are relatively abundant. However, they are not much covered and accounted for in existing valuation databases. Also, the valuation studies that would shed light on the recreation values of natural areas in Central and Eastern Europe are still relatively scarce. For example, in TEEB (Van der Ploeg and de Groot, 2010), which covers 1310 estimates of worldwide monetary values of ecosystem services, there are only 12 values associated with recreation in temperate and boreal forests or woodlands in Europe, and only 2 of these values are based in travel cost methodology. Neither of them covers Central or Eastern European countries.

Despite the fact that the stock of empirical evidence worldwide has been undisputably growing, the synthesis of the overall preferences of human society for different ecosystem goods and services is not a trivial task. The research on ecosystem values has been based on many different approaches, valuation techniques, data collection techniques and geographic scales of analysis, which contributes to the fact that up to the present, the overall findings are rather mixed (Schägner et al., 2018, de Salvo and Signorello, 2015). Even the syntheses of studies that focus on one specific type of ecosystem such as European forests, and one specific ecosystem service such as recreation (Zandersen and Tol, 2009; Giergiczny et al., 2008; Kaprová and Melichar, 2014) may bring contradictory evidence on the determinants of the environmental values and their effects.

The practice in evaluation of policies often calls for environmental cost-benefit studies, which should incorporate values of non-market goods and services. Not always the time and resource constraints of analysts enable to implement a primary valuation study, and the transfer of the benefits from existing studies to other natural sites has represented a feasible solution for the estimation of non-market values. But in line with the nonuniform results regarding the synthesis of the previous research, also the validity of benefit transfer in an international setting remains to large extent uncertain and needs to be tested.

In reaction to the presented state-of-art, we conduct a meta-analysis of primary studies investigating forest recreation values in Europe in this study. These studies are methodologically very consistent and their results are comparable in terms of valued environmental good and type of its use (recreational use value). The scope of this study is twofold: i) to disentangle the environmental and methodological variables on the recreation use value, and ii) to derive a model appropriate for a benefit transfer of forest recreation values in Europe.

We employ a meta-analysis as the most complex means of benefit transfer methods, which allows for a synthesis of previous recreation demand research results, testing hypotheses with respect to the effects of particular determinants of demand and facilitates validity testing. Meta-analysis represents a methodology for use of statistical methods to synthetize the results of a large collection of primary empirical studies, and for estimating statistical relationships between study results and explanatory variables that capture heterogeneity within and across studies (Glass, 1976; Smith et al., 2002; Bergstrom and Taylor, 2006; Liu and Stern, 2008). The meta-analysis has been used for three general purposes:

- Integration of findings of previous research on a particular topic (Bergstrom and Taylor, 2006)
- Discussion on the magnitude and range of the effect of explanatory variables (knowing that the original welfare measures were yielded by a variety of original studies and may differ due to area of study, range of environmental change, type of benefit or different valuation methods used; Ibid.),
- Utilization of meta-regression model in benefit function transfer (Rosenberger and Loomis, 2001a; Johnston et al., 2005; Brander et al., 2006; Schägner et al., 2018),
- Detection of potential publication bias (Rosenberger and Stanley, 2006)

The methodology originates in health sciences (Pearson, 1904) and was widely accepted and applied in many fields ranging from psychology, medicine, education to labour, transport and environmental economics (Van den Bergh et al., 1997; Bateman and Jones, 2003). The fundamental rationale for the meta-analytic technique was laid out by Glass (1976). First applications in the field of environmental valuation emerged in the 1990s (Walsh et al., 1990; Smith and Kaoru, 1990a) and since that have covered a wide variety of environmental goods such as wetland functions (Brouwer et al., 1999), water quality benefits (Magnussen, 1993), fishing (Sturtevant et al., 1995), benefits of endangered species (Loomis and White 1996), landscape changes (Barton, 1999), urban pollution (Schwartz, 1994), noise nuisance (Button 1995), or valuation of life (Mrozek and Taylor, 2002).

There exist relatively a large set of meta-analytic studies that aim at outdoor and forest recreation. Apart from that, several other studies include primary welfare estimates concerning forest recreation in a larger set that include also other types of outdoor recreation, or in a set including also welfare measures associated with other types of forest benefits.The following two tables summarize the previous meta-analytic studies in environmental economics that focus either directly on forest recreation (Table 1), or on recreation in terrestrial natural areas, including forests (Table 2).

The tables 1 and 2 show that the last study of similar aim to ours is Zandersen and Tol (2009), which covers the period of 1979 to 2001. Our study may bring new insights into synthesis of European recreation demand modeling: 60% of the sample (170 out of 282) are studies focusing on the period after year 2000. Also, the geographical coverage is enhanced. The predominate body of research has focused on the areas located in Western and Northern Europe. Neither of the previous meta-analyses focusing specifically on forest recreation demand covers a nonmarginal portion of studies from Central and Eastern Europe. Also the last analysis of open space recreation in Europe by Schägner et al. (2018) does not cover post-transition countries in the sample. We therefore also try to fill this gap.

Table 1: Overview of meta-analytic studies for forest recreation benefits

Study	Geographical coverage (no. of countries)	Time coverage	Dependent variable[1]	Welfare per visit (EUR 2017)[2] *Avg (med) range*	Valuation technique[3]	No. of studies included	No. of observations used	R^2
Bateman et al. (1999)	United Kingdom	1988-1997	WTP/v	1.2 (N/A) 1.0 -3.0	CV	8	48	0.61
Bateman et al. (2000)	United Kingdom	1972-1997	WTP/v	N/A 0.14-7.9	CV	8	44-77	0.05-0.73
Bateman and Jones (2003)	United Kingdom	1972-1997	WTP/v	2.5 (N/A) 0.14-7.9	CV	8	44-77	0.02-0.72
Zandersen (2005)	Europe (9 countries)	1977-2001	CS/v; CS/v/ha	23.6 (6.1) 1.1-153.3	TC	25 (5-10 used)	151-168	0.34-0.89
Lindhjem (2007)	Norway, Finland, Sweden	1985-2005	WTP/a*	N/A*	CV	28	72	0.74-0.82
Giergiczny et al. (2008)	Europe (8 countries)	N/A	WTP/a/ha; CS/a/ha	N/A	TC, CV	49	253	0.61
Zandersen and Tol (2009)	Europe (9 countries)	1977-2001	CS/v; CS/v/ha	23.6 (6.1) 1 – 152.5**	TC	26 (6-12 used)	166-189	0.28-0.85
Kaprová and Melichar (2014)	Europe (15 countries)	1989-2013	CS/v; CS/d; CS/a; CS/pop/a; CS/v/ha; CS/pop/ha	44.7 (14.9) 0.003-468.8***	TC	42 (7-18 used)	65-160	0.34-0.96

1 *CS/v: CS per visit, CS/d: CS per person per day, CS/a: CS per annum per person; CS/pop/a: CS per annum per population; CS/v/ha: CS per visit per hectare of the study site; CS/pop/ha: CS per population per annum per hectare of the study site; WTP/v: WTP per visit; WTP/a/ha: WTP per annum per hectare of the study site*

2 *Values have been recalculated to EUR 2017 using EU HICP deflator and PPP exchange rate by EUROSTAT.*

3 *TC: travel cost, CV: contingent valuation, CE: choice experiment, HP: hedonic pricing, MP: market prices, PF: production function, RC: replacement cost, NFI: Net factor income*

* The study focuses on non-timber values of forests including recreation, existence and option values. The willingness to pay is set for a scenario, which in most cases is not related to visitation to the area.

** Total means by study were available only.

*** The maximum is by Huhtala and Pouta (2006) and stands for CS of visitors in the upper quartile of income. Based on PPP exchange rate (when using market exchange rate from FIM to EUR, the values drop cca by a factor of 5). The final analysis in the study was done with a cutoff of outlying values.

Table 2: Overview of meta-analytic studies for recreation benefits associated with terrestrial ecosystems (including forests)

Study	Geographical coverage (no. of countries)	Time coverage	Dependent variable[1]	Welfare (EUR 2017)[2] *Avg (med), range*	Valuation technique[3]	No. of studies included	No. of observations used	R^2
Walsh et al. (1989a, 1989b, 1992)	USA	1968-1988	CS/d	56.7 (45.0), 6.7-366.7	TC, CV	120	129-287	0.36-0.44
Smith and Kaoru (1990a)	USA, Canada	1970-1986	CS/v	82.2 (N/A, 0.4-1065.1	TC	77	399-405	0.15-0.45
Smith and Kaoru (1990b)	USA, Canada	1970-1986	price elasticity of demand	not relevant	TC	77	185	0.45-0.65
Rosenberger and Loomis (2001, 2003)	USA, Canada	1967-1998	CS/v	26.6 (18.6), 2.0-258.5*	TC, CV, HP	131	701	0.27
Shrestha and Loomis (2001)	USA	1967-1998	CS/v	76.3	TC, CV, HP	131	682	0.26
Shrestha and Loomis (2003); Shrestha et al. 2007)	USA	1967-1998	WTP/d	41.1 (N/A), 2.4-140.1	TC, CV, HP	131	95-682	0.26-0.66
Sen et al. (2014)	United Kingdom	1975-2008	CS/v	N/A (for CS/v)	CV, CE, TC, mixed	98	297	0.72
De Salvo and Signorello (2015)	Italy	1982-2008	CS/v	10.1 (N/A), 0.9-65.8	CV, TC, CE	46	265	0.32-0.43
Schägner et al. (2018)	Europe	1985-2011	CS/v	7.5 (2.9), 0.2-67.4	TC, CV	75	244 used	N/A

1 *CS/v: CS per visit, CS/d: CS per day, CS/a: CS per annum; WTP/v: WTP per visit; WTP/pop: WTP per population, WTP/a: WTP per annum; WTP/ha: WTP per hectare of the study site*

2 *Values have been recalculated to EUR 2017 using EU HICP deflator (for EU studies) or OECD CPI deflator (for US and Canada studies) and PPP exchange rate by EUROSTAT*

3 *TC: travel cost, CV: contingent valuation, CE: choice experiment, HP: hedonic pricing, MP: market prices, PF: production function, RC: replacement cost, NFI: Net factor income*

* Total means by recreation activity were available only; presented are estimates for “general recreation”.

Study design

The definition of the environmental good and welfare measure represents a key point in the discussion of transferability of monetary values and application of unit value benefit transfers. Concerning the dependent variable examined in meta-analyses, in the vast majority of cases welfare measures such as willingness to pay or consumer surplus have been employed. One exemption is the price elasticity of recreation demand, which was subject to a meta-analysis by Smith and Kaoru (1990b). Welfare measures may be associated to existing level of environmental good or to changes in quantity or quality of the good. Among meta-analytic studies conducted so far, it has been common both to include only values of one type, use or non-use (for example Loomis and White, 1996; Kukielka et al., 2008; Bateman et al., 2000), or to analyse a pooled sample of use and non-use values (Chiabai et al., 2011; Ojea et al., 2009, 2010, 2011). Broader geographical analyses of ecosystem services frequently employ average yearly values per hectare of natural areas as the dependent variable (Ojea et al., 2009, 2010) so that the geographical prediction of values per area is more feasible.

The previous experience with meta-analysis suggests that to the studies in the meta-analysis should be of some similarity in content and context to be combined and statistically analysed (Desvousges et al., 1998; Bartczak et al., 2009) - to enhance the model fit and reduce transfer errors, covering only e. g. recreation values is advisable. Also the incidence of very specific sites or sites with unusual characteristics in the meta-database may negatively affect the accuracy of the benefit transfer for the more common sites (Rosenberger and Phipps, 2001).

In meta-analyses focucing on recreation values only, the dependent variable is usually set as per visit, less frequently as per day consumer surplus. In case that particular meta-analysis covers also stated preference studies, it is set rather as WTP per trip or per day. When recreation valuation studies are part of a broader set examining general forest benefits, it is common to use per year specification of WTP, as several evaluation methods such as production function and net factor income do not produce estimates of WTP per person.

Within forest recreation, meta-analyses have been based only on one evaluation technique (the most relevant example for this study is Zandersen and Tol, 2009), or across methods where researchers have to deal with inconsistency of estimates originating in different valuation methodologies - Marshallian vs. Hicksian surplus measures (Shrestha and Loomis, 2001; Schägner et al., 2018). Smith et al. (2002) provide an insight into a method for calibration of these differing value estimates.

According to Kaprová and Melichar (2014), the most homogeneous specification among recreation values is recreation value per visit (or also per visit-day), which is also the specification of welfare that most meta-analyses employed for analysis (see Table 1 and Table 2). Schägner et al. (2018) show that the levels of visitation are dominating determinants of total annual recreation values per hectare of natural areas, compared to any determinants of recreation values per visit (including the environmental characteristics of the site). Kaprová and Melichar (2014) also suggest that aggregation of per visit values to values per population and averaging the values per area of the recreation site may expand the range of values multiple times and there is risk of hindering the fit of the meta-analytic model. In this article, we therefore analyse recreation values per visit to natural areas.

The description of natural areas in previous studies varies from using a simple binary variables indicating whether the site consists of a forest, a wetland or is located in a national park (e. g. Rosenberger and Loomis, 2001a; de Salvo and Signorello, 2015), to continuous variables describing land cover, heterogeneity of landscape and terrain, recreation facilities or the socio-economic context (Zandersen and Tol, 2009; Kaprová and Melichar, 2014; Schägner et al., 2018). The depth of the analysis depends on the focus of the study - whether it is designated for a benefit transfer on national level (the benefit of such a study is that the researcher does not need to collect data on many characteristics of the site where the benefit transfer function should be transferred to, at the cost of yielding more rough numbers), or whether rather a detailed disentanglement of the preferences of recreationists is at the heart of the analysis. Of course, the data availability and interrelations among explanatory variables may also be a limiting factor.We focus on primary studies investigating forest recreation values in Europe, as they are methodologically very consistent and their results are comparable in terms of valued environmental good and type of its use (recreational use value). Consistency in terms of economic concept of value, as well as environmental good characteristics represents a key condition for hypothesis testing (Smith et al., 2002) and for benefit transfer (Boyle and Bergstrom, 1992). Further, forest recreation studies are published in sufficient quantity and geographic distribution for synthesis and prediction purposes.

Within processing of forest recreation studies, we focus on studies aiming at recreation value of forests, or mixed areas (such as national parks) where forest represent the dominant type of land cover. The dataset does not cover urban forests - no such studies have been identified among the reviewed literature. Travel cost method was designed for natural areas in the open landscape; for a potential application in the urban area, the definition of travel cost and the method of their calculation has to be thoroughly considered to match the real process of recreation choices and the real tradeoffs faced by the urban greenery visitors - most of them travel by public transport with a prepaid time (monthly, annual) tickets, the objectively measured distance to parks using GIS may not be relevant. However, the sample of forests in the study includes forests adjacent to a town in open landscape.

Data

The meta-analysis includes primary environmental valuation studies that apply travel cost method (Parsons, 2003) and are employed to model forest recreation values across European countries. The scope of the literature search was set as primary (original) environmental valuation studies and meta-analyses of primary valuation studies reviewing past research in environmental valuation of land use changes, impacts of global change on land use changes, and leisure activities. The literature search aims at primary studies with year of data collection no older than 1980. Only estimates concerning terrestrial ecosystems that are found in Europe were taken into account. The language coverage of the analysed studies is English, French and Czech.

Relevant papers and studies were searched through databases such as EVRI, DEFRA UK and EPA US, further using the online research databases like ScienceDirect, JSTOR, EBSCO and peer review journals like Ecological Economics, Journal of Environmental Economics and Management, Environmental and Resource Economics. We also reviewed EU funded projects that aimed at assessment of impacts upon non-market goods relevant for climate change (e.g. INTARESE, ClimateCost) and their monetary valuations (e.g. NEEDS, PASHMINA). In the second step, the reference list was supplemented with relevant studies from the reference list of reviews found, and with papers known to the authors.

Within these studies, several specifications of outcome measure were recorded (CS per visitor per day, per trip, per year; CS per population per year, including specification per 1 square kilometre of study site); for the model reported in this contribution, we focus on per visitor per trip specification of the consumer surplus (i. e. a monetary measure of recreation welfare associated with a visit to a natural area). We focus on per person per trip values, which are more homogeneous in terms of range and are much more frequently reported within primary studies than the other specifications (per person per year, per population, or per area of the study site).

The dataset contains 282 estimates of recreation surplus per trip to European forest areas from 39 travel cost studies published between 1989 and 2013. Geographically, we identified studies from 14 European countries. The dataset covers Czech Republic, Denmark, Finland, France, Germany, Great Britain, Ireland, Italy, Netherlands, Poland, Romania, Slovakia, Spain and Switzerland. One study reports on 1 to 48 estimates of recreation welfare. The geographic distribution of the studies is depicted in Figure 1.

Following table 3 provides brief information about the origin of the study, number of estimates of consumer surplus per trip available within the study, sample size used and average value with standard deviation for the estimated recreation values.

Figure 1: Geographic distribution of the forest study sites covered

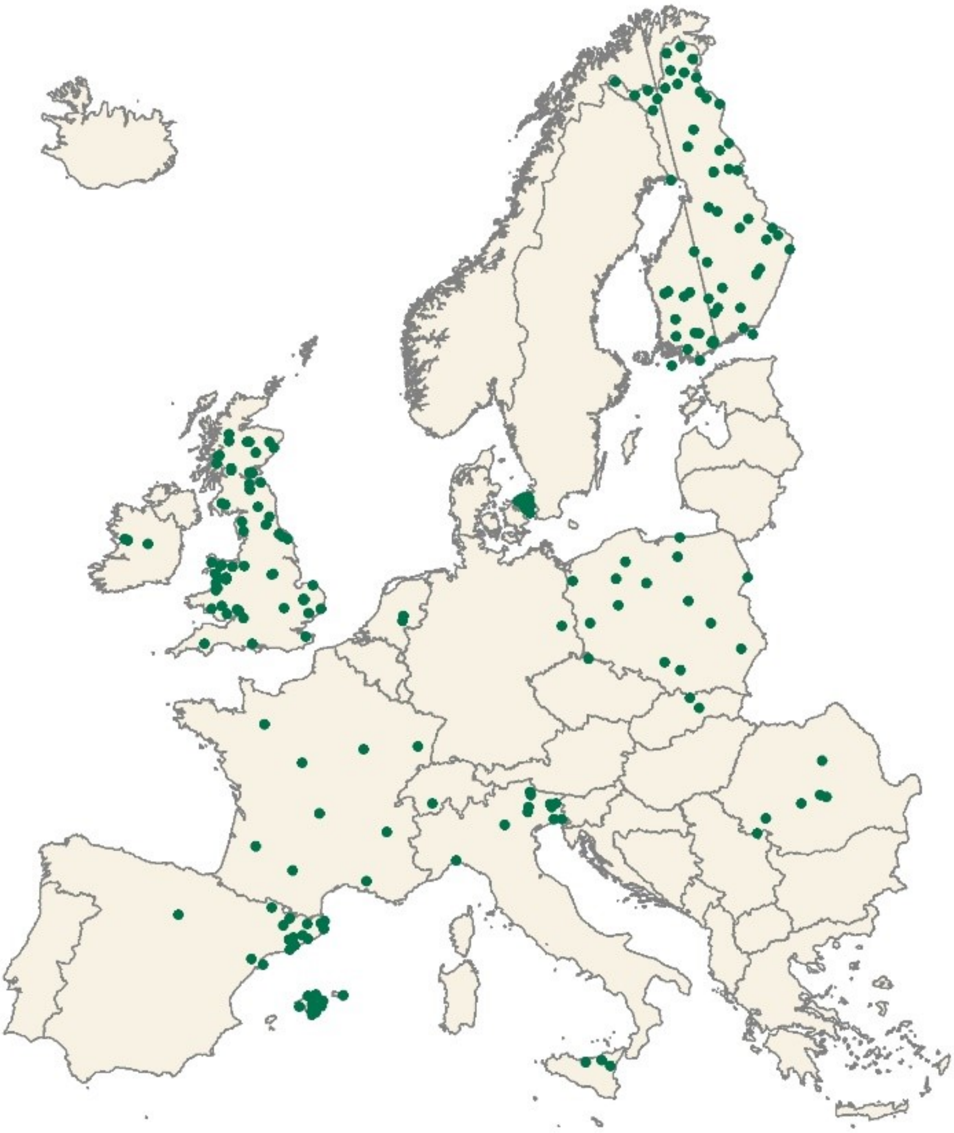


Table 3: TCM studies used in the meta-analysis on forest recreation welfare measures

Study	Country	No. of estimates	Sample size	Mean CS per trip (EUR 2012)	Std. Deviation
Baranzini, A., D. Rochette (2008)	Switzerland	2	61	38.61	8.27
Bartczak, A., Czajkowski, M., Giergiczny, M., Zylicz, T., Checko, E., Navrud, S., Englin, J., Pang, A. (2010)	Poland	18	740	4.51	1.18
Bartczak, A., J. Englin, A. Pang (2012)	Poland	18	740	4.69	1.23
Bartczak, A., Lindhjem, H., Navrud, S., Zandersen, M., Zylicz, T. (2008a)	Poland	2	1002	26.15	9.19
Bateman, I. J., G. D. Garrod, J. S. Brainard, A. A. Lovett (1999)	Great Britain	2	351	5.11	0.49
Bellu, L. G., V. Cistulli (1997)	Italy	8	cca 800	12.37	8.43
Bestard, A. B., A. R. Font (2010)	Spain	2	841-1043	49.65	34.68
Creel, M., M. Farell (2008)	Spain	14	1838	36.92	4.72
Cullinan, J. (2011)	Ireland	2	188	2.28	0.83
Cullinan, J., S. Hynes, C. O´Donoghue (2011)	Ireland	1	254	2.76	0.13
Czajkowski, M., Giergiczny, M., Kronenberg, J., Tryjanowski, P. (2012)	Poland	2	583	123.22	59.15
Czajkowski, M., M. Giergiczny, J. Kronenberg, J. Englin (2013)	Poland	5	411	12.72	5.08
Christie, M., N. Hanley, B. Garrod, T. Hyde, N. Lyons, A. Bergmann, S. Hynes	Great Britain	11	81-416	25.44	14.28
De Frutos, P., F. Martínez Pena, P. Ortega Martínez, S. Esteban (2009)	Spain	9	126	12.86	1.74
Dumitras D. E., S. Dragoi (2006)	Romania	11	351-356	169.21	66.71
Dumitras, D. E., M. Ilea, I. M. Jitea, F. H. Arion (2012)	Romania	8	87-261	89.28	19.7
Englin, J., A. Gelan, A. Pang (2011)	Great Britain	3	246	19.81	5.27
Font, A. R. (2000)	Spain	10	723	0.87	0.97

Study	Country	No. of estimates	Sample size	Mean CS per trip (EUR 2012)	Std. Deviation
Garcia, S., J. Jacob (2010)	France	9	1593	34.55	23.82
Getzner, M. (2009)	Poland, Slovakia	2	289	254.76	27.76
Hanley, N. D. (1989)	Great Britain	4	319	5.89	5.05
Hein, L. (2011)	Netherlands	1	561	11.52	-
Huhtala, A., E. Pouta (2006)	Finland	16	363-567	208.12	134.55
Hynes, S. and W. Greene (2007)	Ireland	1	269	27.88	16.95
Klein, R. J. T., I. J. Bateman (1998)	Great Britain	1	160	1.17	-
Liston-Heyes, C. and A. Heyes (1999)	Great Britain	16	170-336	15.99	2.09
Lupa, P. (2012)	Poland	3	195	2.63	1.36
Mayor, K., S. Scott, R. S. J. Tol (2007)	Ireland	4	514-544	2.53	2.2
Melichar, J. (2007)	Czech Republic	6	719	153.16	60.22
Mitrica, E., B Mitrica, A. Stanculescu (2013)	Romania	1	29	8.96	-
Ovaskainen, V., J. Mikkola and E. Pouta (2001)	Finland	16	656	69.67	16.59
Signorello, G., J. Englin, A. Longhorn, M. De Salvo (2009)	Italy	12	1280	29.33	6.35
Tempesta T., Visintin F., Marangon F. (2002)	Italy	18	"very small"	6.82	3
Termansen, M., Zandersen, M., C. J. McClean (2008)	Denmark	15	286	0.78	0.45
Van der Heide, C. M., J. C. J. M. van den Bergh, E. C. van Ierland, P. A. L. D. Nunes (2005)	Netherlands	2	216	0.28	0.30
Willis, K. G. (1991)	Great Britain	15	21	5.85	1.59
Willis, K. G., G. D. Garrod (1991)	Great Britain	30	21	3.25	3.36
Total mean by study		**8.1**	**488**	**39.9**	**16.1**

The primary studies provided data on the dependent variable, which were converted to EUR 2012 using OECD consumer price index and exchange rate adjusted for purchasing power parity, taking year of data collection (or if unavailable, year of study publication) as baseline for value conversion. The sample consists of: i) estimates of consumer surplus per person per trip to the area and ii) other estimates (e. g. consumer surplus per person per year) recalculated to the per person per trip specification in case the originating study provided the information on the yearly number of trips to the site. More than 95% of the sample accounts for of direct estimates of consumer surplus as reported by the original authors. All welfare measures were expressed in the same price level and currency using OECD CPI and PPP exchange rate, taking the year of publication as baseline.

Estimates of all consumer surplus specifications vary considerably among studies in Europe and there is strong evidence of outliers and positively skewed distribution of estimates (Table 3). Practically all similar meta-analyses focusing on welfare values associated with environmental goods exhibit similar patterns. For our sample, the consumer surplus per trip in the reported European studies has an average value of 38 EUR and median 14 EUR (i. e. 40 EUR, resp. 14.8 EUR 2017). The highest reported recreation values by Huhtala and Pouta (2006) up to 439 EUR 2012 per trip belong to visitors in upper two quartiles of income; income was highly significant in this study and affected the estimated welfare.

We include several methodological variables that enable us to control for the quality of the studies and estimates and model the impacts of different methodologies on the recreation value estimates. They are also important for prediction and transfer purposes, as they allow to account for the preferred methodological approach for benefit transfers. Variables that describe methodological approach that was employed by researchers to provide the estimates of recreation surplus have been also coded from the primary studies.

Variable choice and definition was based on previous research (Brouwer et al. 1999, Loomis and White 1996, Woodward and Wui 2001, Rosenberger and Loomis 2001a, Krupnick and McLaughlin 2011, Chiabai 2011, Zandersen and Tol 2009, Ojea 2010 etc.). The focus of this study is specifically on recreation demand modelling (travel cost method), which enables us to cover much more detailed methodological variables than previous meta-analytic studies that involve both stated and revealed preference research (Walsh et al., 1990, 1992; Smith and Kaoru, 1990a; Rosenberger and Loomis, 2001a; Shrestha and Loomis, 2001; Giergiczny et al., 2008; Schägner et al., 2018). Bateman et al. (1999) and Bateman and Jones (2003) cover forest recreation values from primary studies employing contingent valuation method only. The most relevant study that provided similar extent of TCM methodological detail is Zandersen and Tol (2009), which is based on a sample of primary studies published in Europe from 1979 to 2001. Since that, the TCM methodology shifted in reaction to different modelling issues. The latest meta-regression focusing on the recreation values available is Schägner et al. (2018), which employs 2 binary methodological variables (TCM vs. CVM study, use value vs. use and option value).

We employed variables informing on the type of travel cost model and corrections for specific data problems that are common in travel cost modelling, further we include information on how the travel cost was calculated or whether substitute sites were modelled in the primary study. We control for the year of publication and whether the estimate is preferred by the author for drawing the conclusion of the study.

We also control for potential presence of publication bias in recreation values (Florax, 2001; Rosenberger and Stanley, 2006). The phenomenon of publication bias encompasses potential selection bias when studies that report statistically significant results with an expected direction conforming to theoretical expectations and of reasonable magnitude of the analysed effect are more likely published in peer-reviewed journals. The source may include the approach of both the researchers, which may use the presence of expected results as a model selection test, and of the reviewers and editors, which may favour to accept papers consistent with the conventional theory. According to Rosenberger and Stanley (2006), the peer-reviewed literature more likely covers lower estimates of environmental benefits, and higher estimates of costs.

Using geographic analysis tools, the variable set was supplemented with variables describing the recreation site and its context. For ech forest recreation site in the sample, a spatial layer describing its boundaries was created using the information from the study and official sources by EEA , ETC/LC and EFI. Most studies (>65%) do not yield enough information on the precise boundaries of the study sites. The primary recreation sites are forests and some of them protected sites, which enables to define them relatively well also on the land cover map (ETC/LC, 1994) or European Forest Institute map set (EFI and EC, 2006), or are also on maps of protected areas (EEA, 2013). Area of each defined polygon was checked against the area of the study site (if provided).

The geographic analysis enabled us to supplement the set of predictor variables by natural characteristics of the recreation areas. We employed geographic data on CORINE Land Cover categories for the year closest to the year of data collection in the primary study by the European Environment Agency (EEA 1990, 2000, 2006, 2012). We also define whether at least 50% of the study site is a protected area (NP or other). We supplement the data by WORLDCLIM datasets on altitude, temperature and precipitation.

Socio-economic variables have been used in many previous studies as proxies for preferences of the population of recreationists from which the sample in particular primary study is drawn. Some studies employ variables related to the specific sample of respondents, as income or age (Jacobsen and Hanley, 2009). However, as many studies lack this information on the sample characteristics, it is common to use exogenous aggregate proxies at regional or national level (Zandersen and Tol, 2009; Rosenberger and Loomis, 2001a) to capture the differences across the populations from which the respondents were generated. We employ GDP per capita at the region in which the forest recreation area is located for the year of data collection as provided by EUROSTAT (the highest resolution data available accounting for the most of the sample of study sites is NUTS2). Further, we measure population density at the study site using data by EEA (we have also tested population density in a perimeter of 30 km around the study site, as both may have different meaning - either presence of settlements in the recreation forest, or rather the presence of a close "source" of potential recreationists).

Table 4 presents the complete list of determinants employed in the analysis, together with descriptive statistics (both for the full sample available, and for the truncated sample employed in the meta-regression).

Table 4: Definitions and descriptive statistics of explanatory variables in the meta-analytic model

Variable type	Variable	Variable description	Full sample					Final sample				
			No. Obs.	Mean	Std. Dev.	Min	Max	No. Obs.	Mean	Std. Dev.	Min	Max
Dependent	*CS_trip*	*Average CS per person per visit, in EUR (2012) **	*282*	*37.9*	*66.9*	*0.003*	*439.2*	*172*	*28.6*	*42.0*	*0.1*	*223.0*
Forest recreation site characteristics	Area	Area of the study site in square km	281	5 666.6	17 719.7	1.2	149 076.5	172	8 225.3	21 640.8	1.2	149 076.5
	Ln (broadleaved)	Natural log of area of broadleaved forests at the study site	281	15.2	6.5	1	23.7	172	15.6	6.8	1	23.7
	Ln (coniferous)	Natural log of area of coniferous forests at the study site	281	16.8	5.2	1	23.4	172	17.2	5.0	1	23.4
	Ln (forests)	Natural log of area of forests at the study site	281	5.0	2.5	1	10.7	172	5.3	2.7	1	10.7
	Ln (grassland)	Natural log of grassland land cover at the study site	281	12.2	6.9	1	22.9	172	12.7	6.7	1	22.9
	Ln (agriculture)	Natural log of agricultural area at the study site	281	18.5	3.2	1	25.2	172	19.2	3.3	12	25.2
	Ln (wetlands)	Natural log of area of inland wetlands at the study site	281	11.1	7.2	1	22.8	172	12.7	6.4	1	22.8
	National Park	Site is a national park (0/1)	282	0.30	0.46	0	1	172	0.32	0.47	0	1
	Other protected	Site is another type of nature protected area (0/1)	282	0.26	0.39	0	1	172	0.28	0.39	0	1
	Latitude	Latitude at the central point of the study site	281	50.9	6.6	37.9	64.5	172	51.6	6.5	37.9	64.5
	Longitude	Longitude at the central point of the study site	281	8.7	11.4	-9.1	28.0	172	10.2	11.1	-9.1	26.3
	Altitude	Altitude at the central point of the study site	281	323.2	382.3	0.0	2 144.5	172	222.6	208.6	1.0	951.1
	Temperature 5-10	Average temperature in the main season (May-October) in °C*10 at the study site	281	140.8	28.9	60.2	211.4	172	143.1	26.8	92.5	211.4
	Precipitation 5-10	Average precipitation in the main season (May-October) in mm3 at the study site	281	69.9	21.4	27.8	145.5	172	64.3	15.2	27.8	114.0
Socio-economic variables	Ln (GDP/cpt)	Gross domestic product at market prices in millions of EUR (from 1.1.1999)/ECU (up to 31.12.1998), in the NUTS 2 of the study site in the year of study publication	255	9.71	0.62	8.20	10.82	172	9.76	0.54	8.63	10.82
	Population density	Average population density at the study site	281	154.0	419.3	0.0	658.9	172	154.7	120.2	1.6	498.7
	Explicit activity	Value accounts for a specific recreation activity that is explicitly mentioned in the study (0/1)	282	0.24	0.43	0	1	172	0.18	0.39	0	1

Variable type	Variable	Variable description	Full sample					Final sample				
			No. Obs.	Mean	Std. Dev.	Min	Max	No. Obs.	Mean	Std. Dev.	Min	Max
Study methodological variables	Substitute	Substitute sites treated in the analysis (0/1)	275	0.18	0.38	0	1	172	0.16	0.37	0	1
	Journal	Estimate is published in a peer-reviewed journal (0/1)	282	0.60	0.49	0	1	172	0.63	0.48	0	1
	Linear model	Linear estimation using OLS employed (0/1)	254	0.11	0.32	0	1	171	0.08	0.27	0	1
	Samplesize	Sample size employed in the analysis	280	563.7	532.9	21	1838	172	630.5	469.9	21	1773
	Year	Year of data collection	282	2003.7	7.2	1989	2013	172	2004.1	7	1991	2013
	Wage rate	Average sample wage rate employed for calculation of travel cost	206	16.1	21.0	0	100	172	13.7	20.8	0	100
	On-site	On-site data collection (0/1)	282	0.55	0.50	0	1	172	0.66	0.48	0	1
	On-site endostrat	On-site model corrected for endogenous stratification (0/1)	282	0.22	0.41	0	1	172	0.33	0.47	0	1
	On-site trunc	On-site model corrected for truncation (0/1)	282	0.30	0.46	0	1	172	0.47	0.50	0	1
	On-site trunc_endostrat	On-site model corrected both for truncation and endogenous stratification (0/1)	282	0.20	0.40	0	1	172	0.31	0.47	0	1
	Estimate preferred	Estimate preferred by the authors for drawing the results of the study (0/1)	282	0.55	0.50	0	1	172	0.47	0.50	0	1

** Converted from original values using OECD CPI, PPP exchange rate, baseline: year of study publication.*

Methodology

The meta-analytic model is formalized as follows:

$$WTP_{ij} = SITE_{ij} + USER_{ij} + STUDY_{ij} + \varepsilon_{ij}$$

where:

WTP_{ij} ....is WTP estimate i from study j,

$SITE_{ij}$ ....is a vector of recreation site characteristics,

$USER_{ij}$ ..is a vector of socio-economic variables describing particular user population,

$STUDY_{ij}$ is a vector of methodological variables characterizing study design,

ε_{ij} ....represents residual unobserved variability of WTP.

As each study, author or country yields several observations of forest recreation value that may be correlated within one study, one author working group or one country, we handle the data with a clustered structure. The specification of grouping or clustering that fits our data best is at study level, as in several previous meta-analyses (e. g. Zandersen and Tol, 2009; Rosenberger and Loomis, 2001a). Rosenberger and Loomis (2001b) attempted also clustering at level of author and data structure; Schägner et al. (2018) employ author working groups.

Concerning the model specification, we consider pooled OLS and random and fixed effect models for panel data. If the Breusch-Pagan Lagrange Multiplier test did not reject the null hypothesis of no within-cluster effect at α=0.05, the equal effect model was preferred over panel effects model and a pooled OLS model was employed. If the panel data structure is appropriate based on the results of Breusch-Pagan LM test, we further employed a test of overidentifying restrictions (Arellano, 1993) to decide between random or fixed panel data model. The overidentifying restriction of RE over FE is the assumption that regressors are uncorrelated with the group-specific error (the random effect). In line with the results of both tests, full model I is estimated using pooled OLS, and model II is fitted using random effect panel data estimator.

We have tested also the multilevel modelling approach (mixed effects model introducing nested random effect on the study level as random intercept, and fixed effects of the modelled variables) employed by Schägner et al. (2018) for our models. This approach provides similar results to those based on model selection procedure described above; therefore, we apply the original models.

Meta-regression results

The univariate exploration data analysis using boxplots shows the presence of a group of outliers and extreme values in the dependent variable. Previous meta-analyses focusing on recreation values of forests or of open space (latest of which are Schägner et al., 2018, and

Zandersen and Tol, 2009) tend to work with much lower range of recreation values; also, the presence of extreme values may hamper the model fit of the meta-analysis. After the statistical regression (Model I), we identify the multivariate outliers - influential points using DFFITS diagnostics (Belsley et al., 1980), and after investigation exclude them from the analysis. The final sample of the models is 172 observations of forest recreation welfare; the difference from the full sample is mostly due to missing data for explanatory variables.

The variable selection for model I was subject to correlation analysis. The pairwise Pearson correlation coefficients did not exhibit strong relationships among the considered variables. However, the postestimation validation of meeting the assumptions of linear regression analysis proved that several land cover types (namely wetlands, water bodies and agricultural areas), as well as the identification of other protected areas than national parks and the sample size represented a source of multicollinearity in the model. For all these variables, the variance inflation factors were of concern (>10; O´Brien, 2007) and these variables had to be omitted from the whole analysis.

We first estimate a full model (model I) with a variable set using pooled OLS and validate the assumptions of linear regression analysis. Since the model heteroskedasticity of residuals is present, we estimate the model with the robust Huber-White variance estimator (Huber, 1967; White, 1980). For this model, the pooled OLS is preferred over panel data estimators. In a second step, we conduct a stepwise variable selection until all remaining variables are significant at the 0.1 level. Under the new model (model II), the data exhibit a significant correlation of errors within the study clusters. Therefore, we employ a random effect panel data estimator. We have plotted the residuals of the final model (II) against all continuous explanatory variables and also against the longitude and latitude of the studies in the data set and did not identify any strong patterns that could be of concern.

Table 5 shows the results of the meta-regression modelling. Model and all other results were created using statistical software STATA SE, version 13.

Table 5: Meta-regression results with Ln (CS_trip) as dependent variable - - full model (I) and final model after stepwise selection of variables (II)

Var. type	Variable	Model (I)		Model (II)	
		Coef. [1]	Std. Err. [2]	Coef. [1]	Std. Err. [2]
-	Intercept	41.570	-33.410	12.890	-50.350
Forest recreation site characteristics	Area	1.39e-05***	0.000	4.94e-06**	0.000
	Ln (broadleaved)	0.0545***	-0.020	0.0351**	-0.017
	Ln (coniferous)	0.027	-0.025		
	Ln (grassland)	-0.0469**	-0.021	-0.001	-0.020
	National Park	1.420***	-0.295	0.555	-0.357
	Altitude	0.00120**	-0.0005	0.001	-0.001
	Precipitation 5-10	-0.014	-0.008	-0.0182*	-0.010
	Temperature 5-10	0.0166***	-0.006	0.011	-0.009
Socio-economic	Ln (GDP/cpt)	-0.270	-0.230	0.190	-0.285
	Population density	-0.00707***	-0.001	-0.00423***	-0.001
	Explicit activity	2.517***	-0.309	2.555***	-0.464
Study methodological variables	Substitute	1.183***	-0.326	0.499	-0.404
	Journal	-0.426**	-0.172	-0.282	-0.449
	Linear model	0.398	-0.442		
	Wage rate	-0.007	-0.005	0.00584*	-0.003
	Year	-0.019	-0.016		
	On-site	-0.253	-0.312		
	On-site endostrat	2.611***	-0.394	1.862***	-0.647
	On-site trunc	0.227	-0.208		
	On-site trunc_endostrat	-2.917***	-0.359	-1.953***	-0.564
	Estimate preferred	0.433***	-0.135	0.216***	-0.074
	Model	**OLS robust**		**RE robust**	
	No. Observations	**172**		**172**	
	No. Studies	**24**		**24**	
	No. Countries	**12**		**12**	
	R^2	**0.744**		**0.653[3]**	
	Breusch-Pagan test (p-value)	**1.000**		**0.000**	
	Average VIF[4]	**3.684**		**3.307**	

Notes:

1 *We report significance as follows: *** p<0.01, ** p<0.05, * p<0.1..*

2 *Standard errors of estimates are corrected for heteroskedasticity using the robust Huber-White estimator.*

3 *Overall R^2 of the random effects panel data model (not directly comparable to reported R^2 in OLS - model I).*

4 *We calculate VIF without incorporation of interaction variables that are correlated by definition.*

For the final model, 9 predictors are statistically significant at 10% level. The area of the forest recreation site is positively related to the recreation welfare measure, and the relationship is significant. This confirms results from Schägner et al. (2018) and previous results using the subset of this sample by Kaprová and Melichar (2014); however, the results of Zandersen and Tol (2009) show the opposite trend - i. e. that the preference grows towards smaller areas of forests. Both results may make sense, as the general preference may depend a lot on the duration of trips that are represented in the sample, where the larger area of the recreation site may play role particularly for longer trips. For one-day trips to large recreation areas, the recreationist is physically able to cover only a limited part of the total area, and thus the visitor may not necesarilly value more the remaining (not visited) extent of the recreation site. Kaprová and Melichar (2014) show that for the meta-regression model incorporating only one-day trips to forests, the visitor value is higher for smaller forests. These forests are typically located in the vicinity of cities and may provide more recreational equipment such as paths, benches or playgrounds from which the one-day visitors benefit more than from large forest areas[15]. The average duration of the trip in our sample is known only for cca 60% of the final sample (108 observation) and is of 1.8 days. On the other hand, for very small recreation areas, the preference for visitation may be significantly lower. Our dataset covers very small areas from 1.2 square kilometer to vast forest areas, and the overall trend is positive.

A positive significant effect was found for the forest cover within the recreational area. While the overall variable had to be omited from the final model due to multicollinearity, both models show that among the forest study sites, there is significant preference of European recreationists for the presence of broadleaved forests at natural recreation sites. Based on the final model, we observe that each percentage of broadleaved cover increases the recreation value per visit by 0.04 %. Previous evidence did not prove that the abundance of forest cover constitutes an important explanatory factor which would enhance the welfare associated with recreation in forests (Zandersen and Tol, 2009), natural areas in general (Schägner et al., 2018) or the visitation loads in national parks (Schägner et al., 2016). We tried to incorporate also the measure of defoliation of the forests as provided by EUROSTAT, but as the variable is aggregated on the country level, it did not work well in the model (nor in previous results by Kaprová and Melichar, 2014).

The area of grassland within the forest site is negatively related to the recreation welfare, although not significantly in the final model. Kaprová and Melichar (2014) also found that visitors in European forests prefer dense forests that do not contain much open land (irrespective of the fact which specification of welfare measure was used as the dependent variable - per day, per trip, per year per person, per population or per area). Zandersen et al. (2007) and Lindhjem and Navrud (2008) have brought consistent results. On the other hand, Zandersen and Tol (2009) find that forest sites including more open land within the borders are more preferred for recreation purposes. Interestingly, Schägner et al. (2018) find that for a meta-analysis of European recreation values of open spaces in general (including marine ecosystems), the share

[15] We unfortunately do not dispose with any data that would be a good proxy for recreational equipment at the forest sites in our sample.

of forest cover shows significant negative effect in all models. Other meta-analyses employ binary variables to identify whether the valued site is a forest (e. g. Smith and Kaoru, 1990a), with mixed results. The previous evidence also shows that European visitors prefer diverse land cover within the natural recreation site (Schägner et al., 2018; Zandersen and Tol, 2009).

Wetlands and water bodies as explanatory variables are scarcely used among studies and the respective variables were omitted even in this study due to multicollinearity problems. Neither of the two is employed in the analysis by Zandersen and Tol (2009); Schägner et al. (2018) finds that the effect of presence of inland water at the recreation site on recreation value is positive but not statistically significant.

Forests with a rich species diversity were shown by primary studies as preferred by recreationists to the ones with lower degree of diversity in primary studies (e. g. Hanley et al., 2002; Scarpa et al., 2000). When used as a predictor in meta-analysis, the relationship is not so clear - neither Schägner et al. (2018), Zandersen and Tol (2009) nor Ojea et al. (2009) find a significant relationship between diversity of species and welfare measures. We dispose with measures of biodiversity by EUROSTAT that are available only at country level, which means the variable is very mildly related to the state at the study site in year of data collection. Instead, we employ variables indicating whether the study site (or study sites - some estimates relate to more forests in a region) is located in national parks or in other nationally or regionally designed protected areas (such as protected landscape areas, regional natural parks etc.). This may on one hand indicate the presence of rich biodiversity or protected species in the study site; on the other hand, it may be related to more restrictions on the visitor behaviour. However, the data show that the location of the recreational natural site in a national park does not yield a significantly higher recreation welfare than the location in other protected areas and non-protected areas (which also include forest recreation parks). Location in other types of protected areas than national park was dropped out of model due to multicollinearity problems (however, when inspected using larger sets or subsets of observations, the effect was never significant).

We account for environmental conditions of the study site in terms of altitude and average temperature and precipitation in the main recreation season (May to October). Altitude may account for specific attractivity of mountain regions, and we expect the sites with higher temperature and less participation to yield higher recreation values as the better climate may attract visitors from longer distances. We incorporated also longitude and latitude, but both bring no further information in the model above the other included variables (they are also partly related to the precipitation and temperature variables) and are therefore excluded from the analysis. Altitude and temperature are found to be positively related to the recreation welfare, but they do not constitute significant predictors in the models (temperature is significant only in the full OLS model I). Precipitation shows negative significant effect in both models as expected, but is significant at 10% level only.

GDP per capita is a proxy variable for the income of the recreationists. We would suppose that recreationists with higher income might exhibit higher recreation values for environmental goods. In richer countries, we would also expect that higher portion of income is devoted to leisure and recreation. Population of richer countries may value the time spent by outdoor recreation higher due to higher opportunity cost of time, which is positively related to CS. On the other hand, with growing income, the outdoor recreation in the country may be substituted with trips abroad. The variable is measured at NUTS2 level, and may reflect the income level of the largest part of the sample of recreationists (those who come most often to the particular study site). For most primary studies, the descriptive statistics on the income of the visitor sample that would be more appropriate is not available, as in previous meta-analytic works. The results on income elasticity of demand for recreation so far are rather weak. In our analysis, the level of GDP per capita does not affect the outdoor recreation values, which is in line with Giergiczny et al. (2008) and Schägner et al. (2018) who did not prove a significant effect of income either. Zandersen and Tol (2009) did not found a significant relationship in 3 out of 4 models, and in their final model, the effect was significant and negative. Bartczak et al. (2008a) also confirm that CS estimates for forest recreation in Western Europe are poorly related to the country GDP per capita. Positive effect of income on WTP for forest goods and services was proved by Barrio and Loureiro (2010) and by Chiabai et al. (2011); and in a study by Ojea et al. (2009) only in one of four used models and with significance at $\alpha=10\%$.

The expected effect of population density in meta-analysis studies depends on the specification of the variable and its geographical extension. At the study site, we measure the presence of settlements and population pressure within the recreation site boundaries. On the other hand, measures of population density in a broader region or around the study site accounts for the accessibility, presence of close “source” of potential recreationists, and also a close source of hotels, restaurations, information centers and other recreational facilities that may not be present at the forest site itself. We confirm the results of Schägner et al. (2018) and previous results based on a subsample of our data (Kaprová and Melichar, 2014) that the population pressure measured directly at the recreation sites is negatively related to the recreation welfare. Lindhjem and Navrud (2008) found that forests in urbanized areas yield a significantly lower WTP for forest goods and services than forests in the open land (this result may, nonetheless, be driven not only by use values such as recreation value, but also by non-use values of forest, since the study covers both value types). Results for the population density in the surrounding area are mixed: Chiabai et al. (2011) do not find any significant effect of population (in totals) of the country of the study site and WTP per hectare per year, while Ojea et al. (2010) prove a positive effect on population in totals on WTP. In case that population density is used as a proxy for geographic location of forest sites in relation to population centres, a positive effect on CS may be observed (Giergiczny et al., 2008; Zandersen and Tol, 2009).

Studies which mention that the recreationists focus on a specific primary activity (18 % of the sample, includes picknicking, camping, rowing, gathering forest products and wildlife watching) influence the recreation consumer surplus positively.

The method of defining the substitute sites is still discussed and there does not exist any single methodologically preferred procedure. Some authors employ substitute price based on the nearest site with similar characteristics as the recreation site (Hellerstein and Mendehlson, 1993), other use indexes of accessibility (Lovett et al., 1997). Inclusion of quality variable of the substitute site is also possible (Rosenberger and Loomis 2001a). Treating substitutes is often hypothesised as a factor decreasing the welfare measure (Smith and Kaoru 1990a, 1990b; Rosenberger and Loomis, 2003; Liu and Stern, 2008). Inclusion of a substitute site in the questionnaire and in the estimation of the recreation demand model in the primary study is hypothesized to yield a negative effect on recreation welfare, which was proved in several previous studies (Smith and Kaoru, 1990a and 1990b; Shrestha and Loomis, 2003; Rosenberger and Loomis 2001a). In other analyses including Zandersen and Tol (2009), and Schägner et al. (2018), the effect is not modelled. In our analysis, inclusion of a substitute site is not statistically significant in the final model; also in Kaprová and Melichar (2014), the only significant negative values of the coefficient were found only in one model, where the dependent variable was CS per day.

Information on publication type allows for controlling of potential publication bias (Florax, 2001). Peer-reviewed studies are assumed to yield lower estimates of benefits than grey literature (Rosenberger and Stanley, 2006). 63% estimates of consumer surplus in our sample were published in peer-reviewed journals. The evidence of higher methodological prudence of studies that were published in peer-reviewed journals against grey literature (dissertation theses, working papers, conference proceedings, reports etc.; the sample does not contain MsC. theses) is found in both models, but is significant only in the first model. On the contrary, Zandersen and Tol (2009), using an older set of European forest recreation studies, found that estimates in MsC. and Ph. D. theses yield lower CS per trip than other types of dissemination. Schägner et al. (2018) do not employ a similar variable. In our case, the publication bias measure may coincide with other binary variables on the model specifications and estimation techniques, as also the selection of the methodology is likely to be influenced by the peer-reviewed process. For predictions, we would suggest to fix the levels of the methodological variables at methodologies that are most advanced (such as on-site model corrected for all econometric and data problems; or random utility models, which are very rare in the sample and thus not distinguished in the analysis).

Linear OLS forms 8% of the final sample and is not significantly related to the welfare measure. In the older sample of Zandersen and Tol (2009) from years 1979 to 2001, 95% of the welfare estimates originated in an OLS regression, and cca 1/3 of the sample was estimated using both sides linear, but the variable itself was not employed in their meta-regression model.

The way of calculation of travel cost as a shadow price of recreation experience may also affect the estimated welfare. Following Smith and Kaoru (1990a, 1990b) and Zandersen and Tol (2009), we focus on the opportunity cost of time in the primary studies, which represents an important input into the travel cost calculation. The magnitude of opportunity cost of time on travel depends on whether recreationists assign a utility value to the time on travel (which may be the case for shorter distance travels) or disutility value (which might hold particularly for long-distance travellers; this issue is further discussed by Freeman, 2003). Some authors exclude not only shadow price of time spent on the site, but also shadow price of time spent on travel - that is based on the assumption that in the short term people in most cases may face labour contract for fixed hours a week, with annual vacation within the contract, and travel time may not have a scarcity value for them (Bhat, 2003). Freeman (2003), nonetheless, shows that in the case of omission of shadow price of time the demand function for visits and downward bias of the travel cost variable results in higher elasticity of the demand curve and underestimation of the welfare measures. In our full sample of 282 observations, only 73% of the studies in the provide information on the calculation of travel cost, which also includes the treatment of opportunity cost of time. The percentage of wage rate used as a shadow cost of time is positively related to the welfare measure, which is in line with the results of our previous analysis where the variable worked in the same way for most specifications of recreation welfare. Also Smith and Kaoru (1990a, 1990b) and Zandersen and Tol (2009) found a positive relationship between opportunity cost of time measured as a fraction of wage and welfare measures.

Year of publication and year of data collection may also control for study quality, as they may represent a proxy for methodological advancements in modelling throughout time (Johnston et al., 2005; Liu and Stern, 2008). There are two contradictory phenomenons due to which we might expect the values to change over time: a decrease in value over time may be caused by methodological improvements over time, where newer studies widely utilize more appropriate techniques of estimation that frequently yield more prudent estimates. Due to this effect, the the time trend may exhibit this downward trend if methodological variables are not specifically modelled in the meta-analysis. On the contrary, this variable may capture the development in the preferences for recreation of the societies studied. We would expect that with growing amount of leisure time over years, a shift of preferences towards natural and forest recreation would occur, which may account for a positive change in welfare. Based on the results, the year in which the study was disseminated negatively affects the welfare measure specification in the first model, but the effect is not statistically significant and is dropped in the second stage of the analysis. The evidence on the time trend effect found in previous meta-analyses is mixed. The decrease of welfare estimates throughout time is confirmed by Zandersen and Tol (2009); although for example Rosenberger and Loomis (2001a) for USA estimates from time period 1967 to 1998 find opposite results. Up to circa 1990s the vast majority of estimates (although not necessarily majority of studies) were estimated using OLS, without accounting for specific data problems. Also, in the last decade the use of zonal travel cost method which was proved to yield lower CS estimates (Zandersen and Tol, 2009; Shrestha and Loomis, 2003) than individual travel cost method decreased sharply. Our study shows that in years 1980 to 2013, even after accounting for PPP and inflation, the welfare estimates in our sample do not change throughout time.

The result of methodological quality of the model is further shown by the effect of dummy variables interacted with onsite data collection in case that the modelling approach in the primary study accounted for the specific problems with on-site collected data: namely truncation and endogenous stratification. On-site collected data (66% of the final sample) do not necesarilly yield higher values than models incorporating general population or user lists. Within on-site models, correction for truncation as such (47% of the sample) brings no further significant improvement in these models. The correction for endogenous stratification (33% of the sample) is significant and positive; studies that manage to account for both of these problems (31% of the sample) yield the expected precision of the estimate downwards (in total by 2.6 EUR).

Concerning the TCM methodological variables, it would be very interesting to test first of all whether there are significant differences between the results of the two branches of recreation demand models that have been prioritized in recent travel cost applications: single site models and random utility models. As random utility models allow for a much more complex way of modelling of the substitution effect among recreation sites than the single site models, they may be theoretically preferred (Mayer and Woltering, 2018). The estimates of recreation value yielded by a single site model may differ from the RUM result mainly for those natural recreation sites which have several substitution possibilities in their surroundings (or also in the surroundings of the recreationists´ origin, if they travel a nonmarginal distance to reach the analyzed natural site).

However, the random utility travel cost studies focusing on terrestrial recreation are very rare in Europe, and only 3 of them are available in our data (Font, 2000; Termansen et al., 2008; Bestard and Font, 2010). These account only for 27 out of 288 observations in the full sample, which makes the RUM variable drop out of the model due to collinearity. One-sided t-test of ln(CS per trip) with unequal variances (as found in the data) proves that RUM yield significantly lower estimates of recreation values (with p-value of 0.0295). Other or newer European RUM studies on recreation in terrestrial ecosystems are not available, as the vast majority of RUM applications in recreation context focus on water quality or fishing values, or do not provide the monetary value estimates for recreation sites (Bakhtiari et al., 2014; Smirnov et al., 2012).

The same holds for all previous meta-analytic works focusing on travel recreation demand - not a study succeeded in collecting enough data on RUM estimates that would allow to compare the estimates of individual TCM and RUM in a meta-regression model. Zandersen and Tol (2009) and Shrestha and Loomis (2003) compare only individual TCM with zonal travel cost model studies. Other more general meta-analyses (e. g. Schägner et al., 2018, Chiabai et al., 2011 or Ojea et al., 2009, 2011) due to incorporation of more environmental valuation techniques (as CVM or CE) do not allow at all for modelling of the methodological effects in such detail.

Frequently, the authors use several model specifications in one study (for example, in single-site travel cost studies it is common to show differences in results yielded by several models that successively relax the assumptions on the data structure), and compare the results in a discussion. The authors often conclude with one or more specifications as preferred for estimation of welfare measures based on methodological or econometric qualities of the model, or based on its flexibility. We supposed that these estimates preferred by the authors for the drawing the conclusions of the studies (46 % of the final sample) would be more conservative than the other ones presented in the study. Similar measure was used by Ojea et al. (2010). On the contrary, we can observe from the results that the preferred estimates are those that yield generally higher welfare measures, on average by 6.2 EUR.

Benefit transfer and transfer errors

After the estimation, we test the reliability of the model for benefit transfers, i.e. prediction of average forest recreation value for specific forests or forest in countries that have not been yet subject to conduction of a primary study. Opposed to the previous scientific evidence, our sample encompasses also a significant portion of studies that report on recreation values of sites in Central and Eastern Europe. The preferences of recreationists in this large post-transition area in Europe for recreation in open spaces may differ from preferences of the Northern and Western (or Southern) European populations, which typically constitute the whole sample or vast majority of the sample in the previous meta-analytic works (e. g. Zandersen and Tol, 2009 and Schägner et al., 2018).

In previous benefit transfer exercises focused on forest recreation, reliability and accuracy of benefit transfer of forest recreation benefits have been tested in various ways when the original value associated with a study site was known. The use of subset transfer experiments is frequent, correlation and regression of predicted and original mean values, and several studies report transfer errors within or out of sample (Bartczak et al., 2008b). The performance of benefit transfer is frequently measured using the absolute transfer error (TE) or the absolute transfer error (ATE), which are defined as:

$$TE = \frac{B_p^{est} - B_p^{obs}}{B_p^{obs}}$$

$$ATE = \frac{|(B_p^{est} - B_p^{obs})|}{B_p^{obs}}$$

where B_p^{est}represents the transferred value of the benefit estimated in meta-analytic study (or using other transfer technique - see Navrud and Ready, 2007) and B_p^{obs} is the original value associated with the study site estimated in a primary study.

According to Navrud and Ready (2007), the differences between the transferred value estimates and the values estimated at the policy site should be small enough to preserve reliability, for example around 20-40%. However, Brander et al. (2006) point out that for wetland ecosystem services, where the reporting of benefit transfer error is more extended than in forest benefit transfer studies, most of the meta-studies achieve a transfer error of cca 80%, which is considered acceptable in using the results of transfer as an input in wetland conservation decisions when taking into account the high costs of performing new primary valuation studies. Actually, very few studies report on the errors and those that do, relate mostly to different biotopes such as marine reefs (Fitzpatrick et al., 2017). Schägner et al. (2018) provide a nice overview in the supplementary materials of their study, which shows that the absolute transfer errors, if reported, commonly exceed 100%.

Concerning the performance of different approaches to benefit transfer, Rosenberger and Phipps (2001) prove in a review that the relative performance of function value transfer is better than unit value transfer. US EPA (2000, p. 87) considers meta-analysis to be "the most rigorous of benefit transfer exercises". On the other hand, in some cases the meta-regression function is very complex and comprises many types of values and different environmental goods (Ojea et al., 2011). The complexity of the function may then hinder the achievement of low transfer errors when predicting specific values attributable to a specific ecosystem service and in this case, a high-quality primary study where the characteristics of the study site correspond well to the policy site, a simple unit value transfer may result in more precise estimate. Santos (2007) represents such a case, where benefit transfer based on single best study clearly outperformed in accuracy other different BT approaches and models.

Figure 2 displays the scatterplot of actual and fitted values in the final sample of observations for the model II. It is apparent that for low values, the prediction is relatively precise; however, for larger primary values, the variability of the predictions increases. Figure 3 displays the prediction error of the model II (positive or negative values) against actual forest recreation values.

Figure 2: Scatterplot of actual vs. fitted forest recreation values in the sample

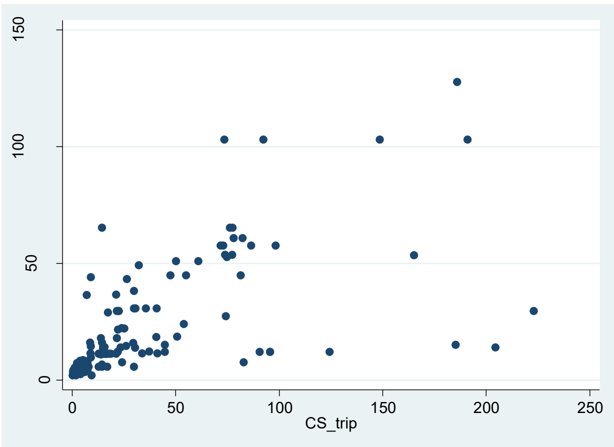


Figure 3: Scatterplot of actual forest recreation values vs. transfer error of the model

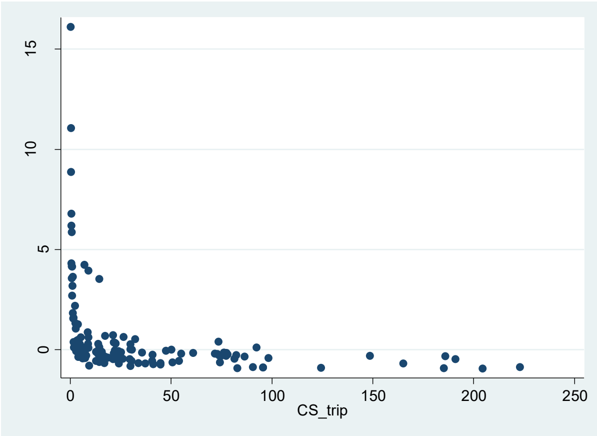
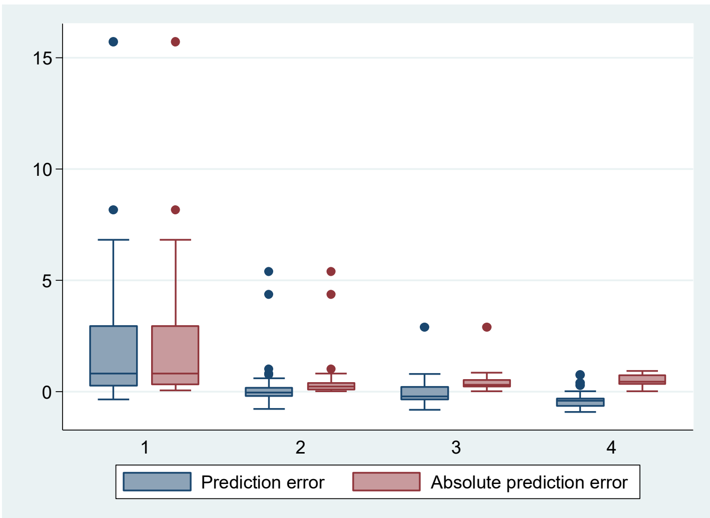


Figure 4 shows the boxplots of in-sample transfer errors and absolute errors of the model II. The average in-sample transfer error is 46%, with a median of -12%. The average in-sample absolute transfer error is 89%, with a median of 33%. Figure 4 further disentangles both errors into data quartiles. The in-sample accuracy of prediction in the first quartile of the dependent variable is however worse (mean absolute error in ascending order of CS per trip quartiles: 225%, 43%, 44%, 46%). The model tends to systematically overpredict very low values (average error in the first quartile, i. e. up to 2.4 EUR per trip, i. e. +221%), and underpredicts high values (average error in the last quartile, i. e. over 30.4 EUR per trip, being -41%). It works best in the second and third quartile of CS per trip. The magnitude of transfer error is not related to any of the original explanatory variables, but has a slight quadratic shape for GDP per capita.

Figure 4: Boxplots of in-sample transfer errors and absolute transfer errors of the model II



We further conduct a simple simulation of the most common geographical distribution of the sample of latest European meta-analyses (i. e. Schägner et al., 2018; Zandersen and Tol, 2009): We estimate the model again (as model III) using a subset of our data, incorporating study sites and visitor populations located in Western, Northern and Southern Europe (WNS). Then we compare the transfer errors of model III with the errors of model II that was based on full sample including also recreation sites in Central and Eastern Europe (CEE). The aim is to test for the transfer errors that would be caused by estimating the European meta-analytic recreation model using only study sites and visitor populations located in Western, Northern and Southern Europe if these values are transferred to study sites located in Central and Eastern Europe.

While the average CS per trip in Western, Northern and Southern part of the sample (accounting for 123 observations) is 30.5 EUR, Central and Eastern European values are lower: 23.8 EUR on average only (49 observations).

Model III was estimated using the same procedure as Model II (stepwise selection), so that to maximize the fit with the subset of data located in Western, Northern and Southern Europe. The results of modelling are displayed in Table 6.

Table 6: Meta-regression results with Ln (CS_trip) as dependent variable - model III based on WNS subset of the data (after stepwise selection of variables)

Var. type	Variable	Model (III)	
		Coef. [1]	Std. Err. [2]
-	Intercept	-107.7***	-40.730
Forest recreation site characteristics	Area		
	Ln (broadleaved)	0.0501**	-0.022
	Ln (coniferous)		
	Ln (grassland)	-0.0779***	-0.028
	National Park	1.091***	-0.281
	Altitude	0.001	-0.001
	Precipitation 5-10		
	Temperature 5-10	0.0275***	-0.005
Socio-economic	Ln (GDP/cpt)		
	Population density	-0.00698***	-0.001
	Explicit activity	2.622***	-0.532
Study methodological variables	Substitute		
	Journal	-1.371***	-0.338
	Linear model		
	Wage rate	0.0211***	-0.007
	Year		
	On-site		
	On-site endostrat	1.258***	-0.353
	On-site trunc		
	On-site trunc_endostrat	-0.842**	-0.371
	Estimate preferred	0.379**	-0.190
	Model	**OLS robust**	
	No. Observations	**123**	
	No. Studies	**17**	
	No. Countries	**7**	
	R^2	**0.739**	
	Breusch-Pagan test (p-value)	**1.000**	
	Average VIF[3]	**3.307**	

Notes:

1 *We report significance as follows: *** p<0.01, ** p<0.05, * p<0.1..*

2 *Standard errors of estimates are corrected for heteroskedasticity using the robust Huber-White estimator.*

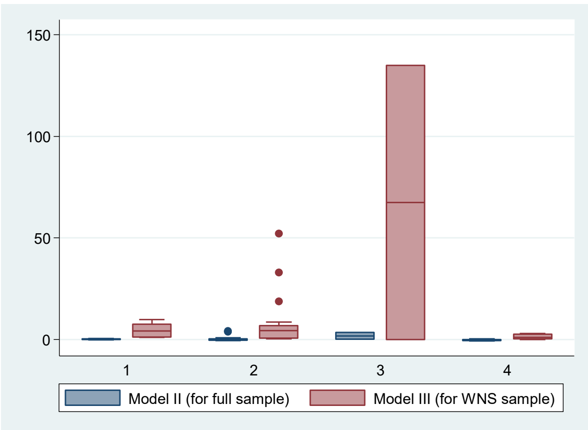
3 *We calculate VIF without incorporation of interaction variables that are correlated by definition.*

The most apparent differences of the results of Model III compared to Model II are that in the WNS countries, recreation areas in the national park yield a significantly higher recreation values (if we employ the whole dataset including also CEE countries - Model II, this effect becomes insignificant). Also, the average temperature at the recreation site seem to matter more in WNS countries and the WNS recreationists do not welcome grassland areas at the natural sites for their recreation. On the contrary, the preferences concerning coverage of broadleaved trees is stable across both models, as well as the effects of socio-economic variables. Concerning the methodological variables, the only apparent difference is that in WNS countries, there is a significant tendency to publish more conservative estimates of the recreation welfare in journals; in the whole sample, there is no difference in the magnitude of published and non-published estimates of welfare.

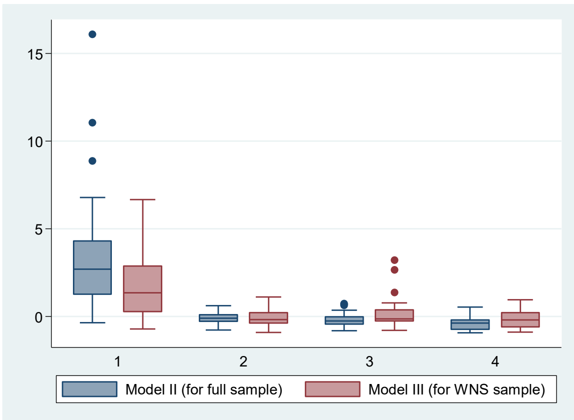
Using Model II and Model III predictions, we calculate the transfer errors using the formulas stated above.Figure 5 shows the (positive and negative) transfer errors, where the blue boxplots indicate in-sample transfer errors of the model II using the whole dataset, and the red boxplots indicate in-sample and out-of-sample transfer errors of the model III fitted to the subset of the dataset accounting only for study sites and visitor populations located in Western, Northern and Southern Europe (WNS subset of the sample).

Figure 5: Boxplots of transfer errors for recreation welfare estimates over quartiles of CS/trip (using either Model II based on the full sample, or Model III designed for the WNS subset of the sample):

a) In Central and Eastern Europe

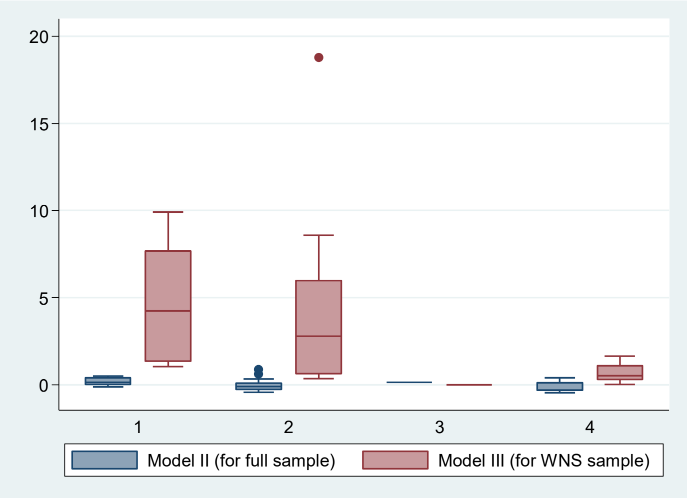


b) in Western, Northern and Southern Europe



We may observe that the meta-analytic transfer of recreation values from the WNS subset of the sample to recreation sites in Central and Eastern Europe (i. e. out of sample) is related with much higher benefit transfer errors than in the case of employing a geographically more balanced sample that incorporates also the studies from these post-transition countries (i. e. our “full sample”). That holds for all quartiles of the dependent variable. If the model is based only on WNS subset, it predicts more precise values for the WNS studies (as we would expect), but much less precise values for the recreation sites in CEE. The CEE studies for which the out-of-sample prediction from the WNS subset works worst are Czajkowski et al. (2013) and Melichar (2007). Even if we do not account for these two studies, the errors of model using WNS sample for Central and Eastern European welfare estimates are significantly higher than those from the model using full data (Figure 6).

Figure 6: Boxplots of transfer errors of the model II for recreation welfare estimates over quartiles of CS/trip (using either Model II based on the full sample, or Model III designed for the WNS subset of the sample) in Central and Eastern Europe, with Czajkowski et al. (2013) and Melichar (2007) omitted:



The results of this chapter show that the model based only on subset of the data located in Western, Northern or Southern Europe tends to systematically overpredict the recreation values of natural sites located in Central and Eastern Europe.

In previous meta-analyses, the samples were based on values with much lower range of variation than we observed. Zandersen and Tol (2009) employs sample where consumer surplus per trip ranges between 0.66 and 112 EUR; Schägner et al. (2018) uses sample from 0.16 to 64.7 EUR per visit. Also in our previous analysis (Kaprová and Melichar, 2014), we trimmed the sample to contain only lower values, where the model works best. That enables to achieve low transfer errors within the sample of values (mean absolute error over quartiles of data in our previous estimation was 41%). There is an evident trade-off between the model fit and representation of the real distribution of the estimated recreation values in the primary studies.

While the cutoff of higher values improves significantly the model fit, the use of lower values for meta-analytic benefit transfers may lead to an overall impression of both researchers and policymakers that the values of natural ecosystems are actually lower than a nonmarginal portion of the primary studies show. Even the meta-models tend to predict lower values than observed for the upper half of the sample (see also our results in Figure 2). For example

Schägner et al. (2018) come to predictions of recreation values in European ecosystems from 1 to 45 EUR per visit. Our previous analysis on more conservative sample of data lead to national values that were half of the magnitude of those presented above. This downward "bias" could be however equally problematic as the publication bias that we discussed above.

Conclusion

The study focuses on synthesis of recreation demand values attributed to natural areas in Europe. We derive a measure of central tendency of European estimates from the published recreation studies in the past 35 years that based on primary microeconomic data. The average CS per trip in Europe based on the full sample of primary studies and welfare estimates is 42 EUR 2017. Since the estimates are substantially heterogeneous across the primary studies, we further disentangle the driving forces of variability in reported values in a meta-analytic model as the next step of the analysis.

One of the key results from our meta-analysis of European forest recreation values is that higher recreation values are associated with larger remote forests in sparsely populated areas, that preferably constitute of broadleaved forests. The methodological variables of travel cost method are inspected in detail and are highly significant in both models that we employ.

The academic debate on the validity of the benefit transfer method still continues. Up to present, our study is the only one on European level that incorporates a significant number of primary value estimates accounting for preferences of recreationists from Central and Eastern Europe into the data sample. Using a simple split sample analysis and out of sample prediction tests we confirm that a meta-analytic benefit transfer from Northern, Western and Southern outdoor recreation sites to sites located in Central and Eastern Europe leads to an overprediction of the recreation values in all quartiles of CS per trip.

There is clearly still a room for improvement in benefit transfer exercises on forest recreation values and other environmental valuation topics in European geographical context. Higher coverage by studies throughout Europe, in particular by those of high methodological prudence, and mainly in Central and Eastern Europe where the empirical evidence is still relatively scarce, would help to increase the knowledge about geographical distribution of forest recreation benefits.

Acknowledgements

This article was supported by the 7th FP EC grant Global-IQ: Impacts Quantification of global changes. The support is gratefully acknowledged.

References

Arellano, M. (1993): On the testing of correlated effects with panel data. *Journal of Econometrics 59*, p. 87–97.

Bakhtiari F. Jacobsen J.T. Jensen F.S. (2014): Willingness to travel to avoid conflicts in Danish forests. *Urban Forestry & Urban Greening 13(4),* p. 662-671.

Barrio, M., and M. L. Loureiro (2010): A Meta-Analysis of Contingent Valuation Forest Studies. *Ecological Economics 69(5),* p. 1023-1030.

Bartczak, A., H. Lindhjem, S. Navrud, M. Zandersen, T. Żylicz (2008a): Valuing forest recreation on the national level in a transition economy: The case of Poland. *Forest Policy and Economics 10 (7-8)*, p. 467-472.

Bartczak, A., H. Lindhjem, A. Stenger (2008b): Review of benefit transfer studies in the forest context. In: *Proceedings of the Biennial Meeting of the Scandinavian Society of Forest Economics*, Lom, Norway, 6-9 April 2008, p. 276-304.

Bartczak, A., M. Czajkowski, M. Giergiczny, A. Kopańska, T. Żylicz, K. Rykowski, E. Chećko, H. Lindhjem, K. G. Bråten (2009). *Review of instruments and valuation methods for multifunctional forest policy.* POLFOREX project. 144 p.

Barton, D.N. (1999): *The quick, the cheap and the dirty. Benefit transfer approaches to the non-market valuation of coastal water quality in Costa Rica*, Ph.D. thesis, Department of Economics and Social Sciences, Agricultural University of Norway.

Bateman, I.J., and A.P. Jones (2003): Contrasting Conventional with Multi-Level Modeling Approaches to Meta-Analysis: Expectation Consistency in U.K. Woodland Recreation Values. *Land Economics 79(2),* p. 235-258.

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*, p. 191-205.

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

Belsley, D. A., E. Kuh, R. E. Welsh (1980): *Regression diagnostics: identifying influential data and sources of collinearity.* Wiley series in probability and mathematical statistics. New York, John Wiley and Sons.

Bergstrom, J. C. and L. O. Taylor (2006): Using meta-analysis for benefits transfer: Theory and practice. *Ecological Economics 60*, p. 351-360.

Bhat, M. G. (2003): Application of non-market valuation to the Florida Keys Marine Reserve management, *Journal of Environmental Management, 67(4),* p. 315–325.

Boyd, J. and A. Krupnick (2009): The Definition and Choice of Environmental Commodities for Nonmarket Valuation," RFF Discussion Paper 09-35, Resources for the Future, Washington D.C.

Boyle, K., J. C. Bergstrom (1992): Benefit transfer studies: Myths, Pragmatism, and Idealism. *Water Resources Research 28(3)*, p. 657-663.

Boyle, K.J., G.L. Poe and J.C. Bergstrom (1994): What do we know about groundwater values? preliminary implications from a meta-analysis of contingent valuation studies, *American Journal of Agricultural Economics 76,* p. 1055–61.

Brander, L.M., R.J.G.M. Florax, and J.E. Vermaat (2006): The empirics of wetland valuation: A comprehensive summary and a meta-analysis of the literature. *Environmental and Resource Economics 33*, p. 223–50.

Brouwer, R., I.H. Langford, I.J. Bateman, R.K. Turner (1999): A Meta-Analysis of Wetland Contingent Valuation Studies. *Regional Environmental Change 1 (1),* p. 47-57.

Button, K.J. (1995): What can meta-analysis tell us about the implications of transport? *Regional Studies 29,* p.507-17.

Caulkins, P. P., R. C. Bishop, N. W. Bouwes (1985): Omitted cross-price variables in the linear travel cost model: correcting common mis-perceptions. *Land Economics 61(2),* p. 182-187.

Chiabai, A., Ch. M. Travisi, A. Markandya, H. Ding, P. A. L. D. Nunes (2011): Economic assesment of forest ecosystem services losses: cost of policy inaction. *Environmental and Resource Economics 50,* p. 405-445.

Desvousges, W. H., F. R. Johnson, H. S. Banzhaf (1998): *Environmental Policy Analysis with Limited Information: Principles and Application of the Transfer Method.* Cheltenham, Edward Elgar, 244 p.

EEA -European Environment Agency (2013): *CDDA (Common Database on Designated Areas)*. On-line. URL:<http://www.eea.europa.eu/data-and-maps/data/nationally-designated-areasnational-cdda-7>. Accessed on 15 January 2015.

EFI and EC (2006): *Forest Mapping.* European Forest Institute and JRC (Joint Research Center) Forest Cover Maps. On-line. URL:<http://forest.jrc.ec.europa.eu/download/data/>. Accessed on 15 January 2015.

ETC/LC - European Topic Centre On Land Cover (1994): *CORINE Land Cover Technical Guide. Office for Official Publications of European Communities*, Luxembourg. 163 p.

Fitzpatrick, L., Ch. Parmeter, J. Agar (2017): Threshold effects in meta-analyses with application to benefit transfer for coral reef valuation. *Ecological Economics 133 (C),* p.74–85.

Florax, R. J. C. M. (2001): *Methodological Pitfalls in Meta-Analysis: Publication Bias.* Research Memorandum 2001-28, Free University of Amsterdam.

Freeman, A. M. III. (2003): *The Measurement of Environmental and Resource Values: Theory and Methods*, Resources for the Future, Washington, DC. ISBN: 1-89185-362-7.

Giergiczny, M., R. Mavsar, Z. Wenchao (2008): *Report Documenting the Results of the Meta-data Analysis Linking the Monetary Values with the Physical Characteristics of Forests.* Report for EC Integrated Project No. 037033 EXIOPOL: A new environmental accounting framework using externality data and input-output tools for policy analysis. 41 p.

Glass, G. V. (1976): Primary, Secondary and Meta-Analysis of Research. *Educational Researcher 5.*

Hanley, N., K. Willis, N. Powe, M. Anderson (2002): *Valuing the benefits of biodiversity in forests.* Report to Forestry Commission Edingurgh. Social and Environmental Benefits of Forestry, Phase 2. Centre for Research in Environmental Appraisal and Management, University of Newcastle. 65 p.

Hellerstein, D., R. Mendelsohn (1993): A theoretical foundation for count data models. *American Journal of Agricultural Economics 75(3),* p. 604-611.

Huber, P.J. (1967): The behavior of maximum likelihood estimates under nonstandard conditions. In: *Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability vol. 1.* Berkeley, CA, University of California Press, p. 221–223.

Huhtala, A., E. Pouta (2006): *Discerning welfare impacts of public providion of recreation areas.* Paper presented at EAERE Conference 2006.

Jacobsen, J. B., N. Hanley (2009): Are there income effects on global willingness to pay for biodiversity conservation? *Environmental & Resource Economics 43*, p. 137-160.

Johnston, R. J., Besedin, E. Y., Iovanna, R., Miller, C. J., Wardwell, R. F., Ranson, M.H. (2005): Systematic variation in willingness to pay for aquatic resource improvements and implications for benefit transfer: a meta-analysis. *Canadian Journal of Agricultural Economics-Revue Canadienne d' Agroeconomie, 53(2-3),* p. 221-248.

Kaprová, K., J. Melichar (2014): *Review and meta-analysis of monetary values for non-market goods and services affected by climate change: land use, ecosystem, leisure.* Deliverable No. D2.1 „Analysis of key determinants of costs and benefits of mitigation policy"of GLOBAL IQ - Impacts Quantification of global changes (Project no 266992). Chapter 1.

Krupnick, A., D. McLaughlin (2011): *Valuing impacts of climate change on terrestrial ecosystem.* Resources for the Future.

Kukielka, J. B., R. J. Johnston, J. M. Duke (2008): *Systematic variation in willingness to pay for agricultural preservation and implication for benefit transfer: a meta-analysis.* Paper presented at the 2008 Annual Meeting of the American Agricultural Economics Association, Orlando, FL. July 27-29.

Lindhjem, H. (2007): 20 years of stated preference valuation of non-timber benefits from Fennoscandian forests: a meta-analysis. *Journal of Forest Economics 12*, p. 251-277.

Lindhjem, H. and S. Navrud (2008): How Reliable are Meta-Analyses for International Benefit Transfers? *Ecological Economics 66(2-3)*, p. 425-435.

Liu, S., and D.I. Stern (2008): *A Meta-Analysis of Contingent Valuation Studies in Coastal and Near-Shore Marine Ecosystems.* Working Paper No. 11720, Munich Personal RePEc Archive. Available at http://mpra.ub.uni-muenchen.de/11720/. Retrieved on June 18, 2010.

Loomis, J.B. and D.S. White (1996): Economic benefits of rare and endangered species: summary and meta-analysis, *Ecological Economics 18*, p. 197–206.

Lovett, A., Brainard, J., and Bateman, I. (1997): Improving benefit transfer functions: a GIS approach. *Journal of environmental management 51*, p. 373–389.

Magnussen, K. (1993): *Mini meta-analysis of Norwegian water quality improvements valuation studies*, Norwegian Institute for Water Research, Oslo.

Mayer, M., M. Woltering (2018): Assessing and valuing the recreational ecosystem services of Germany's national parks using travel cost models. *Ecosystem Services 31*, p. 371-386.

Mrozek, J. R., L. O. Taylor (2002): What Determines the Value of Life? A Meta- Analysis. *Journal of Policy Analysis and Management 21(2)*, p. 253-270.

Navrud, S. and R. Ready, eds. (2007): *Environmental value transfer: issues and methods.* Springer, 290 p.

O´Brien, R. (2007). A Caution regarding ruels of thumb for variance inflation factors. *Quality and Quantity 41*, p. 673-690.

Ojea, E., M. L. Loureiro (2011): Identifying the scope effect on a meta-analysis of biodiversity valuation studies. *Resource and Energy Economics 33*, p. 706-724.

Ojea, E., P. A. L. D. Nunes, M. L. Loureiro (2009): Mapping of forest biodiversity values: a plural perspective. Fondazine Eni Enrico Mattei 04.2009.

Ojea, E., P. A. L. D. Nunes, M. L. Loureiro (2010): Mapping biodiversity indicators and assessing biodiversity values in global forests. *Environmental and Resource Economics 47(3),* p. 329-347.

Parsons, G. R. (2003): The Travel Cost Method. In Champ, P. A., Boyle, K. J., Brown, T. C. (eds.). *A Primer on Nonmarket Valuation*, London: Kluwer Academic Publishers.

Pearson, K. (1904): Report on certain enteric fever inoculation statistics. *British Medical Journal 3*, p. 1243–1246.

Rosenberger, R. S., J. B. Loomis (2001a): *Benefit Transfer of Outdoor Recreation Use Values. A Technical document supporting the Forest Service Strategic Plan (2000 Revision).* Gen. Tech. Rep. RMRS-GTR-72. Fort Collins, CO: U. S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 59 p.

Rosenberger, R. S., J. B. Loomis (2001b): Panel stratification in meta-analysis of economic studies: an investigation of its effects in the recreation valuation literature. *Journal of Agricultural and Applied Economics 32 (3)*, p. 459–470.

Rosenberger, R. S., J. B. Loomis (2003): Benefit transfer. In P.A. Champ, K.J. Boyle, & T.C. Brown (Eds.), *A primer on nonmarket valuation*, Dordrecht, The Netherlands: Kluwer Academic Publishers.

Rosenberger, R. S., T. D. Stanley (2006). Measurement, generalization, and publication: Sources of error in benefits transfers and their management. *Ecological Economics 60,* p. 372-378.

Rosenberger, R. S., T. T. Phipps (2001): *Site correspondence effects in benefit transfers: A meta-analysis transfer function.* Research Paper 2001-6, West Virginia University.

de Salvo, M., G. Signorello (2015): Non-market valuation of recreational services in Italy: A meta-analysis. *Ecosystem Services 16,* p. 47-62.

Santos, J. M. L. (2007): Transferring landscape values: How and how accurately? in S. Navrud and R. Ready, Eds, *Environmental Value Transfer: Issues and Methods.* Springer.

Scarpa, R., W. G. Hutchinson, S. Chilton, J. Buongiorno (2000): Importance of forest attributes in the willingness to pay for recreation: A contingent valuation study of Irish forests. *Forest Policy and Economics 1(3-4),* p. 315-329.

Schägner, J. P., L. Brander, M. L. Paracchini, J. Maes, F. Gollnow, B. Bertzky (2018): Spatial dimensions of recreational ecosystems service values: A review of meta-analyses and a combination of meta-analytic value-transfer and GIS. *Ecosystem Services 31(C)*, p. 395-409.

Schwartz, J. (1994): Air pollution and daily mortality: a review and meta analysis. *Environmental Research 64*, p. 36-52.

Sen, A., A. R. Harwood, I. J. Bateman, P. Munday, A. Crowe, L. Brander, J. Raychaudhuri, A. A. Lovett, J. Foden, A. Provins (2014): Economic Assessment of the Recreational Value of Ecosystems: Methodological Development and National and Local Application. *Environmental and Resource Economics 57*, p. 233-249.

Shrestha, R. K., J. B. Loomis (2003): Meta-analytic benefit transfer of outdoor recreation economic values: testing out-of-sample convergent validity. *Environmental and Resource Economics 25 (1),* p. 79–100.

Shrestha, R. K., Loomis, J. B. (2001): Testing a meta-analysis model for benefit transfer in international outdoor recreation. *Ecological Economics 39*, p. 67-83.

Shrestha, R. K., R.S. Rosenberger, and J.B. Loomis (2007): Benefit Transfer Using Meta-Analysis in Recreation Economic Valuation. In Navrud S., and R. Ready (eds.): *Environmental Value Transfer: Issues and Methods*, Springer, p. 161-177.

Smirnov, O. A., K. J. Egan (2012): Spatial random utility model with an application to recreation demand. *Economic Modelling 1*, p. 72-78.

Smith, V.K., G. Van Houtven, S. K. Pattanayak (2002): Benefit transfer via preference calibration: "prudential algebra" for policy, *Land Economics 78 (1),* p. 132–52.

Smith, V.K., Y. Kaoru (1990a): Signals or noise? Explaining the variation in recreation benefit estimates, *American Journal of Agricultural Economics, 72 (2),* p. 419–33.

Smith, V.K., Y. Kaoru (1990b): What have we learned since Hotelling´s letter? A Meta-analysis. *Economic Letters 32,* p. 267-272.

Sturtevant, L.A., F.R. Johnson, W. H. Desvousges (1995): *A Meta -analysis of Recreational Fishing*. Triangle Economic Research, Durham.

US EPA (2000): *Guidelines for Preparing Economic Analyses*. Office of the Administrator. EPA-240- R-00-003. September.

Van den Bergh, J.C.M., Button, K.J., Nijkamp, P., Pepping, G.C. (1997): *Meta-analysis in Environmental Economics.* Kluwer, Dordrecht.

Van der Ploeg, S., R.S. de Groot (2010): *The TEEB Valuation Database – a searchable database of 1310 estimates of monetary values of ecosystem services.* Foundation for Sustainable Development, Wageningen, The Netherlands.

Walsh, R. G., D. M. Johnson, and J. R. McKean (1989a): Issues In Nonmarket Valuation And Policy Application: A Restrospective Glance. *Western Journal of Agricultural Economics 14,* p. 178-188.

Walsh, R. G., D. M. Johnson, J. R. McKean (1989b): *Review of outdoor recreation economic demand studies with nonmarket benefit estimates, 1968-1988*. Colorado Water Resources Research Institute. 134 p.

Walsh, R.G., D.M. Johnson and J.R. McKean (1990): *Nonmarket values from two decades of research on recreation demand' in Advances in Applied Micro-economics*, vol. 5, Greenwich, CT: JAI Press Inc., p. 167–93.

Walsh, R.G., D.M. Johnson, J.R. McKean (1992): Benefit transfer of outdoor recreation demand studies, 1968–1988, *Water Resources Research, 28 (3),* p. 707–14.

White, H. (1980): A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica 48*, p. 817–830.

Willis, K., G. Garrod, R. Scarpa, N. Powe, A. Lovett, J. I. Bateman, N. Hanley, and D. C. Macmillan (2003): *The social and environmental benefits of forests in Great Britain*, Report to Forestry Commission, Edinburgh.

Woodward, R. T., Y.-S. Wui (2001): The Economic Value of Wetland Services: A Meta-Analysis. *Ecological Economics 37*, p. 257-270.

Zandersen, M. (2005): *Valuing Forest Recreation in Europe: Time and Spatial Considerations.* Dissertation Thesis. Hamburg University.

Zandersen, M., M. Termansen, F. S. Jensen (2007): Testing benefit transfer of forest recreation values over a twenty-year time horizon. Land Economics 83(3), p. 412-440.

Zandersen, M., R. S. J. Tol (2009): A Meta-analysis of Forest Recreation Values in Europe. *Journal of Forest Economics 15,* p. 109-130.

Primary studies

Baranzini, A., D. Rochette (2008): La demande des usages récréatifs pour un parc naturel. Une application au Bois de Pfyn-Finges, Suisse. *Économie rurale 306,* p. 55-70.

Bartczak, A., Czajkowski, M., Giergiczny, M., Zylicz, T., Checko, E., Navrud, S., Englin, J., Pang, A. (2010): Report on national and local forest sites survey. POLFOREX.

Bartczak, A., H. Lindhjem, S. Navrud, M. Zandersen, T. Zylicz (2008a): Valuing forest recreation on the national level in a transition economy: The case of Poland. *Forest Policy and Economics 10 (7-8),* p. 467-472.

Bartczak, A., J. Englin, A. Pang (2012): When are forest visits valued the most? An analysis of the seasonal demand for forest recreation in Poland. *Environmental and Resource Economics 52*, p. 249-264.

Bateman, I. J., J. S. Brainard, A. A. Lovett, G. D. Garrod (1999): The impact of measurement assumptions upon individual travel cost estimates of consumer surplus: a GIS approach. *Regional Environmental Change 1 (1),* p. 24-30.

Bellu, L. G., V. Cistulli (1997): Economic valuation of forest recreation facilities in the Liguria region (Italy). CSERGE working paper GEC 97-08.

Bestard, A. B., A. R. Font (2010): Estimating the aggregate value of forest recreation in a regional context. *Journal of Forest Economics 16*, p. 205-216.

Creel, M., M. Farell (2008): Usage and valuation of natural parks in Catalonia, 2001-2001. *Investigaciones económicas 23 (1),* p. 5-25.

Cullinan, J. (2011): A spatial microsimulation approach to estimating the total number and economic value of site visits in travel cost modelling. *Environmental and Resource Economics 50,* p. 27-47.

Cullinan, J., S. Hynes, C. O´Donoghue (2011): Using spatial microsimulation to account for demographic and spatial factors in environmental benefit transfer. *Ecological Economics 70,* p. 813-824.

Czajkowski, M., Giergiczny, M., Kronenberg, J., Tryjanowski, P. (2012): *The economic value of a White Stork nesting colony: a case of 'stork village' in Poland.* Working Papers, 11/2012 (77). Faculty of Economic Sciences, University of Warsaw.

Czajkowski, M., M. Giergiczny, J. Kronenberg, J. Englin (2013): *The individual travel cost method with consumer-specific values of travel time savings.* Paper presented at EAERE 2013 conference, Toulousse.

De Frutos, P., F. Martínez Pena, P. Ortega Martínez, S. Esteban (2009): Estimating the social benefits of recreational harvesting of edible wild mushrooms using travel cost method. Investigación Agraria: *Sistemas y Recursos Forestales 2009 18(3),* p. 235-246

Dumitras D. E., S. Dragoi (2006): Estimation of the recreation values of romanian parks by travel cost methods. *Buletin USAMV-CN* 63/2006.

Dumitras, D. E., M. Ilea, I. M. Jitea, F. H. Arion (2012): The recreation value of Piatra Craiului National Park: A combined travel cost and contingent valuation survey. *Bulletin UASVM Horticulture, 69 (2),* p. 116-121.

Englin, J., A. Gelan, A. Pang (2011): *Modeling Recration Demand for British Forests - an application of an endogenously stratified and truncated log-normal distribution.* Paper presented at the 18th annual conference of the European Association of Environmental and Resource Economists, Rome, Italy, 29 June - 2 July 2011. Nairobi, Kenya: ILRI.

Font, A. R. (2000): Mass Tourism and the Demand for Protected Natural Areas: A Travel Cost Approach. *Journal of Environmental Economics and Management 39*, p. 97-116.

Garcia, S., J. Jacob (2010): La valeur récréative de al forêt en France: une approche par les coûts de déplacement. *Revue d´Etudes en Agriculture et Environment 91 (1),* p. 43-71.

Getzner, M. (2009): Economic and cultural values related to protected areas. Part A: valuation of ecosystem services in Tatra (PL) and Slovensky Raj (SK) national parks. Final report, 13 November 2009. Commissioned by WWF and Danube Carpathian Programme.

Hanley, N. D. (1989): Valuing rural recreation benefits: an empirical comparison of two approaches. *Journal of Agricultural Economics 40 (3),* p. 361-374.

Hein, L. (2011): Economic benefits generated by protected areas: the case of the Hoge Veluwe Forest, the Netherlands. *Ecology and Society 16(2)*, Article 13.

Huhtala, A., E. Pouta (2006): *Discerning welfare impacts of public providion of recreation areas.* Paper presented at EAERE Conference 2006.

Hynes, S., B. Cahill (2007): *A combined stated-revealed preference model of recreation in irish forestry.* The rural economy research centre working paper series, working paper 07-WP-RE-10.

Christie, M., N. Hanley, B. Garrod, T. Hyde, N. Lyons, A. Bergmann, S. Hynes (2005): *Valuing Forest Recreation Activities.* Final Phase 2 Report to the Forestry Commission.

Klein, R. J. T., I. J. Bateman (1998): The Recreational Value of Cley Marshes Nature Reserve: An Argument Against Managed Retreat? *Water and Environment Journal 12*, p. 280-285.

Liston-Heyes, C., A. Heyes (1999): Recreational benefits from the Dartmoor National Park. *Journal of Environmental Management 55*, p. 69-80.

Lupa, P. (2012): Ecosystems´local recreational services valuation. Krajenka municipality case study. *Ekonomia i Srodowisko 2(42),* p. 209-222.

Mayor, K., S. Scott, R. S. J. Tol (2007): *Comparing the travel cost method and the contingent valuation method: An application of convergent validity theory to the recreational value of Irish forests.* Working paper, The Economic and Social Research Institute, Dublin, no. 190.

Melichar, J. (2007): *Aplikace metody cestovních nákladů v oblasti Jizerských hor (In Czech: Application of travel cost method in Jizerske hory Mountains).* Dissertation thesis. University of Economics.

Mitrica, E., B Mitrica, A. Stanculescu (2013): Economic analysis of nature preservation investments: the zonal travel cost approach applied for Harghita County of Romania. *Environmental and Ecological Statistics.*

Ovaskainen, V., J. Mikkola, E. Pouta (2001): Estimating recreation demand with on-site data: an application of truncated and endogenously stratified count data models. *Journal of Forest Economics 7(2),* p. 125-144.

Signorello, G., J. Englin, A. Longhorn, M. De Salvo (2009): Modelling the demand for Sicilian Regional Parks: A Compound Poisson Approach. *Environmental and Resource Economics 44,* p. 327-335.

Starbuck, C.M., S.J. Alexander, R.P. Berrens and A.K. Bohara (2004): Valuing special forest products harvesting: A two-step travel cost recreation demand analysis. *Journal of Forest Economics 10,* p. 37-53.

Tempesta T., Visintin F., Marangon F. (2002): *Ecotourism demand in North-East Italy.* Proceedings of Monitoring and Management of Visitor Flows in Recreational and Protected Areas 1 Conference, p. 373-379.

Termansen, M., Zandersen, M., C. J. McClean (2008): Spatial substitution patterns in forest recreation. *Regional Science and Urban Economics 38,* p. 81-97.

Van der Heide, C. M., J. C. J. M. van den Bergh, E. C. van Ierland, P. A. L. D. Nunes (2005): *Measuring the Economic Value of Two Habitat Defragmentation Policy Scenarios for the Veluwe, The Netherlands.* Fondazione Eni Enrico Mattei working paper 42.2005

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 (1),* p. 58-75.

Willis, K. G., G. D. Garrod (1991): An individual travel cost method of evaluating forest recreation. *Journal of Agricultural Economics 42 (1)*, p. 33-42.

Discussion

The thesis elaborates on the question how the recreation services of natural and urban areas are reflected in the real behaviour of people on the property market and in their recreation behaviour. Based on the results of several geographical levels of modelling in the Czech Republic and in Europe, we disentangled the recreation values that people associate with particular sites, and discussed the factors that affect the level of the revealed recreation use values of natural areas.

In this section, I synthesize the findings of the Studies I to V presented in the previous chapters of the thesis and elaborate on the specific research questions set out in this thesis in Chapter Research aims and questions.

1. Which attributes affect the revealed preferences of people for recreation?

The results of published meta-analyses integrating the findings of previous research on recreation values (Walsh et al., 1990, 1992; Smith and Kaoru, 1990a; Rosenberger and Loomis, 2001; Shrestha and Loomis, 2001; Zandersen and Tol, 2009; Sen et al., 2014; de Salvo and Signorello, 2015; Schägner et al., 2018), and also the results of Study V suggest that there are several categories of variables that affect the results of the recreation studies concerning the revealed preferences of people for recreation .

The first category of attributes that affect the recreation values of particular natural areas, including urban greenery, are attributes that describe the **natural or environmental conditions of the site.** Both in primary research studies and in meta-analytic works, the description of natural areas in previous studies varies from using a simple binary variables indicating whether the site consists of a forest, a wetland or is located in a national park (Rosenberger and Loomis, 2001; de Salvo and Signorello, 2015), to continuous variables describing land cover, heterogeneity of landscape and terrain, area of the natural site, presence or lack of settlements, level of protection etc. (Zandersen and Tol, 2009; Kaprová and Melichar, 2014; Schägner et al., 2018). In meta-analytic studies, it is evident that even the frequently used low-detailed variables work well in explaining the variability of the recreation welfare. The depth of the analysis of environmental conditions of the site depends on the focus of the meta-analytic study - whether it is designated for a benefit transfer on national level (the benefit of such study is that the researcher does not need to collect data on many characteristics of the site where the benefit transfer function should be transferred to, at the cost of yielding less precise estimates), or whether rather a detailed disentanglement of the preferences of recreationists is at the heart of the analysis. The data availability and interrelations among explanatory variables may also be a limiting factor. *I discuss separately the effects of particular environmental characteristics, including the protection status, on the recreation values further below under the subquestions 1.a. and 1.b.*

Apart from natural conditions of the site, the **equipment of the site with recreation facilities** plays a role (Schägner et al., 2018). None of Studies I, IV and V of the thesis which would theoretically allow for inclusion of such variables we disposed with any data that would be a good proxy for recreational equipment at the sites in our sample. We cannot therefore comment on their effect on implicit prices of urban greenery in Prague, or on the extent to which they affect the demand for large natural areas in the Czech Republic and forest sites in Europe. Studies by Kaprová et al. (2012; 2014) however show that the surface type of hiking trails affects the recreation welfare in the forests of Jizerské mountains. Visitors of Jizerské mountains preferred most sandy stabilized trails, which contributed to the welfare associated with a hiking trip by 91 CZK (3.5) 2017[16] compared to an asphalt trail, and unstabilized forest trails was also popular (+ 30 CZK/1.1 EUR 2017 per trip compared to asphalt trail; Ibid.).

The recreation values of a particular recreation area depend also on the **broader geographical context of the natural recreation area and its location**, e. g. whether the site and its landscape is unique or other similar sites are abundant in its vicinity, how accessible it is for visitors, and whether it is located in a populated area or in a remote place. Recreation values associated with trips to urban natural areas may differ from the values of areas in the open landscape (Zandersen, 2005; Heagney et al., 2018).

The magnitude of the recreation value of a specific natural area is affected by the **characteristics of the population of recreationists** and their preferences on leisure and landscape (values are "co-created by visitors" - Mayer and Woltering, 2018), and may differ among populations with various visitation habits and various preferences regarding available natural recreation sites. This context is interrelated with the specifics of the available natural recreation sites, their abundance and variety of landscapes within the country. We would expect

[16] All values stated in this chapter are recalculated from the original price level to CZK 2017 and EUR 2017 using EU HICP deflator and PPP exchange rate by EUROSTAT.

that large differences in recreation values of natural areas could be observed for different cultural contexts worldwide: for example among USA and European protected sites, where the latter are part of the countryside and not necessarily only on their borders are interwoven with settlements, roads and agricultural land, which would be unthinkable for most US national parks. Such extent has been tested in several meta-analytic studies in broader context of environmental valuation and value context - e. g. a worldwide meta-analytic study by Brander et al. (2006) suggest that there exist some continent-related discrepancies in the magnitude of values of ecosystem services provided by wetlands. Up to present, there has been no similar evidence in the meta-analytic literature on recreation demand research.

However, Study V in this thesis shows that the context of the population of recreationists may matter even on a smaller scale, as there are differences in visitors´ preference between post-transition countries and the rest of Europe. The results of Study V suggest that the recreation values of natural areas in post-transition countries tend to be lower than those perceived by recreationists in Western, Northern and Southern European (WNS) countries. The preferences also slightly differ in the context of natural conditions of the sites - the average temperature at the recreation site seem to matter more for visitors from WNS countries and the WNS recreationists do not welcome grassland areas at the natural sites for their recreation.

In almost all meta-analytic studies, the proxies for preferences of recreationists involve measures such as visitors´ income (almost in all cases substituted with local GDP per capita due to unavailability of data on the sample of visitors in primary studies) or population density around the study site, which may account for rural vs. urban populations. The previous evidence on the effect of GDP per capita on the recreation values suggests that it is a weak predictor (Schägner et al., 2018; Zandersen and Tol, 2009; Bartczak et al., 2008; Giergiczny et al., 2008; Study V), which may be due to generalization issues. Study V shows that the no effects of local GDP on the recreation values for a model that includes only WNS countries and also for a model that incorporates also sites from the rest of Europe. Study V suggests that remote natural areas are associated with higher recreation value per trip. On the contrary, Lindhjem and Navrud (2008) found that forests in urbanized areas in Northern Europe are associated with a significantly lower WTP for different forest goods and services than forests in the open landscape (the analysis however covers not only recreation values, but also non-use or other use values of forests). Study I does not provide estimates of values of particular units of greenery so we cannot compare values urban and nonurban greenery (*as discussed in more detail below in 1a)*).

The recreation preferences of visitors and consequently the observed recreation values of natural sites may evolve over time. In Study V, we capture the potential development of European recreation values of forests in the analysed period of 1991 to 2013 using the time trend variable. After accounting for the methodological, environmental and population characteristics of recreation values encompassed in Study V (and of course after accounting for PPP and inflation), the time trend was not significant, which means that the newer European primary studies on forest recreation do not yield systematically lower or higher values than the older ones.

Last but not least, it has been proven that the estimates of recreation values associated with natural areas may vary substantially according to the **methodology applied in the valuation study** (Smith and Kaoru, 1990a, 1990b; Zandersen and Tol, 2009; study V of this thesis). The research on recreation values has been based on many different methodological approaches - valuation techniques, data collection techniques, estimation techniques and on various geographic scales. Study V of the thesis shows that even results that stem from a single methodological approach (travel cost modelling) may vary in a substantial way. *(I discuss separately the effects of methodology below under the hypothesis 2.)*

1a) Which environmental characteristics of natural sites do people prefer for recreation use?

Under the term "environmental characteristics" we consider environmental conditions of particular natural and urban greenery sites, such as land cover, size of the natural area or heterogeneity of landscape and terrain, and protection status (*the effect of protection status is discussed separately below in subquestion b)*).

The value of the total recreational benefits of a natural recreational area, considering the whole population of recreationists, has two main sources of variation: the recreation value per visit and the number of visits to the natural area (Schägner et al., 2018; Sen et al., 2014). The direction and significance of the effect of almost all environmental characteristics of natural sites on the magnitude of recreation benefits provided by the sites have been highly variable among the meta-analytic evidence so far. For recreation values per trip, this is clearly shown by the latest meta-analytic study on recreation in European natural sites by Schägner et al. (2018, Table 5 on p. 8). It is necessary to bear in mind that each of the meta-analytic studies tells a bit different story. The variability of their results may be driven by the different focus of the particular meta-analyses (whether it encompasses one or more types of economic value - e. g. only recreational values or the context of more ecosystem services; whether the authors distinguish specific recreational uses; on which types of ecosystems they focus) and differences across the populations of recreationists involved, their visitation habits and their preferences regarding available natural recreation sites, which is interrelated also with the specifics of the natural recreation sites, their abundance etc. (as discussed above).

Since the comparation of results across most published meta-analytic studies with our results is complicated, I summarize the results on the insights regarding the preferences of urban residents of Prague (Study I), visitors of large natural areas in the Czech Republic (Study IV), and visitors of European forested areas (Study V), and discuss the results with the scientific evidence of similar context of type of value, climatic context and ecosystem range. The single-site model (Study II and III) cannot contribute to this hypothesis, as the environmental characteristics of the Šumava National Park are constant for all recreationists, which responded about their recreation behavior in the same time period.

The **type of natural site described by vegetation cover** seems to play role in all studies in the thesis. Study I proves that urban forests and specially protected areas (SPA) have a significant positive effect on property prices in Prague, and agricultural land does not affect the price. The effects of urban forests are of a larger magnitude than of SPAs. In hedonic modelling, the estimated value may constitute of recreation value, but also of values of other ecosystem services of urban greenery that the residents perceive, such as microclimate. The previous research, as well as definition of variables in Study I, together with their unsignificant correlation with microclimatic variables, suggest that in our study, recreation ecosystem services provided by urban greenery play the most important role for Prague residents. For both types of greenery, smaller areas are preferred by inhabitants. It is not straightforward to estimate the value of particular urban greenery units from the hedonic model, since that requires: i) estimation of the second stage of the hedonic model, and ii) availability of data on all properties in the urban area and their location with respect to greenery units so that a geographical prediction from the model can be administered. Study I does not provide estimates of values of particular units of greenery.

Study IV on the preferences of Czech visitors to large natural areas shows that one-day visitors prefer sites with abundance of natural land cover, such as forests and seminatural areas, and are indifferent about the presence of pastures in the natural area that they choose for their trips. For overnight trips, the visitors prefer forests rather than natural sites with the presence of pastures and other types of semi-natural areas. Both types of visitors in the Czech Republic have a significant preference for natural areas where the dominant forest is coniferous or broadleaved (over the omitted category of mixed forest). The dataset did not allow for further precision of the forest characteristics using e. g. age categories, but the preferences for other forest are documented in several Czech studies which suggest that the age of forest stand, as well as the forest management that would enhance diversity of the vertical distribution of tree canopies, affect the preference in context of recreation in a positive way. Braun Kohlová and Melichar (2017) prove that in the reclaimed sites after the brown coal mining in the Sokolov mining area, the preferences for mature spruce forest stands and mature broadleaved natural succession stands are the highest among other types of forests that are typically grown during the reclamation process; these two forest stands are not significantly different in the stated preference from each other. Melichar et al. (2018) suggest that in Podkomorské forests near Brno, the recreationists favour broadleaved forests which combine diverse age categories in one forest stand from young to mature trees, with medium permeability of the view and with presence of undergrowth; the second most preferred forest stand were young managed broadleaved forests with high permeability of the view and no undergrowth. The lowest preference of visitors was for clear-cuts.

On European level, Study V confirms that there is significant preference for the presence of broadleaved forests at forest recreation sites. We tried to incorporate also the measure of defoliation of the forests as provided by EUROSTAT, but as the variable is aggregated on the country level, it did not work well in the model (see also previous results by Kaprová and Melichar, 2014). Previous scientific evidence did not prove that the abundance of forest cover would constitute an important explanatory factor of the welfare associated with recreation in forests (Zandersen and Tol, 2009), or in natural areas in general including marine ecosystems (Schägner et al., 2018) or would help predict the visitation loads in European national parks (Schägner et al., 2016). Zandersen and Tol (2009) found that forest sites including more open land within the borders are more preferred for recreation purposes in Europe. Interestingly, Schägner et al. (2018) show that for a meta-analysis of European recreation values of open spaces in general (including marine ecosystems), the share of forest cover shows significant negative effect on recreation values in all models; and the results of previous meta-analyses are by half positive, by half negative (Ibid., Table 5 on p. 8). Also, the previous evidence shows that visitors may prefer diverse land cover within a natural recreation site (Schägner et al., 2018; Zandersen and Tol, 2009).

The presence of a water body in the Czech large-scale natural recreation areas (Study IV) enhances the likelihood of a visit, but this holds only for one-day visitors. The recreational uses of water bodies by visitors are not further distinguished in the model, and may range among aesthetical experience during hiking or cycling (for those water bodies in protected areas where swimming or fishing is restricted) to active recreation in and around the ponds. The presence of wetlands dropped out of the analysis due to scarcity among the recreation sites modelled. For the European dataset (Study V), the presence of wetlands and water bodies are relatively scarce among studies and the respective variables were omitted due to multicollinearity problems. Neither of these variables was employed in the analysis by Zandersen and Tol (2009). Schägner et al. (2018) found that the effect of presence of inland water at the recreation site on the recreation value is positive but not statistically significant.

Concerning the **size of the recreation area**, Study I suggests that urban residents of Prague prefer smaller areas, irrespective of the type of urban greenery. The finding is in accordance to some other studies (e. g. Morancho, 2003) that the presence of smaller plots of greenery is sufficient for residents. However, it is necessary to point out that this conclusion refers only to larger greenery units in Prague, as we have not considered small dispersed greenery areas in the model. Also, the results of hedonic price analyses are site-specific and problematically transferable to other markets, as the results reflect specific conditions of supply and demand that exist at a particular property market (Day, 2001).

Larger natural areas are however preferred for recreation by Czech visitors to natural areas (Study IV), and also yield on average larger recreation values of forested areas on European level (Study V). This confirms results from Schägner et al. (2018); however, the results of Zandersen and Tol (2009) show the opposite trend - i. e. that the preference grows towards smaller areas of forests.

The preference for recreation may depend on the duration of trips that are represented in the sample, where the larger area of the recreation site may play role particularly for longer trips.

For one-day trips to large recreation areas, the recreationist is physically able to cover only a limited part of the total area, and thus the visitor may not necessarily value more the remaining (not visited) extent of the recreation site. Study IV really shows that the size of the recreation site plays much larger role for overnight trips. For one-day trips, the size of site is also important and positively affects the probability of making a trip to the particular area, but the effect is only half the effect observed for overnight visitors. We cannot address the effect of trip duration in Study V, as only cca 60% of the sample of European value estimates contain information on the average trip length. Similar issues with data unavailability were experienced in the previous studies by Schägner et al. (2018) and Zandersen and Tol (2009). Studies II and III of the thesis are based solely on the sample of overnight visitors, as less than 30 one-day visitors were present in the sample.

1b) Are protected areas associated with a significantly different recreational value than other open space areas?

In Study I, IV and Study V of the thesis, I have focused on the question whether the protected sites are associated with a significantly different recreational value than other landscape, since the existing evidence has not yet documented in a consistent way whether the status and specific landscape of protected sites affect the recreation values. Also, the hypothesized direction of the effect of protection on the recreation preferences is not straightforward.

The effect of protection level on the recreation value may be twofold. On one hand, protected areas tend to be established due to the presence of rare biotopes, remarkable landscape, and presence of species that are not found in the other natural areas in the country (IUCN, 1998). Due to that, the protected sites are promising in enhancement of aesthetic functions and recreation welfare. Such sites may promote non-consumptive recreational activities such as hiking or cycling. For a smaller subset of visitors that focus on specific wildlife-related recreation uses such as birdwatching, the wilderness or even isolation is an important part of the recreational experience (Ibid.). In Central Europe, the establishment of protected areas was proved to reduce the anthropogenic pressures in the area and to contribute to maintain biodiversity (Vačkářů et al., 2016), which supports the hypothesis that these areas are different than other natural sites. The “protected area” status may also work well for the image of the area for recreation, as it promotes the presence of rare species, and may be a guarantee of a pristine area (IUCN, 1998; BIO Intelligence Service, 2011). Moreover, people (including visitors) may form bonds with protected areas of a specific character in terms of place attachments (Lin and Lockwood, 2013; BIO Intelligence Service, 2011), including emotional connection or identity with the place that may affect their willingness to travel often even long distances to reach the site. All these aspects may be positively reflected in the recreation values of protected areas.

On the other hand, the recreational use in protected areas is frequently restricted in a specific way so that the excess visitation does not interfere with the protection targets (Heagney et al., 2018). Restrictions may be placed on consumptive recreation uses such as recreational fishing, mushrooming or forest fruit picking. Even hikers and bikers may face limitations of access to some parts of the protected area due to conservation of endangered biotopes or species, and limits may be placed also on the recreational infrastructure provided.

While the scientific evidence in the USA shows that national parks have generally higher recreation values (Smith and Kaoru, 1990; Neher et al., 2013; Duffield et al., 2013) than other natural sites, the evidence from previous European studies is mixed. Previous European meta-analyses on recreation values suggest that there is no difference in recreation values of protected sites or sites with enhanced presence of endangered species and the other natural areas (Zandersen and Tol, 2009; Sen et al., 2011; Schägner et al., 2018). There exist several other recent studies that cannot contribute to the issue, as they either focus on protected areas only, but do not compare the result with the baseline of the nonprotected sites (Schägner et al., 2016), or studies the methodology of which is broader and does not allow to distinguish that for the recreation function (Brander et al., 2006; Frélichová et al. 2014; Daněk et al., 2018). Many other studies do not distinguish the protection status of the sites in the analysis (Sen et al., 2014, Kaprová et al., 2014). Also, the scientific evidence on interrelations between ecosystem services does not suggest whether there is a clear positive or negative association between cultural services based on experience (e. g. recreation) and habitat protection (Lee and Lautenbach, 2016).

Schägner et al. (2016) shows that visitation to European national parks is significantly increasing with the age of the national parks, which could suggest that the parks that were allowed to build their label for a longer time are more successfull in attracting visitors. In line with the discussion above, it may also mean that the first established areas were those that already were known for the outstanding natural and landscape values among the natural sites in the particular country.

Study I shows that in the context of the property market of Prague, residents have a positive attitude towards the presence of specially protected areas in the vicinity of their home in the urbanized area of Prague, but smaller SPAs are preferred. However, the closeness to (unprotected) urban forest parks enhances the property prices in Prague more than of SPAs.

Study IV proves that among large Czech natural recreational areas, national parks are generally more probably chosen for a trip than protected landscape areas, and the unprotected sites have the lowest probability of visitation (all other being equal). This holds both for one-day and overnight visitors, but the importance of the protection status is higher for overnight trips.

In Study V, we employ variables indicating whether the European forest recreation study site is located within a national park or in within other nationally or regionally designed protected areas such as protected landscape areas, regional natural parks etc. The data show that the location of the recreational natural site in a national park does not yield a significantly higher recreation welfare than the location in other protected areas and non-protected areas (which also include forest recreation parks); and there is no difference between the latter two categories either. The effect of location in a national park was significant only for a subset of Western, Northern and Southern European visitors.

The evidence in our Studies I, IV and V is not able to disentangle the specific factors that contribute to the results. As I discussed above, several factors may play role at once. The available scientific evidence provides more insights into the specific factors of the effect of level of protection or biodiversity on the recreation demand. Several primary studies show that sites with a rich species diversity are preferred by visitors of forest recreation sites (e. g. Hanley et al., 2002; Scarpa et al., 2000). However, when used as a predictor in meta-analysis, the relationship between diversity of species and welfare measures is frequently insignificant - as seen in studies by Schägner et al. (2018), Zandersen and Tol (2009) and Ojea et al. (2009). The meta-analyses on recreation use focused mainly on general recreation activities such as hiking and cycling. Specific recreation uses that could be most affected by enhanced biodiversity such as wildlife watching and birdwatching, and consumptive uses that may be most touched by the protection status of the area (for example mushroom or berry picking) have been very rarely covered by the primary European recreation studies and subsequently rarely appeared in the meta-analytic datasets (as discussed by de Salvo and Signorello, 2015; Kaprová and Melichar, 2014; Study V). Wildlife watching as the main focus of the primary recreational studies in Europe is rare - the very few existing studies that are covered in the sample of Study V are Czajkowski et al. (2014), Christie et al. (2005) and Tempesta et al. (2002). The same holds for gathering of forest products - the studies encompassing this specific recration use form together less than 1% of the sample of Study V.

What follows is that more primary scientific evidence on European level is needed to get more insights into the potential differences among recreation values of specific recreation uses. Irrespective of the knowledge on the relationship between the level of protection and recreation values, Haefele et al. (2016) prove that nonuse values associated with national parks in the USA are of similar magnitude or larger than their recreation values. The results suggest that whether important for recreation or not, the protected sites provide substantial benefits to the society.

2. Does the methodology of recreation studies play an important role in estimating recreation values?

Several studies have proven that the differences in the methodological approach adopted by researchers affect the magnitude of estimated recreation values per trip even more dramatically than the differences in environmental conditions of the natural sites or other site-specific variables (Schägner et al., 2016, 2018; Study V). Concerning methodological aspects, the previous meta-analytic studies frequently focused on testing of convergence between stated and revealed preference research (Walsh et al., 1990, 1992; Smith and Kaoru, 1990a; Rosenberger and Loomis, 2001a; Shrestha and Loomis, 2001; Giergiczny, 2008; de Salvo and Signorello, 2015; Schägner et al., 2018) with mixed results. Few other binary variables on methodology have been applied in these studies (e. g. to identify use vs. non-use values), most of which are not of concern in recreation demand modelling.

Travel cost studies represent one branch of revealed preference research, and even within this branch the results of particular studies are affected by the methodological approach applied. In the only European peer-reviewed study that focus on meta-analysis of recreation values of forests, Zandersen and Tol (2009) show that the magnitude of the estimate of recreation value depends on travel cost model applied (zonal model yields lower CS estimates than individual single site model) and on several other methodological variables. However, their sample of primary studies was rather old (up to year 2001) and does not enable to distinguish among the effects of more recent methodological advancements. Other study of a similar extent is Shrestha and Loomis (2003), who focus on US travel cost studies and bring similar results. In the last two decades, the use of zonal travel cost model decreased sharply in favour of individual single site models, random utility models, and other approaches, together with quick development of estimation techniques that allow to account for the theoretical and econometric issues in modelling. In Study V, we managed to include a more recent sample of studies, and also more detailed variables informing on the type of travel cost model and corrections for specific econometric and data problems that have been frequently employed in the latest applications of travel cost modelling.

The results of Study V prove that among travel cost studies, there are significant differences in estimated recreation values due to the specific methodological approach applied by the researchers. It is important to control for the econometric and data collection problems when administering a recreation demand study, since the corrections have significant effects on the recreation value estimates. Specifically, we found that not correcting of on-site data problems in the modelling leads to an upward bias of the recreation value estimates. Within onsite models, correction for truncation as such (47% of the sample) brings on average no further significant improvement in these models. The correction for endogenous stratification, i. e. oversampling of avid users (33% of the CS estimates in the sample) is significant and positive; studies that manage to account for both of these problems (31% of the sample) yield the expected precision of the estimate downwards (in total by 2.6 EUR). The results support findings of Loomis (2003), who empirically proved in a TCM study that the correction for the oversampling of avid users lead to a reduction of CS by 40%. After the correction, the estimates were be considered unbiased as they were not statistically different from those generated in an off-site household survey (Ibid.).

Concerning the TCM methodological variables, it would be very interesting to further analyse whether there are significant differences between the results of the two branches of recreation demand models that have been prioritized in recent travel cost applications: single site models vs. random utility models. Random utility models allow for a much more complex way of modelling of the substitution effect among recreation sites than the single site models, and therefore they might be theoretically preferred (Mayer and Woltering, 2018). The estimates of recreation value from a single site model may differ from the RUM results mainly for those natural recreation sites that are highly substitutable - these may be surrounded by similar sites or there may be similar sites around the recreationists´ origin.

RUM studies focusing on terrestrial recreation are very rare in Europe, where the majority of applications in recreation context focused on water quality values or values of fishing; several studies that would be applicable focus on methodological issues and do not provide the monetary value estimates for recreation sites (Bakhtiari et al., 2014; Smirnov et al., 2012). Three RUM studies were available for Study V (Font, 2000; Termansen et al., 2008; Bestard and Font, 2010), which did not yield enough variability to test the effect of RUM approach on the magnitude of recreation value estimates in the meta-analytic model - the variable drops out of estimation. A simple one-sided t-test based on Study V dataset and ln(cs_trip) variable suggests that RUM studies yield lower estimates of recreation values than the other approaches at 5% significance level. Other meta-analytic studies focusing on travel recreation demand also do not provide comparison of individual TCM and RUM results in a meta-regression model. Zandersen and Tol (2009) and Shrestha and Loomis (2003) compare only individual TCM with zonal travel cost model studies. Other more general meta-analyses (e. g. Schägner et al., 2018, Chiabai et al., 2011; or Ojea et al., 2010, 2011) do not allow at all for modelling of the methodological effects in such detail due to incorporation of more environmental valuation techniques (as CVM or CE).

The discussion of the differences between the two branches of travel cost modelling is important as they are apparent when contrasting the results of single-site travel cost models in the Czech Republic (including Studies II and III) with the results for the same areas based on random utility approach (Study IV). First, I have to note that the RUM studies usually report values associated with a person from the population of potential users - including non-users; these values are not comparable with SSM results which account for actual users only. But even when comparing the recreation values estimated for users only using the RUM framework in Study V, we may observe these are in all cases substantially lower than the values of the same sites estimated by single site models:

- Study II estimated the recreation value for Šumava National Park using SSM at 417 CZK (23.6 EUR) 2017, with seasonal value per visitor of 807 CZK (45.7 EUR) 2017. All the trips in the sample are overnight. The corresponding RUM estimates for overnight trips are 146 CZK (8.3 EUR) 2017 per trip, 319 CZK (18.1 EUR) 2017 per season.

- Melichar (2007) estimated the value of recreation in Jizerské mountains at 1 277 to 3 960 CZK 2017 (72.3 to 224.3 EUR 2017) per trip, depending on the SSM model employed (2 517 CZK / 142.6 EUR 2017 on average). The majority of the sample account for one-day trips. The magnitude of the estimate is probably driven by the average income level in the sample of recreationists, the significant part of which consists of Prague residents for whom this specific area has been very popular. The RUM model yields much lower values of 63 CZK (3.6 EUR) 2017 per one-day trip, and 109 CZK (6.2) 2017 per overnight trip to this natural area (Table 6 in Study IV).

- Špaček and Antoušková (2013) estimate the value of Bohemian Paradise Geopark at 530 CZK 2017 per visit (20.1 EUR 2017) using an OLS model not corrected for on-site data collection issues. 33% of the sample accounted for one-day visits, the rest for overnight trips. The corresponding RUM estimate for overnight trips is 90 CZK (3.6 EUR) 2017.

We may observe that the RUM recreation value estimates from Study IV are 3-14x lower than the results of the three existing Czech single-site studies. First methodological issue that may contribute to the disproportion of the results among the models is the method of geographical calculation of travel cost, as Study II suggests. SSM studies for Šumava and Jizerské mountains employ objectively measured travel distance using the route network analysis, and Bohemian Paradise Geopark model employs the subjectively stated travel cost, which probably do not differ much from the objectively measured cost (as Study II suggests). RUM model (Study IV) employs a simplified measure of euclidean distance („as the crow flies“) to the edge of the large natural recreation area, which is suggested to provide lower estimates of travel cost and consumer surplus than the more precise geographical representations (or subjectively stated level of travel costs) for the whole sample of recreationists. There is not much difference in the way of treatment of opportunity cost of travel time among the studies: Špaček and Antoušková (2013) employ 2/5 of wage rate, all the other studies employ 1/3 of wage rate. Should the Bohemian geopark model employ also a lower rate of 1/3, we could expect according to the results of Study V that the observed demand would shrink a bit and so would the estimate of consumer surplus.

The magnitude of the disproportion of single-site model and RUM estimates depends also on the real substitution patterns of the three Czech natural sites and the extent to which the SSM and RUM models allow to account for it. The SSM models for Šumava and Jizerské mountains incorporated a substitute variable into the equation; that is not the case of the Bohemian Paradise Geopark model, but that needs not play a role as Study V suggests. The RUM model allows to introduce a wide range of available substitutes of the particular natural recreation sites into the model and to account for the substitution patterns for the whole set of recreation sites. While both Jizerské mountains and Bohemian Paradise are located in vicinity of other similar natural areas that are in high demand for recreation (Study IV), the Šumava National Park is rather unique in its location, which is especially true for overnight visits that have been of focus in SSM studies (Study II and III). Accordingly, the RUM are much lower than SSM results for the first two sites (the CS from RUM model accounts for 7% of the estimate of the SSM study of Jizerské mountains on average, and 17% of the estimate for SSM of Bohemian Paradise Geopark), than for the Šumava National Park (where the relation of RUM to SSM estimate of recreaton value is 35%).

In Study V, we test whether other variables related to methodology, namely the way of calculation of travel cost (i. e. the shadow price for the recreation experience) and publishment type affect the estimate of recreation value, affect the recreation value. The percentage of wage rate used as measure of opportunity cost of time was shown to be positively related to the estimate of recreation welfare, in line with the results of Smith and Kaoru (1990a, 1990b) and Zandersen and Tol (2009). The evidence of systematical publication bias, i. e. that recreation value estimates in peer-reviewed articles would be systematically lower (or higher) than those in grey literature (Rosenberger and Stanley, 2006), was not found in European recreation demand studies.

3. What are the recommendations for benefit transfer of recreational values:

a) from one site in the Czech Republic to another site in the Czech Republic

to minimize the benefit transfer errors?

Following the classification of benefit transfer methods by Navrud and Ready (2007) which was summarized in part III of the chapter Theoretical framework and state of the art, I group the recommendations on benefit trasfer of recreational values in the Czech Republic by three main transfer options: unit value transfer with adjustment, value function transfer (from a single study) and meta-analytic transfer of values. For transfer of recreation benefits from one site in the Czech Republic to another site within the country, only the first two options are feasible, since there is not enough evidence to construct solely Czech evidence-based meta-analysis (national meta-analyses in Europe are available for UK - Bateman et al., 1999 and 2000; Bateman and Jones, 2003; Sen et al., 2014; and for Italy - de Salvo and Signorello, 2015). Both transfer methods require that the value is adjusted for inflation, preferably using consumer price indices such as EU HICP (Harmonised Index of Consumer Prices by EUROSTAT), as CPI indices deal with prices of consumption and account for different cost of living among countries that are faced by visitors (with regard to travel cost method theory, the second best opportunity for taking the trip to nature is consumption). On the other hand, GDP deflator takes into account domestically produced goods and services; but generally the adjustment would not differ dramatically even if we employ GDP deflator for longer time periods (it may however diverge from CPI in the short term).

The value transferred should preferably be set per trip or per day of visit, not per population of recreationists and per area of the natural recreation site for a more precise transfer (Study V, Heagney et al., 2018). The latter approach has been common in meta-analyses (Giergiczny et al., 2008; Zandersen and Tol, 2009) and also in studies evaluating ecosystem services on national level both in the Czech Republic and Europe (Frélichová et al., 2014; Melichar et al., 2016a; also among TEEB-inspired country studies[17] such as Hönigová et al., 2012; Chiabai et al., 2011), as it provides a reasonable trade-off betwen the precisement and feasibility of the transfer for more aggregated results.

The valuation literature consistently supports the rule that a **unit value transfer** should respect the similarities in characteristics of both sites; however, Study V confirms that the necessary condition of a sound transfer is the correct and most up-to-dated methodology of the original study. Studies IV and V and the Discussion section suggest that we should at minimum account for a similar size of site, distinguish whether the site is urban/suburban or more remotely located (also suggested by Heagney et al., 2018), whether it has many or few substitute sites in its vicinity, and whether the site is typically visited for one-day trips or overnight stays (or the visits are not so specific), and also similar main recreational use of the two sites might be important (values may differ if most tourists engage in a more specific activity than hiking or cycling). If the size of the site differs, we may adjust the value for the difference in sizes, a linear approximation should be sufficient. For the other characteristics, our results may suggest the direction of the bias of the value transfer. Remotely located areas are associated with higher

[17] Full list of studies available at URL:<http://www.teebweb.org/areas-of-work/teeb-country-studies-2> (cited on 9 December 2018).

recreation values (Study V, Study IV - mainly for overnight visitors). For a well substitutable site, a RUM estimate is expected to be more precise (and the SSM estimate overestimated - see Studies IV and V and the Discussion section, part 2). Overnight trips are generally associated with a higher per trip value (Study IV; Study V did not distinguish that as we unfortunately did not have data on the duration of trips for a large portion of primary studies in the sample), and the other recreational uses than general hiking/cycling could be associated with different values (in all our samples, the other uses were in minority; Study V shows that specific recreation activities were associated with significantly higher recreation values).

If the original study employs a simplified way of calculation of travel cost, the CS estimate will most likely be underestimated, in the Czech conditions by cca up to a third (Study II, the Discussion section, part 2); in this case, we may consider also an upper bound of the original estimate of value for the transfer, if available in the primary study. When large differences between the income level of the visitors in the primary site and the site where the value is transferred are obvious (for some sites such as Jizerské mountains or Brdy, it is known that the majority of visitors come from Prague), it may affect the recreation values (Study IV, Study V) - in such case, the **value transfer with adjustment** for income, or **value function transfer** (in case the transferred value function from the primary site incorporates income effect and it is significant) will be more precise. Even if Study V and previous European meta-analytic research showed that GDP per capita is in most cases not related to the level of recreation consumer surplus, I would recommend to reconsider this issue for each particular benefit transfer context. The previous evidence (including Study V) may be also driven by the fact that GDP per capita in the region is a poor proxy for the visitors´ income, or part of the effect may be driven away by employing country dummies or geographical coordinates of the natural sites.

Study V does not suggest that recreation value estimates in peer-reviewed articles would be systematically different from those in grey literature, so even in case the suitable estimates are found in diploma or dissertation theses or conference proceedings and not in peer-reviewed articles, they may be suitable for value transfer (having in mind all recommendations concerning the methodology of the primary studies that I suggested above).

Value function transfer from a single-site model estimated for a particular primary site allows to account for differences in the population of recreationists (income, age etc.) or recreation uses, but only when it is modelled. As the consumer surplus per trip in SSM is calculated as the reciprocal of the travel cost coefficient, the recreation value will only differ if the travel cost variable is interacted with these variables in the model (which allows for a shift or pivot of the demand curve), which is not the case for neither of the models discussed here (Study II and III; Melichar, 2007; Špaček and Antoušková, 2013) and is not frequent in the other European SSM studies either. The prerequisite for the value function transfer is that the values of the variables describing the visitors are known to the researcher also for the new site to which the value is transferred, which may be difficult to ascertain without administering a survey among recreationists. It is advised to contact the regional tourism agencies or management of the protected area for a basic idea on the population of recreationists.

As SSM studies do not identify the drivers of recreation demand among the site attributes, their value functions cannot be adjusted in benefit transfer to match the site attributes of the newly evaluated site. As in the case of unit value transfer, the similarities in characteristics of both sites should be respected when choosing the primary study for transfer of values. RUM models cannot be easily transferred to yield access value of new sites for non-owners of the dataset of the primary study and without knowledge on the levels of variables describing the new site. Parsons and Kealy (1994) demonstrate several techniques of benefit transfer of a change in an environmental attribute of a natural site in a RUM for lake recreation and discuss their precision. **Value transfer with adjustment** for site characteristics is theoretically possible if we have an idea about the elasticity of demand with respect to the particular variable. Also **other nonmarket valuation approaches** such as models of stated preference or contingent behaviour models enable to account for the site attribute changes.

3. What are the recommendations for benefit transfer of recreational values:

b) from an international transfer (with special regard to meta-analytic transfers) to the Czech Republic

to minimize the benefit transfer errors?

All international transfers require an adjustment of the transferred value for inflation (discussed above in 3a)), as well as recalculation among currencies of the two countries using exchange rate. Recalculations based on purchasing power parity (PPP) exchange rate are preferred to market exchange rates (Czajkowski and Ščasný, 2010), since they account for the ability of people to buy the same amount of goods and services in each country (taking into account local prices and affordability of goods and services that are not traded across countries). The empirical differences between the two exchange rate measures are larger between countries that are heterogenous in economic development level. Czajkowski and Ščasný (2010) show that using PPP-corrected exchange rates instead of market exchange rates may substantially increase the performance of benefit transfer from more developed countries to Czech context - in their contingent valuation study evaluating WTP for lake water quality, this alone decreased the average transfer errors from Norway to Poland and Czech Republic by 50%.

For **unit value transfers**, all the recommendations following from the discussion above in part 3a) hold also for a transfer of values from a foreign natural recreation site to Czech context. Since now a more extended number of natural recreation sites had been valued in the Czech Republic, the international transfer of unit values may not be necessary, and could be recommended only if the site valued differs dramatically from the natural sites for which the recreation values exist. In case of an international unit value transfer, sites with similar population characteristics and landscape context should be preferred, advisably from neighbouring countries. It is not important whether the original estimate comes from a peer-reviewed article or from grey literature, but the methodology has to be sound and has to match the state-of-the-art of TCM, and also the substitution patterns of the visitors of the new site where the value should be transferred to. **Value transfer with adjustment** for income, or **value function transfer** would help to account for differences between the recreation contexts and contexts of the population - if the original model allows to account for that (as discussed above in 3a)). Czajkowski and Ščasný (2010) propose to control for differences in income using the income elasticity approach, based on most desagreggated data on household income available, rather than using GDP per capita of the country as a proxy of income. In their study, the adjustment for income decreased the mean transfer error by 90%.

There exist several **meta-analyses** on European level which may be employed for benefit transfer of values to Czech sites. The previous experience with meta-analytic transfers suggests that the studies in the meta-analysis should be of some similarity in content and context to be combined and statistically analysed (Desvousges et al., 1998); also incidence of very specific sites or sites with specific characteristics in the meta-database may negatively affect the accuracy of the benefit transfer (Rosenberger and Phipps, 2001). For a transfer of recreation values, a meta-analytic model that includes only recreation use values could be preferred over meta-analyses encompassing both use and non-use values or different contexts of valued environmental goods (Chiabai et al., 2011; Ojea et al., 2009, 2010, 2011). There are several studies which may offer meta-analytic functions for transfer of values to new sites: Schägner et al. (2018) provide a European meta-analystic model of recreation values associated with terrestrial and marine ecosystems, including the predictions of recreation value per visit and per area of natural site for the whole Europe. Zandersen and Tol (2009) provide a meta-analytic study of forest recreation studies in Europe. Giergiczny et al. (2008, Tables 8 and 11) provide a meta-analytic model of WTP/ha/year for forest recreation, including estimates of average values of WTP/ha/year for each European country; for the Czech Republic, the value is 187.5 CZK (10.9 EUR) 2017. Study V provides a meta-analytic function encompassing forest recreation values in Europe, and encorporates also studies from Central and Eastern Europe.

For predictions to new sites, only estimates of high methodological prudence should be considered, so the methodological variables in the meta-analytic function should be fixed at the levels that account for most advanced or most theoretically sound methodologies (such as on-site model corrected for all econometric and data problems; or random utility models if available in a future meta-analytic study). As the main determinant of economic value is the methodology (Study V, Schägner et al., 2016, 2018; Bateman et al., 2006; the Discussion section, part 2), this step is absolutely essential.

Study V suggests that transfer of forest recreation values from Western, Northern and Southern (WNS) Europe to study sites in Central and Eastern Europe leads to an overestimation of recreation values even after we account for PPP-adjusted exchange rate and income. To reduce the transfer error in these areas, the meta-analyses should therefore involve also sites from transition countries, which is not frequently the case. The predicted values using meta-analytic function transfer in Study V tends to be lower than observed values for the upper half of the sample. Average predicted value for Jizerské mountains from Model II (Study V), which includes also Central and European sites, is 100.0 CZK 2017; when employing only the WNS part of the sample in Study V (Model III), the average prdicted value for Jizerské mountains jumps to 293.5 CZK 2017. This example represents an in-sample prediction, as Jizerské mountains are involved in the sample of Study V. Prediction of the recreation values associated with the Šumava National Park would account for an example of out of sample prediction from the meta-analytic models in Study V. Prediction from Model II of Study V, holding the methodology at the state-of-the-art level (comparable to Study III), yields 35 CZK 2017; Model

III that excludes Central and Eastern European sites predicts 263.5 CZK 2017 per trip. The dataset in Study V does not allow to distinguish the length of the trip. The predicted recreation values from Study V for Jizerské mountains PLA and for the Šumava National Park are within the bounds of the RUM estimates for one-day and overnight trips (see the Discussion section, part 2 for a summary of predicted values by the original SSM and RUM studies for both sites), which suggests that the meta-analytic value transfer of this model to Czech sites is feasible and provides reliable estimates.

The **value of the aggregate recreational benefits of a natural recreational area**, considering the whole population of recreationists, has two main sources of variation: the recreation value per visit, which we discussed so far; and the **number of visits to the natural area** (Schägner et al., 2018; Sen et al., 2014). The thesis does not elaborate much on the ways of estimation of the number of visits and its reliability, but it is obvious that the number of visits represents a no less important input into the aggregate recreation value estimate of a particular natural site than the recreation value per visit. Moreover, the scientific evidence so far agrees on the fact that total annual visits (and not actually the value per trip) are the main determinant of the aggregate recreational economic value of natural sites (Bateman et al., 2006; Schägner et al., 2016, 2018). The estimates of visitor numbers are extremely variable among natural sites and are frequently associated with nonmarginal uncertainties (Schägner et al., 2016).

In the last decade, we have experienced a quick development of visitor monitoring in natural areas of the Czech Republic and the data on visitor numbers have been available for an expanding set of natural sites (Monteiro, 2015; Vítek, 2017, 2018). Braun Kohlová et al. (2015, 2017) discuss a number of techniques of visitor monitoring, and proposes methods of data aggregation so that to enhance the precision of estimation of total visitor numbers in natural areas. It is recommended to follow these guidelines to minimize the aggregation errors, and subsequently, to estimate a correct and unbiased number of visitors which enters the total recreational value of a natural recreational area. In case that no data on visitor numbers are available, a meta-analysis may be employed or prediction of visitation loads - Schägner et al. (2016) provide a meta-analytic model that predicts the total numbers of trips to European national parks.

The results of the thesis on the estimates of outdoor recreation values and their precision represent a valuable input into the discussion of **visitor management of Czech natural areas**. With growing pressure on the recreation use of natural areas, the burden on nature protection goals and on touristic infrastructure expenses increases. The management of protected areas is not able to fully cover these costs and their economy is partially or completely dependent on state subsidies. The pricing of recreation is one of the options how to manage the number of visitors entering the protected area (Alpízar, 2006), and how to enhance the budgetary self-sufficiency of the protected areas. While the access fees are not very common in Czech natural areas, our research (Melichar et al., 2015) suggests that visitors are willing to contribute at least small amounts for the touristic infrastructure maintenance. Melichar et al. (2016b, 2017) developed an optimization model which confronts the recreation demand with the supply that is based on costs of recreation in protected areas. The optimization model is useful for developing an efficient regulation of visitation through pricing in areas where the decrease of visitor load is necessary due to conservation purposes. It can be employed for setting an optimal fee that maximizes the social benefits from visitation to a protected area given the expensiveness of the maintenance of the area, and also predicts the revenue that may contribute to financing the costs of protected areas management.

References

Bakhtiari F., J. T. Jacobsen F. S. Jensen (2014). Willingness to travel to avoid conflicts in Danish forests. *Urban Forestry & Urban Greening 13(4),* p. 662-671.

Bartczak, A., H. Lindhjem, S. Navrud, M. Zandersen, T. Zylicz (2008): Valuing forest recreation on the national level in a transition economy: The case of Poland. *Forest Policy and Economics 10 (7-8),* p. 467-472.

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

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

Bateman, I. J., A.P. Jones (2003). Contrasting Conventional with Multi-Level Modeling Approaches to Meta-Analysis: Expectation Consistency in U.K. Woodland Recreation Values. *Land Economics 79(2),* p. 235-258.

Bateman, I. J., B. H. Day, S. Georgiou, I. Lake. (2006). The aggregation of environmental benefit values: welfare measures, distance decay and total WTP. *Ecological Economics, Environmental Benefits Transfer: Methods, Applications and New Directions Benefits Transfer S.I., 60(2)*, p. 450–460.

Bestard, A. B., A. R. Font (2010). Estimating the aggregate value of forest recreation in a regional context. *Journal of Forest Economics 16*, p. 205-216.

BIO Intelligence Service (2011). *Estimating the economic value of the benefits provided by the tourism/recreation and employment supported by Natura 2000.* Final Report prepared for European Commission - DG Environment. 158 p.

Brander, L.M., R.J.G.M. Florax, and J.E. Vermaat (2006). The empirics of wetland valuation: A comprehensive summary and a meta-analysis of the literature. *Environmental and Resource Economics 33*, p. 223–50.

Braun Kohlová, M., J. Melichar (2017). Environmental preferences for forest growth in post-mining landscape. *Journal of Landscape Management 2017/1,* p. 14-19.

Braun Kohlová, M., J. Melichar, K. Kaprová (2017). *Metodika monitoringu návštěvnosti v přírodních oblastech*. Prague, Charles University Environment Center.

Braun Kohlová, M., Melichar, J., Kaprová, K., Škopková, H., Máca, V. (2015). Visitor monitoring methods for good management of protected areas. *Journal of Landscape Management 6/2*, p. 49-55.

Czajkowski, M. M. Ščasný (2010). Study on benefit transfer in an international setting. How to improve welfare estimates in the case of the countries' income heterogeneity? *Ecological Economics 69*, p. 2409-2416.

Czajkowski, M., M. Giergiczny, J. Kronenberg, P. Tryjanowski (2014). The economic value of a white stork nesting colony: a case of 'stork village' in Poland. *Tourism Management 40, p.* 352-360.

Daněk, J., D. Vačkářů, E. K. Lorencová, (2018). Economic value of ecosystem services in Protected Landscape Areas in the Czech Republic. *Beskydy10 (1,2),* p. 99-112.

Day, B. (2001). *The Theory of Hedonic Markets: Obtaining welfare measures for changes in environmental quality using hedonic market data*. Economics for the Environment Consultancy.

Desvousges, W. H., F. R. Johnson, H. S. Banzhaf (1998): *Environmental Policy Analysis with Limited Information: Principles and Application of the Transfer Method.* Cheltenham: Edward Elgar, 244 p.

Duffield, J. W., C. J. Neher, D. Patterson, J. Loomis (2013). Valuation of recreation in the national parks: Estimating micro meta models for benefit transfer. *Western Econonomics Forum, Spring 2013*, p. 16-30.

Font, A. R. (2000). Mass Tourism and the Demand for Protected Natural Areas: A Travel Cost Approach. *Journal of Environmental Economics and Management 39*, p. 97-116.

Frélichová, J., D. Vačkářů, A. Pártl, B. Loučková, Z. V. Harmáčková, E. Lorencová (2014). Integrated Assessment of Ecosystem Services in the Czech Republic. Ecosystem Ser vices 8, p. 110-117.

Giergiczny, M., R. Mavsar, Z. Wenchao (2008). *Report Documenting the Results of the Meta-data Analysis Linking the Monetary Values with the Physical Characteristics of Forests.* Report for EC Integrated Project No. 037033 EXIOPOL: A new environmental accounting framework using externality data and input-output tools for policy analysis. 41 p.

Haefele, M., C. Fort Collins, J. Loomis, J., L. J. Bilmes (2016). *Total economic valuation of the national park service lands and programs.* On-line. URL:< https://www.nationalparks.org/sites/default/files/NPS-TEV-Report-2016.pdf>. Accessed on 7 December 2018.

Hanley, N., K. Willis, N. Powe, M. Anderson (2002). *Valuing the benefits of biodiversity in forests.* Report to Forestry Commission Edingurgh. Social and Environmental Benefits of Forestry, Phase 2. Centre for Research in Environmental Appraisal and Management, University of Newcastle. 65 p.

Heagney, E. C., J. M. Rose, A. Ardeshiri, M. Kovač (2018). Optimising recreation services from protected areas - role of natural values, built infrastructure and contextual factors. *Ecosystem Services 31,* p. 358-370.

Hönigová, I., D. Vačkář, E. Lorencová, J. Melichar, M. Gotzl, G. Sonderegger, V. Oušková, M. Hošek, K. Chobot (2012). *Survey on grassland ecosystem services. Report to the EEA – European Topic Centre on Biological Diversity.* Prague, Nature Conservation Agency of the Czech Republic. 78 p.

Chiabai, A., Ch. M. Travisi, A. Markandya, H. Ding, P. A. L. D. Nunes (2011). Economic assesment of forest ecosystem services losses: cost of policy inaction. *Environmental and Resource Economics 50,* p. 405-445.

Christie, M., N. Hanley, B. Garrod, T. Hyde, N. Lyons, A. Bergmann, S. Hynes (2005). *Valuing Forest Recreation Activities.* Final Phase 2 Report to the Forestry Commission.

Giergiczny, M., R. Mavsar, Z. Wenchao (2008). *Report Documenting the Results of the Meta-data Analysis Linking the Monetary Values with the Physical Characteristics of Forests.* Report for EC Integrated Project No. 037033 EXIOPOL: A new environmental accounting framework using externality data and input-output tools for policy analysis. 41 p.

IUCN - Task Force on Economic Benefits of Protected Areas of the World Commission on Protected Areas (WCPA) of IUCN, in collaboration with the Economics Service Unit of IUCN (1998). *Economic Values of Protected Areas: Guidelines for Protected Area Managers.* IUCN, Gland, Switzerland and Cambridge, UK. 52 p.

Kaprová, K., J. Melichar (2014). Review and meta-analysis of monetary values for non-market goods and services affected by climate change: land use, ecosystem, leisure. Deliverable No.

D2.1 „Analysis of key determinants of costs and benefits of mitigation policy"of GLOBAL IQ - Impacts Quantification of global changes (Project no 266992). Chapter 1.

Kaprová, K., J. Melichar, J. Urban (2012). *Composite Approach of Forest Scenic Beauty Model and Choice Experiment.* Paper presented at EAERE Conference 2012, Prague.

Kaprová, K., J. Melichar, J. Urban (2014). *Investigating public preferences for forest recreation attributes: Combined scenic beauty and discrete choice model.* Paper presented at 7th International conference on monitoring and management of visitors in recreational and protected areas, August 20- 23 2014, Tallinn.

Lee, H., S. Lautenbach (2016). A quantitative review of relationships between ecosystem services. *Ecological Indicators 66*, p. 340-351.

Lindhjem, H. and S. Navrud (2008). How Reliable are Meta-Analyses for International Benefit Transfers? *Ecological Economics 66(2-3)*, p. 425-435.

Loomis, J. (2003). Travel cost demand model based river recreation benefit estimates with on-site and household surveys: Comparative results and a correction procedure. *Water Resources Research 39(4),* p. 5-1 - 5-4.

Mayer, M., M. Woltering (2018). Assessing and valuing the recreational ecosystem services of Germany's national parks using travel cost models. *Ecosystem Services 31*, p. 371-386.

Melichar, J. (2007). *Aplikace metody cestovních nákladů v oblasti Jizerských hor.* Dissertation thesis. Prague: University of Economics, 150 p.

Melichar, J. et al. (2015). Využití cenového mechanismu pro regulaci turismu a financování péče o zvláště chráněná území ČR (The use of pricing mechanism for tourism directing and financing the management of specially protected areas in the Czech Republic). Final report. Prague, COŽP UK.

Melichar, J., K. Kaprová, M. Ščasný (2016a). The biodiversity change in the Czech Republic, driving forces and associated welfare impacts. *Journal of Landscape Management 7/2*, p. 37-44.

Melichar, J., K. Kaprová, M. Braun Kohlová (2016b). Software pro ekonomický optimalizační model hodnocení cenových mechanismů regulace turismu (Software for the economic optimalisation model for assessment of price mechanisms to regulate tourism). Výsledek projektu TAČR TD020049. Prague, COŽP UK.

Melichar, J., M. Braun Kohlová, K. Kaprová (2017). Optimal pricing of recreation in Czech protected areas. IN: Proceedings of Public recreation and landscape protection, 1 - 3 May 2017, Brno, p. 229-233.

Melichar, J., D. Zahradník, V. Zatloukal, P. Pavelčík, K. Kaprová, J. Halfar, M. Roubalová, J. Beranová, M. Banaš (2018). *Vyhodnocení funkčního potenciálu lesů v oblasti záměru vyhlášení „Lesnického parku Podkomorské lesy“ včetně návrhu optimálního nastavení jeho polyfunkčního využití“.* Final report of project no. 5/2017 by the Grant Agency of the State Forests Enterprise. Prague: COŽP UK, Monitoring návštěvnosti s. r. o., IFER - Institute for Forest Ecosystem Research, s. r. o.

Monteiro, L. (2015). Seeking standardization on monitoring visitors with automated counting devises in Czech Protected Areas. *Journal of Landscape Management 7(1).*

Morancho, A.B., 2003. A hedonic valuation of urban green areas*, Landscape and urban planning 66*, 35-41.

Navrud, S. and R. Ready, eds. (2007). *Environmental value transfer: issues and methods.* Springer, 290 p.

Neher, C., J. Duffield, D. Patterson (2013).Valuation of National Park System visitation: the efficient use of count data models, meta-analysis, and secondary visitor survey data. *Environmental Management 52(3),* p. 683–698.

Nunes, P. A. L. D., E. Ojea, M. L. Loureiro (2009). *Mapping of forest biodiversity values: A plural Perspective.* Fondazione Eni Enrico Mattei: Sustainable development series 04.2009.

Ojea, E., M. L. Loureiro (2011). Identifying the scope effect on a meta-analysis of biodiversity valuation studies. *Resource and Energy Economics 33,* p. 706-724.

Ojea, E., P. A. L. D. Nunes, M. L. Loureiro (2010). Mapping biodiversity indicators and assessing biodiversity values in global forests. *Environmental and Resource Economics 47(3)*, p. 329-347.

Parsons, G. R., M. J. Kealy (1994). Benefits transfer in a random utility model of recreation. *Water resources research 30(8),* p. 2477-2484.

Rosenberger, R. and J. Loomis (2001). *Benefit Transfer of Outdoor Recreation Use Values. A Technical document supporting the Forest Service Strategic Plan (2000 Revision).* Gen. Tech.

Rep. RMRS-GTR-72. Fort Collins, CO: U. S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 59 p.

Rosenberger, R., T. T. Phipps (2001). *Site correspondence effects in benefit transfers: A meta-analysis transfer function.* Research Paper 2001-6, West Virginia University.

de Salvo, M., G. Signorello (2015). Non-market valuation of recreational services in Italy: A meta-analysis. *Ecosystem Services 16,* p. 47-62.

Scarpa, R., W. G. Hutchinson, S. Chilton, J. Buongiorno (2000). Importance of forest attributes in the willingness to pay for recreation: A contingent valuation study of Irish forests. *Forest Policy and Economics 1(3-4),* p. 315-329.

Sen, A., A. R. Harwood, I. J. Bateman, P. Munday, A. Crowe, L. Brander, J. Raychaudhuri, A. A. Lovett, J. Foden, A. Provins (2014). Economic Assessment of the Recreational Value of Ecosystems: Methodological Development and National and Local Application. *Environmental and Resource Economics 57*, p. 233-249.

Shrestha, R. K., Loomis, J. B. (2001). Testing a meta-analysis model for benefit transfer in international outdoor recreation. *Ecological Economics 39*, p. 67-83.

Shrestha, R. K., J. B. Loomis (2003). Meta-analytic benefit transfer of outdoor recreation economic values: testing out-of-sample convergent validity. *Environmental and Resource Economics 25 (1),* p. 79–100.

Schägner, J. P., L. Brander, J. Maes, M. L. Paraccini, V. Hartje (2016). Mapping recreational visits and values of European National Parks by combining statistical modelling and unit value transfer. *Journal for Nature Conservation 31*, p. 71-84.

Schägner, J. P., L. Brander, M. L. Paracchini, J. Maes, F. Gollnow, B. Bertzky (2018). Spatial dimensions of recreational ecosystems service values: A review of meta-analyses and a combination of meta-analytic value-transfer and GIS. *Ecosystem Services 31(C)*, p. 395-409.

Smirnov, O. A., K. J. Egan (2012). Spatial random utility model with an application to recreation demand. *Economic Modelling 1*, p. 72-78.

Smith, V.K. and Y. Kaoru (1990a). Signals or noise? Explaining the variation in recreation benefit estimates, *American Journal of Agricultural Economics, 72 (2),* p. 419–33.

Smith, V.K. and Y. Kaoru (1990b). What have we learned since Hotelling´s letter? A Meta-analysis. *Economic Letters 32,* p. 267-272.

Špaček, J., M. Antoušková (2013). Individual single-site travel cost model for Czech Paradise geopark. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis LXI (7),* p. 28512858.

Tempesta T., Visintin F., Marangon F. (2002). Ecotourism demand in North-East Italy. *Proceedings of Monitoring and Management of Visitor Flows in Recreational and Protected Areas 1 Conference*, p. 373-379.

Termansen, M., Zandersen, M., C. J. McClean (2008): Spatial substitution patterns in forest recreation. *Regional Science and Urban Economics 38,* p. 81-97.

Vačkářů, D., Z. Harmáčková, H. Kaňková, K. Stupková (2016). Human transformation of ecosystems: Comparing protected and unprotected areas with natural baselines. *Ecological Indicators 66,* p. 321-328.

Vítek, O. (2017). Methodological questions raised from visitor monitoring in the Czech Republic. *Monitoring and Management of Visitors in Recreational and Protected Areas 8 Proceedings.* 26-30 September 2017, Novi Sad. p. 283-285.

Vítek, O. (2018). "Master of Data" shows some jewels from his visitor monitoring drawer (interesting results from visitor monitoring in Czechia). *Proceedings of the 9th International Conference on Monitoring and Management of Visitors in Recreational and Protected Areas - Place, recreation and local development.* 29-31 August 2018, Bordeaux. p. 56-57.

Walsh, R. G., D. M. Johnson, J. R. McKean (1990). Nonmarket values from two decades of research on recreation demand. IN: *Advances in Applied Micro-economics 5*. Greenwich, CT, JAI Press Inc., p. 167–193.

Walsh, R. G., D. M. Johnson, J. R. McKean (1992). Benefit transfer of outdoor recreation demand studies 1968–1988, *Water Resources Research, 28 (3),* p. 707–14.

Zandersen, M. (2005). *Valuing Forest Recreation in Europe: Time and Spatial Considerations.* Dissertation Thesis. Hamburg University.

Zandersen, M., and R. S. J. Tol (2009). A Meta-analysis of Forest Recreation Values in Europe. *Journal of Forest Economics, 15*, p. 109-130.

Conclusion

The results of the dissertation thesis show that outdoor recreation values are reflected in the real behaviour of people on the property market and in their recreation behaviour. All Studies I to V prove that natural areas are associated with positive recreation values.

The property market of Prague is affected by the presence of urban greenery in housing prices. The proximity to greenery and its area are important determinants of housing prices in Prague, and the magnitude of benefits perceived by residents differs with greenery type. The effects of urban forests are larger than the effects of protected areas, but interestingly, the presence of agricultural land does not have an impact on the property prices. Residents of Prague prefer smaller areas of greenery. This result has important implications for the urban planning, as it suggests that not only the large-scale greenery units bring substantial benefits to Prague inhabitants, but also the small-scale open spaces should be protected from the ongoing urbanization pressures for development of housing and infrastructure.

The recreation market both in the Czech Republic and in Europe also reflects the values associated with natural areas. Czech visitors to large-scale natural areas prefer to visit natural sites where the dominant forest cover is coniferous or broadleaved (over the omitted category of mixed forest). Larger natural areas are visited more often, and the size of the recreation area is more important for overnight visitors than for one-day visitors. For overnight trips, visitors prefer sites with a high representation of forests over sites that include also pastures and other types of semi-natural areas. On the other hand, one-day visitors prefer sites with an abundance of natural land cover, and are indifferent about the presence of pastures in the visited natural area. Among large Czech natural recreational areas, national parks are generally more probably chosen for a trip than protected landscape areas, and unprotected sites have the lowest probability of visitation.

On the European level, there is a significant preference of visitors to outdoor recreation areas dominated by forests for the presence of remote broadleaved forests. Larger forested areas are associated with higher recreation values per trip. The protection status of the recreational natural site (national parks, other protected areas and non-protected areas) does not yield a significantly higher recreation welfare.

When employing the recreation welfare estimates in decision-making or for cost-benefit analyses, it is necessary to bear in mind that the methodology applied in estimation of the recreation demand has a large impact on the magnitude of the recreation values.

First of all, it is absolutely essential to comply with the requirements on the representativeness of the sample in the analyses of outdoor recreationists, although the statistical information on the whole population of visitors are not available. While the practice of preference surveys administered in Czech natural areas still frequently involves low-cost self-administered data collection, the self-selection bias associated with this type of data collection affects the results significantly. The employment of a self-selected visitor sample in a recreation demand analysis of Šumava National Park lead to an overestimation of the value by a factor of 3 compared to representative visitor sampling.

The simplification of travel distance calculation to euclidean distance ("as the crow fly") may not affect the model fit, but may lead to an underestimation of recreation values, which is apparent particularly for distant sites such as Šumava National Park. Instead, travel costs reported by the visitors may be conveniently employed, as Czech visitors to Šumava National Park did not err systematically when stating the distance and time travelled even for long-distance travels.

If the data in travel cost studies are collected on-site in the single site model, it is necessary to control for econometric and data collection problems, since the correction significantly affects the magnitude of the estimated recreation value.

The recreation value differs according to whether the study manages to account correctly for the substitutability of the recreation sites or not. In particular, when estimating or transferring the recreation values or sites with good substitutes in their vicinity (such as Jizerské mountains or Bohemian Paradise Geopark), random utility travel cost model estimates should be preferred, as they allow to account for more complex substitution relationships.

The dissertation thesis provides new estimates of recreation values for a range of natural sites in the Czech Republic. The valuation of recreation benefits of other Czech natural sites may be feasible through a benefit transfer approach. For most such evaluations, unit value transfers of existing Czech values may be sufficient, but it is necessary that the source study for the value transfer complies with the methodological standards discussed above. The international transfer of unit values can be recommended only if the site valued differs dramatically from the natural sites for which recreation values exist. We should at minimum account for a similar size of site, distinguish whether the site is urban/suburban or more remotely located, whether it has many or few substitute sites in its vicinity, whether most tourists come specifically for either one-day visits or overnight stays, and whether the main recreational use involves general recreation activities such as hiking or cycling or is based on more specific activities.

For an international meta-analytic transfer of values to Czech Republic, the transfer of recreation values per person per trip is preferable over the transfer of aggregate recreation values. To decrease the benefit transfer errors, meta-analytic models aiming at recreation values only (not including other value types) and models including studies from post-transition countries are preferable. Transfer of recreation values from Western, Northern and Southern Europe to natural sites in Central and Eastern Europe leads to an overestimation of recreation values even after we account for PPP-adjusted exchange rate and income.

The results of the thesis on the estimates of outdoor recreation values and their precision represent a valuable input into the discussion of visitor management of Czech natural areas. Based on the results, an optimization model for setting entrance fees to Czech protected areas was developed, which may help to manage the visitation loads and to contribute to financing the costs of management of protected areas.