Ewa **ZAWOJSKA** • Zbigniew **SZKOP** • Mikołaj **CZAJKOWSKI** • Tomasz **ŻYLICZ**

ECONOMIC VALUATION OF ECOSYSTEM SERVICES PROVIDED BY THE WILANÓW PARK. A BENEFIT TRANSFER STUDY

Ewa **Zawojska,** MSc • Zbigniew **Szkop,** MSc • Prof. **Mikołaj Czajkowski,** PhD • Prof. **Tomasz Żylicz**, PhD – *University of Warsaw, Poland*

Correspondence address:
Department of Economics
Długa 44/50, 00–241 Warsaw
e-mail: tzylicz@wne.uw.edu.pl

"EKONOMICZNA WYCENA USŁUG EKOSYSTEMOWYCH ŚWIADCZONYCH PRZEZ PARK W WILANOWIE. BADANIE METODĄ TRANSFERU KORZYŚCI

STRESZCZENIE: Rezydencja królewska w Wilanowie to unikalne połączenie zdumiewającej architektury, historii i przyrody. Park w Wilanowie dostarcza wielu korzyści zarówno odwiedzającym go turystom, jak i mieszkańcom Warszawy. W niniejszym badaniu podjęto się oszacowania wartości ekonomicznej tych z korzyści, które mają związek z przyrodą, to jest wartości usług ekosystemowych świadczonych przez park. W oparciu o metodę transferu korzyści wartość usług ekosystemowych dostarczanych przez park w Wilanowie oszacowano na 500 tys. euro rocznie. Choć liczba wydaje się duża, jest znacznie niższa niż wartość innych świadczeń dostarczanych przez zasoby rezydencji.

SŁOWA KLUCZOWE: ekonomiczna wycena wartości; usługi ekosystemowe; metoda transferu korzyści; Park w Wilanowie

Introduction

King Jan III Sobieski (1629–1696), known as an excellent military commander who defeated the Turkish army near Vienna in 1683, was a profound nature lover. Unhappy with living in a castle in the capital city, he bought Wilanów near Warsaw, where he established his suburban residence with a beautiful baroque palace and gardens. After the World War II, the estate was nationalised, restored and turned into a museum.

There are probably no trees planted by king Jan III Sobieski himself, but the Park is remarkable. It comprises gardens in various styles (baroque, neo-Renaissance, English and English-Chinese) and a nature reserve Morysin with valuable habitats of meadows and forests. Woodlands, grasslands and ponds constitute three main ecosystems in the Park.

Tourists and Warsaw inhabitants appreciate the nature of the gardens and of the Morysin reserve. In addition to their unquestioned historical and cultural value, the Park ecosystems provide multiple environmental benefits. In this paper, we estimate the economic value of these benefits.

Ecosystem services

Economic assessments of ecosystem services have been conducted for at least two decades. Costanza et al. (1997)[1] is an early example of a global valuation exercise. In 2014[2] they revisited their study and found the value reported therein was largely underestimated. Costanza and his team are credited for grouping ecosystem services into three general categories: provision of raw materials, regulation of natural processes and societal functions (such as recreation).

The original 1997 study identifies 17 types of ecosystem services. This list has been amended. Current assessments typically use the *Common International Classification of Ecosystem Services* (CICES 2015)[3]. The latest CICES list includes 46 items, of which 15 refer to the provision of raw materials, 20 to the regulation of natural processes and 11 to societal functions.

1 R. Costanza et al., *The value of the world's ecosystem services and natural capital*, "Nature" 1997 vol. 387, p. 253–260.

2 R. Costanza et al., *Changes in the global value of ecosystem services*, "Global Environmental Change" 2014 vol. 26, p. 152–158.

3 CICES 2015 *Towards a common classification of ecosystem services*, cices.eu [21-05–2016].

Benefit transfer technique

To assess ecosystem services, an empirical study at the location of interest is the first-best approach. However, it is often impossible because of time and cost constraints. Alternatively, one can extrapolate results from another study, similar in relevant aspects to the site analysed. This method is called "benefit transfer"[4].

The literature provides two main approaches how to use values from a study of a different site. One approach splits a good G into components g_1, g_2, ..., g_n, and identifies the value of each component on the basis of other studies. Formally,

$$G = (g_1, g_2, ..., g_n), \text{ and } TEV(G) = TEV(g_1) + TEV(g_1) + ... + TEV(g_n), \quad (1)$$

where TEV denotes the total economic value. The approach is useful in assessing projects with multiple benefits. For instance, if switching from using a car to a bus reduces air pollution, noise and road accidents, then the overall gain from the change in the transport mode can be decomposed into gains from the separate elements, each of which is evaluated using earlier assessments.

The second approach interprets value estimates for one site from a perspective of another site[5]. If good G is assessed at site s (the empirical study site) at the level $TEV_s(G)$, then the approach gives $TEV_p(G)$, the value of the same good at site p (the policy site).

The simplest way would be to assume $TEV_p(G) = TEV_s(G)$, but it may generate high errors of the estimates[6]. Why may $TEV_p(G)$ be different from $TEV_s(G)$?

---

4 R.J. Johnston et al., *Benefit transfer of environmental and resource values: A guide for researchers and practitioners*, Dordrecht 2015.

5 H. Ahtiainen et al., *Performance of different approaches in international benefit transfer: Insights from a nine country experiment*, Working Paper Series of the Department of Economics of the University of Warsaw 2015 no. 28(176); M. Czajkowski, M. Ščasný, *Study on benefit transfer in an international setting. How to improve welfare estimates in the case of the countries' income heterogeneity?* "Ecological Economics" 2010 vol. 69(12), p. 2409–2416.

6 L.M. Londoño, R.J. Johnston, *Enhancing the reliability of benefit transfer over heterogeneous sites: A meta-analysis of international coral reef values*, "Ecological Economics" 2012 vol. 78, p. 80–89; I.J. Bateman et al., *Making benefit transfers work: Deriving and testing principles for value transfers for similar and dissimilar sites using a case study of the non-market benefits of water quality improvements across Europe*, "Environmental and Resource Economics" 2011 vol. 50(3), p. 365–387; H. Lindhjem, S. Navrud, *How reliable are meta-analyses for international benefit transfers?* "Ecological Economics" 2008 vol. 66(2–3), p. 425–435.

One reason is that the people whose preferences are examined have different incomes in both sites (say Y_p and Y_s, $Y_p \neq Y_s$). Let the value of good G depend on the incomes with constant elasticity ε (that is, $TEV_p(G)/TEV_s(G) = (Y_p/Y_s)^{\varepsilon}$, then

$$TEV_p(G) = TEV_s(G)(Y_p/Y_s)^{\varepsilon}. \qquad (2)$$

(2) is, perhaps, the most frequently used statement in benefit transfers. The elasticity ε has to be determined based on additional information. Lacking this information, analysts may assume ε = 1[7].

Another reason for $TEV_p(G) \neq TEV_s(G)$ is that people's characteristics other than income may affect the value of $G : TEV_s(G) = f\,(x_s, y_s, ..., z_s)$, where x_s, y_s, ..., z_s are variables observed at s that influence $TEV_s(G)$; function f is called a benefit function. The benefit transfer gives

$$TEV_p(G) = f\,(x_p, y_p, ..., z_p). \qquad (3)$$

(2) is a special case of (3), with income Y being the only relevant variable and $f\,(Y_p)$ defined as $TEV_s(G)(Y_p/Y_s)^{\varepsilon.}$

Some researchers claim the more explanatory variables in f, the better[8]. Increasing the number of the variables improves the estimation fit, however, this needs not imply better transfer accuracy. The more variables taken into account at site s, the more likely that some of them are specific for site s and not for site p. It may give rise to a high error of the assessment.

The benefit transfer function f should have firm foundations in economic theory[9]. Parsimony is a good guide when transferring results from a study site to a policy site. Economic theory heavily relies on income, and neither age nor attained education seem to play a similarly strong role. Thus, including income in benefit transfer functions is inevitable.

7 H. Lindhjem, S. Navrud, *Reliability of meta-analytic benefit transfers of international value of statistical life estimates: Tests and illustrations*, in: R. J. Johnston et al. (eds), *Benefit transfer of environmental and resource values: A guide for researchers and practitioners*, Dordrecht 2015, p. 441–464.

8 I.J. Bateman et al., op. cit.

9 Ibidem.

Study of Wilanów Park

Using the benefit transfer technique, we evaluate ecosystem services provided by the Wilanów Park.

The first group of ecosystem services in CICES (2015)[10] encompasses provision of raw materials. The Park produces only one material of that sort: compost from grass and other organic residues in the amount of 350 tonnes annually. Assuming the market price of compost is 15 euro per tonne, it gives the year value of 5,250 euro.

The second group of ecosystem services covers regulation of natural processes. We evaluate them using two benefit transfer approaches. Our study area is composed of three ecosystems: grasslands, woodlands and ponds. Their surfaces are 17 ha, 8 ha and 17 ha, respectively, with additional 41 ha of woodlands in the Morysin reserve. Figure 1 presents the study area.

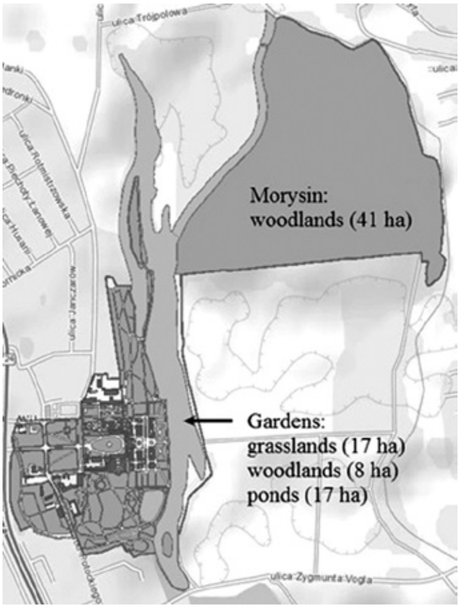

Figure 1.
A map of the study area

Our benefit transfer analysis shows that regulation of natural processes in the Park is valued annually 3,100 euro per ha of grasslands, 3,200 euro per ha of woodlands and 8,900 euro per ha of ponds. Given the Park area, the total year value of regulation services is 320,000 euro. Including Morysin increases the value by 135,000 euro.

The estimates in the paragraph above are based on the extensive literature review[11]. Only

---

10 CICES 2015, op. cit.

11 J. Barreiro et al., *How much are people willing to pay for silence? A contingent valuation study*, "Applied Economics" 2005 vol. 37(11), p. 1233–1246; T.B. Bjørner, *Comparing the value of quiet from contingent valuation and hedonic pricing methods*, paper presented at the 13th Annual Conference of the European Association of Environmental and Resource Economists, Budapest, Hungary 2004, June 25–28; T.B. Bjørner, *Combining socio-acoustic and contingent valuation surveys to value noise reduction*, "Transportation Research Part D: Transport and Environment" 2004 vol. 9(5), p. 341–356;

studies conducted in objects similar in terms of biotopes to the Wilanów Park were used to derive the estimates.

Relative to other biotope types, ponds provide ecosystem services of a high value. This is because empirical studies emphasise the important role of aquifers in regulating the water cycle and neutralising contamination. Although, this may seem an overstatement at first glance, ponds in the Park indeed play a significant environmental role, given that water pollution from southern Warsaw flows through the ponds, instead of reaching the Vistula river directly.

C.K. Chau et al., *A choice experiment to estimate the effect of green experience on preferences and willingness-to-pay for green building attributes*, "Building and Environment" 2010 vol. 45(11), p. 2553–2561; W.Y. Chen, C.Y. Jim, *Assessment and valuation of the ecosystem services provided by urban forests*, in: M.M. Carreiro, Y.-C. Song, J. Wu (eds), *Ecology, planning, and management of urban forests*, New York 2008, p. 53–83; B. Day et al., *Beyond implicit prices: Recovering theoretically consistent and transferable values for noise avoidance from a hedonic property price model*, "Environmental and resource economics" 2007 vol. 37(1), p. 211–232; R. de Groot et al., *Global estimates of the value of ecosystems and their services in monetary units*, "Ecosystem services" 2012 vol. 1(1), p. 50–61; M. Fosgerau, T.B. Bjørner, *Joint models for noise annoyance and willingness to pay for road noise reduction*, "Transportation Research Part B: Methodological" 2006 vol. 40(2), p. 164–178; C.Y. Jim, W.Y. Chen, *Ecosystem services and valuation of urban forests in China*, "Cities" 2009 vol. 26(4), p. 187–194; T. Kroeger, *The economic value of ecosystem services in four counties in Northeastern Florida*, Conservation Economics Working Paper 2005 no. 2; E. MacMullan, S. Reich, *Economic arguments for protecting the natural resources of the east buttes area in southeast Portland*, Eugene, OR 2009; B. Martín-López et al., *The conservation against development paradigm in protected areas: Valuation of ecosystem services in the Doñana social-ecological system (southwestern Spain)*, "Ecological Economics" 2011 vol. 70(8), p. 1481–1491; A.A. Millward, S. Sabir, *Benefits of a forested urban park: What is the value of Allan Gardens to the city of Toronto, Canada?* "Landscape and urban planning" 2011 vol. 100(3), p. 177–188; S. Navrud, *Economic benefits of a program to reduce transportation and community noise – A contingent valuation survey*, in: *Proceedings of Internoise* 2000 vol. 5, p. 3395–3400; S. Navrud, *Economic valuation of transportation noise in Europe*, "Revista italiana di Acustica" 2010 vol. 34(3), p. 15–25; J.E. Noel et al., *A benefit transfer estimation of agro-ecosystems services*, "Western Economics Forum" 2009 vol. 8(1), p. 18–28; N. Olewiler, *The value of natural capital in settled areas of Canada*, Ducks Unlimited and the Nature Conservancy of Canada, Manitoba 2004; D. Pimentel et al., *Economic and environmental benefits of biodiversity*, "BioScience" 1997 vol. 47(11), p. 747–757; A. Troy, K. Bagstad, *Estimating ecosystem services in southern Ontario*, Ontario Ministry of Natural Resources, Ontario 2009; S.J. Wilson, *Lake Simcoe basin's natural capital: The value of the watershed's ecosystem services*, David Suzuki Foundation, Friends of the Greenbelt Foundation Occasional Paper Series 2008, June; S.J. Wilson, *Ontario's wealth, Canada's future: appreciating the value of the Greenbelt's eco-services*, David Suzuki Foundation 2008; S.J. Wilson, *Natural capital in BC's Lower Mainland: Valuing the benefits from nature*, David Suzuki Foundation 2010; S.J. Wilson, *Canada's wealth of natural capital: Rouge National Park*, David Suzuki Foundation, 2012; H. Xu et al., *Assessment of indirect use values of forest biodiversity in Yaoluoping national nature reserve, Anhui province*, "Chinese Geographical Science" 2003 vol. 13(3), p. 277–283; D. Xue, C. Tisdell, *Valuing ecological functions of biodiversity in Changbaishan Mountain Biosphere Reserve in northeast China*, "Biodiversity and Conservation" 2001 vol. 10(3), p. 467–481.

To evaluate the regulating ecosystem services, we also took another approach, based on an inventory of more than 3,000 trees in the Park. Empirical studies show that urban trees provide many benefits, such as stabilising the temperature and removing toxic substances[12]. We focus on the latter as removing toxic substances is the main service the Park trees provide. Tree species, their physical characteristics and ability to decrease the air concentration of toxic substances such as sulphur dioxide (SO_2), nitrogen dioxide (NO2), particulate matter (PM10) and volatile organic compounds (VOCs) are identified as in McPherson et al. (2007)[13]. Based on that, we estimate the total year pollution removal by the Park trees at the following levels: 1.82 tonne of SO2, 1.16 tonne of NO2, 1.65 tonne of PM10 and 0.1 tonne of VOCs. We use the estimates of external costs of pollutants developed in the EU research project NEEDS (2008)[14] to express the monetary value of the pollution removal. Table 1 shows the external year costs of each of the considered air pollutants for Poland as given by NEEDS.

Table 1. The estimates of external costs of air pollutants based on NEEDS (2008)

	SO_2	NO_2	PM_{10}	VOC
External cost (in euro per tonne of the pollutant)	7,767	5,760	667	566

Source: P. Preiss *et al.*, *Report on the procedure and data to generate averaged / aggregated data*, NEEDS project, Stuttgart 2008.

Based on the above estimates, the total year value of the ecosystem services provided by the Park trees is 22,000 euro. This value is lower than the estimate from the preceding approach because it omits the value provided by other elements of the Park ecosystems than trees.

Valuation of the third group of ecosystem services (societal functions) would ideally be based on surveys among actual and potential visitors to the Park and people living nearby. Surveys are widely applied to find people's

12 S. Pauleit, F. Duhme, *GIS assessment of Munich's urban forest structure for urban planning*, "Journal of Arboriculture" 2000 vol. 26(3), p. 133–141; N.D. Dawe, *Sprinting toward sustainability*, "American Forests" 1996 vol. 102(2), p. 22–30, 45; C. Rosenzweig et al., *Green roofs in the New York metropolitan region: Research report*, Columbia University Center for Climate Systems Research and NASA Goddard Institute for Space Studies 2006; P.J. Peper et al., *New York municipal forest resource analysis. Technical report*, New York 2007; D.J. Nowak, *Atmospheric carbon dioxide reduction by Chicago's urban forest*, in: McPherson et al. (eds), *Climate urban forest ecosystem: Results of the Chicago urban forest climate project*, Chicago 1994.

13 E.G. McPherson et al., *Northeast community tree guide: Benefits, costs, and strategic planting*, Albany, CA 2007.

14 P. Preiss et al., *Report on the procedure and data to generate averaged / aggregated data*, NEEDS project, Stuttgart 2008.

preferences. In surveys, respondents are asked (i) directly about their preferences or (ii) about their consumption behaviour. Approach (ii) enables a travel cost analysis: based on people's choices, the demand for visits to the Park could be estimated, which would reflect the value of the Park's societal functions. However, we do not have data for such an analysis. Given high costs of conducting a survey, we refer to value estimates from other studies. Because the Wilanów Park is unique, a direct transfer of benefits identified in other objects (as done above for regulating ecosystem services) is associated with large uncertainty. Thus, we only say that the year value estimates in the existing assessments range from 200 euro per ha for open space[15] to 2,000 euro per ha for urban forests[16]. On this basis, a rough estimate of societal functions of the Park is 1,000 euro per ha, which gives the value of 42,000 euro per year. Including Morysin doubles this number.

Table 2 summarises our valuation. In terms of year flows, the Wilanów gardens supply services: of providing raw materials at 5,250 euro, of regulating natural processes at 320,000 euro and of societal functions at 42,000 euro. Including Morysin increases the values to: 455,000 euro for the regulating services and 83,000 euro for the societal functions. Summing the numbers gives the *TEV* of the Park's services of 365,250 euro annually, and of 543,250 euro annually when Morysin is included.

Table 2. The year values of ecosystem services provided by the Wilanów Park [euro]

	Gardens	Gardens and Morysin
Providing raw materials	5,250	5,250
Regulating natural processes	320,000	455,000
Societal functions	42,000	83,000
Total	365,250	543,250

To account for uncertainty and divergence in the existing valuations, we estimate that the year *TEV* of the Park's ecosystem services (with the mean of 365,250 euro) would be 41,000 euro if lower bounds of the relevant values were adopted, or 546,000 euro if the respective upper bounds were adopted. As we do not have any hints about the income elasticity of these services, we use the benefit transfer approach as in (1).

The *TEV* of the Park's services is a large number, but it yields to the historical value of the place. In 2013, the state budget allocated 5.75 million euro for the Wilanów Museum. This number reflects a so-called *implicit*

15 A. Troy, K. Bagstad, op. cit.; R. de Groot et al., op. cit.

16 W.Y. Chen, C.Y. Jim, op. cit.

value: it shows what the society pays for the supply of the good (here, the Palace with the Park). This number exceeds by far the value of the ecosystem services.

Conclusion

The total *implicit value* of the Wilanów Park is much higher than the value of ecosystem services. This does not imply that these ecosystems are of little value, but rather shows the high value of the Park's historical assets. Protecting the Park nature is certainly called for, but it cannot be the main argument for adequate financing of the estate.

The Park is a unique combination of magnificent architecture and nature. Both ingredients are valuable, but the uniqueness of the architecture and the historical tradition is probably more important. The local natural resources are precious and provide users with many benefits. Nevertheless, losing the natural assets, however painful, would imply smaller economic damage to the society than a loss of the Palace. Subsidies from the state budget reflect these proportions.

The contribution of the authors in the article:

Ewa Zawojska, MSc – 40%
Zbigniew Szkop, MSc – 40%
Prof. Mikołaj Czajkowski, Ph.D – 10%
Prof. Tomasz Żylicz, Ph.D – 10%

Literature

Ahtiainen H. et al., *Performance of different approaches in international benefit transfer: Insights from a nine country experiment*, Working Paper Series of the Department of Economics of the University of Warsaw 2015 no. 28(176)

Barreiro J. et al., *How much are people willing to pay for silence? A contingent valuation study*, "Applied Economics" 2005 vol. 37(11), p. 1233–1246

Bateman I.J. et al., *Making benefit transfers work: Deriving and testing principles for value transfers for similar and dissimilar sites using a case study of the non-market benefits of water quality improvements across Europe*, "Environmental and Resource Economics" 2011 vol. 50(3), p. 365–387

Bjørner T.B., *Combining socio-acoustic and contingent valuation surveys to value noise reduction*, "Transportation Research Part D: Transport and Environment" 2004 vol. 9(5), p. 341–356

Bjørner T.B., *Comparing the value of quiet from contingent valuation and hedonic pricing methods*, paper presented at the 13th Annual Conference of the European Association of Environmental and Resource Economists, Budapest, Hungary 2004, June 25–28

Chau C.K. et al., *A choice experiment to estimate the effect of green experience on preferences and willingness-to-pay for green building attributes*, "Building and Environment" 2010 vol. 45(11), p. 2553–2561

Chen W.Y., Jim C.Y., *Assessment and valuation of the ecosystem services provided by urban forests*, in: M.M. Carreiro, Y.-C. Song, J. Wu (eds), *Ecology, planning, and management of urban forests*, New York 2008

CICES 2015 *Towards a common classification of ecosystem services*, cices.eu

Costanza R. et al., *Changes in the global value of ecosystem services*, "Global Environmental Change" 2014 vol. 26, p. 152–158

Costanza R. et al., *The value of the world's ecosystem services and natural capital*, "Nature" 1997 vol. 387, p. 253–260

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

Dawe N.D., *Sprinting toward sustainability*, "American Forests" 1996 vol. 102(2), p. 22–30, 45

Day B. et al., *Beyond implicit prices: Recovering theoretically consistent and transferable values for noise avoidance from a hedonic property price model*, "Environmental and resource economics" 2007 vol. 37(1), p. 211–232

de Groot R. et al., *Global estimates of the value of ecosystems and their services in monetary units*, "Ecosystem services" 2012 vol. 1(1), p. 50–61

Fosgerau M., Bjørner T.B., *Joint models for noise annoyance and willingness to pay for road noise reduction*, "Transportation Research Part B: Methodological" 2006 vol. 40(2), p. 164–178

Jim C.Y., Chen W.Y., *Ecosystem services and valuation of urban forests in China*, "Cities" 2009 vol. 26(4), p. 187–194

Johnston R.J. et al., *Benefit transfer of environmental and resource values: A guide for researchers and practitioners*, Dordrecht 2015

Kroeger T., *The economic value of ecosystem services in four counties in Northeastern Florida*, Conservation Economics Working Paper 2005 no. 2

Lindhjem H., Navrud S., *How reliable are meta-analyses for international benefit transfers?* "Ecological Economics" 2008 vol. 66(2–3), p. 425–435

Lindhjem H., Navrud S., *Reliability of meta-analytic benefit transfers of international value of statistical life estimates: Tests and illustrations*, in: R. J. Johnston et al. (eds), *Benefit transfer of environmental and resource values: A guide for researchers and practitioners*, Dordrecht 2015

Londoño L.M., Johnston R.J., *Enhancing the reliability of benefit transfer over heterogeneous sites: A meta-analysis of international coral reef values*, "Ecological Economics" 2012 vol. 78, p. 80–89

MacMullan E., Reich S., *Economic arguments for protecting the natural resources of the east buttes area in southeast Portland*, Eugene, OR 2009

Martín-López B. et al., *The conservation against development paradigm in protected areas: Valuation of ecosystem services in the Doñana social-ecological system (southwestern Spain)*, "Ecological Economics" 2011 vol. 70(8), p. 1481–1491

McPherson E.G. et al., *Northeast community tree guide: Benefits, costs, and strategic planting*, Albany, CA 2007

Millward A.A., Sabir S., *Benefits of a forested urban park: What is the value of Allan Gardens to the city of Toronto, Canada?* "Landscape and urban planning" 2011 vol. 100(3), p. 177–188

Navrud S., *Economic benefits of a program to reduce transportation and community noise – A contingent valuation survey*, in: *Proceedings of Internoise* 2000 vol. 5, p. 3395–3400

Navrud S., *Economic valuation of transportation noise in Europe*, "Revista italiana di Acustica" 2010 vol. 34(3), p. 15–25

Noel J.E. et al., *A benefit transfer estimation of agro-ecosystems services*, "Western Economics Forum" 2009 vol. 8(1), p. 18–28

Nowak D.J., *Atmospheric carbon dioxide reduction by Chicago's urban forest*, in: McPherson et al. (eds), *Climate urban forest ecosystem: Results of the Chicago urban forest climate project*, Chicago 1994

Olewiler N., *The value of natural capital in settled areas of Canada*, Ducks Unlimited and the Nature Conservancy of Canada, Manitoba 2004

Pauleit S., Duhme F., *GIS assessment of Munich's urban forest structure for urban planning*, "Journal of Arboriculture" 2000 vol. 26(3), p. 133–141

Peper P.J. et al., *New York municipal forest resource analysis. Technical report*, New York 2007

Pimentel D. et al., *Economic and environmental benefits of biodiversity*, "BioScience" 1997 vol. 47(11), p. 747–757

Preiss P. et al., *Report on the procedure and data to generate averaged/ aggregated data*, NEEDS project, Stuttgart 2008

Rosenzweig C. et al., *Green roofs in the New York metropolitan region: Research report*, Columbia University Center for Climate Systems Research and NASA Goddard Institute for Space Studies 2006

Troy A., Bagstad K., *Estimating ecosystem services in southern Ontario*, Ontario Ministry of Natural Resources, Ontario 2009

Wilson S.J., *Canada's wealth of natural capital: Rouge National Park*, David Suzuki Foundation, 2012

Wilson S.J., *Lake Simcoe basin's natural capital: The value of the watershed's ecosystem services*, David Suzuki Foundation, Friends of the Greenbelt Foundation Occasional Paper Series 2008, June

Wilson S.J., *Natural capital in BC's Lower Mainland: Valuing the benefits from nature*, David Suzuki Foundation 2010

Wilson S.J., *Ontario's wealth, Canada's future: appreciating the value of the Greenbelt's eco-services*, David Suzuki Foundation 2008

Xu H. et al., *Assessment of indirect use values of forest biodiversity in Yaoluoping national nature reserve, Anhui province*, "Chinese Geographical Science" 2003 vol. 13(3), p. 277–283

Xue D., Tisdell C., *Valuing ecological functions of biodiversity in Changbaishan Mountain Biosphere Reserve in northeast China*, "Biodiversity and Conservation" 2001 vol. 10(3), p. 467–481