Landscape and Urban Planning 103 (2011) 198–206

Contents lists available at ScienceDirect

Landscape and Urban Planning

journal homepage: www.elsevier.com/locate/landurbplan

# The use of economic valuation to create public support for green infrastructure investments in urban areas

Valerie Vandermeulen[a,*], Ann Verspecht[a], Bert Vermeire[b], Guido Van Huylenbroeck[a], Xavier Gellynck[a]

[a] Department of Agricultural Economics, Ghent University, Coupure Links 653, 9000 Gent, Belgium
[b] Regionaal Landschap Meetjesland, Marktstraat 65, 9990 Maldegem, Belgium

ARTICLE INFO

*Article history:*
Received 18 February 2011
Received in revised form 8 July 2011
Accepted 27 July 2011
Available online 20 August 2011

*Keywords:*
Urban planning
Economic valuation
Green infrastructure

ABSTRACT

Increasing urbanization has created pressure on land use. Today more and more land in urbanized areas is used for housing, industry, community services or other economic functions. However, green spaces have a proven positive effect on people living in the neighborhood of green spaces, as well as on people working or recreating in the urbanized area. Therefore, green infrastructure investments have been put high on the agenda in many European countries. In order to convince the public and other stakeholders of the usefulness of these kind of green investments, it is necessary to give a correct, understandable and easily repeatable method to value the investment. The current article describes a model that can be used to put the value of green infrastructure investments into economic terms. Evaluating the project at site scale and regional scale will give a complete overview of all direct, indirect and use values of the investment. By using cost–benefit as well as multiplier analyses the monetary values can be estimated. The article shows that using this model helps to justify policy's support for and investment in green space.



## 1. Introduction

In Western Europe the level of urbanization (measured as the percentage of population living in urban areas) increases by 0.2% each year and is expected to reach a level of 89.1% in 2050, compared with 79.5% in 2010 (United Nations, 2010). This urban growth puts pressure on the use of land (Vandermeulen, Gellynck, Van Huylenbroeck, Van Orshoven, & Bomans, 2009), often in the disadvantage of green space (Tzoulas et al., 2007). It seems that 'green' space has to give in to construction buildings, housing, industries and community services (Bomans, Steenberghen, Dewaelheyns, Leinfelder, & Gulinck, 2010), although 'green' space does offer multiple benefits for human populations (Matsuoka & Kaplan, 2008). It leads to recreational or leisure opportunities (Tzoulas & James, 2010), it is an important place for children to play and stay (Taylor, Kuo, & Sullivan, 2001) and for people to meet and therefore has a clear social function (a.o. Coley, Sullivan, & Kuo, 1997; Seeland, Dubendorfer, & Hansmann, 2009). It reduces stress (Hartig, Evans, Jamner, Davis, & Garling, 2003), fear, violence and aggression (Kuo & Sullivan, 2001). 'Green' space furthermore creates health benefits (a.o. de Vries, Verheij, Groenewegen, & Spreeuwenberg, 2003) and environmental benefits (a.o. Aldous, 2007), stimulated by the fact that it creates alternative transportation networks, such as cycling routes, which will have a lower impact on nature and the environment and will increase the physical activity levels of citizens (a.o. Seymour, Wolch, Reynolds, & Bradbury, 2010).

James et al. (2009) point out that these multiple functions of 'green' space have been studied extensively in literature in the past. It seems that scholars as well as policy makers agree that the demise of green space poses a threat to natural and environmental protection, however the relation to other societal functions is often not recognised. This has lead to a lack of application of these studies in policy implementation with respect to regional development, urban and spatial planning (Banzhaf, 2010; Kansanen, 2004). This lack can be explained by the less obvious and indirect benefits of green infrastructure in several societal fields and the location specific effects of green space (Schipperijn et al., 2010). Therefore, to make policy makers aware of the benefits to incorporate green functions in development and planning processes, it is necessary to assess the multiple functions of green spaces in a correct, understandable and easily repeatable way. This assessment will then create persuasive arguments to demonstrate the added value of green space, not only to the direct concerned stakeholders, but also to the regional economy as a whole. Within the current article the focus is on economic valuation as a way to value complex societal issues. The strength of the model used in this article is that it visualizes how investment costs can contribute to the regional economy and can be turned into a benefit rather than a cost. The model not only looks at the local costs and benefits of an investment project, but combines this with a regional oriented valuation.

* Corresponding author. Tel.: +32 9 264 59 43; fax: +32 9 264 62 46.
*E-mail address:* valerie.vandermeulen@ugent.be (V. Vandermeulen).

0169-2046/$ – see front matter © 2011 Elsevier B.V. All rights reserved.
doi:10.1016/j.landurbplan.2011.07.010

The use of economic valuation has received a lot of attention and applications have been made to a wide range of subjects. Originally, economic valuation was applied to specific cases with specific costs and benefits, i.e. will I buy this piece of equipment or not? What are the costs and benefits of introducing system Y in the health care sector? Recently, policy makers have called for economic valuations of far more complex societal issues, characterised by several levels in geographic scope, timing, stakeholders, values. Within this article we focus on the use of economic valuation of more nature related investments (Fuller, Monson, Ward, & Mathews, 2005), such as investments in green space, also called green infrastructure, which has not been done often in the past. Green infrastructure is thereby defined as the network of multi-functional open spaces, parks, waterways, trees and woodlands needed to support a high quality of life in and around our towns and cities (Tzoulas et al., 2007). Policy makers around Europe want to know whether these green investments can have a considerable economic return on both regional and community scale. This has lead to the commissioning of a research study, namely the European Interreg IV project named VALUE, in which scientists together with policy stakeholders are analyzing different ways to value landscape within an urbanizing environment. Part of the results of the value project has been used in the current article. The current article not only contributes to literature by applying a combined local–regional economic valuation model to a green infrastructure investment, but the results will also be used to communicate the benefits and costs of a green investment project to the public. On top of this, the evaluation of the investment project will aid policy makers to appraise the project and to decide on future investments.

In next section, the theoretical model is explained that defines the economic valuation in the case of green infrastructure. The third section reports on the case of a green infrastructure investment in the urban fringe of Bruges, Flanders. This is followed by the results which show the total economic value for the green infrastructure. The article ends with a discussion and conclusion.

## 2. Methodology

### 2.1. Defining a green infrastructure

In order to assess the economic value of green infrastructure, we propose to use the concept of total economic value (TEV). In the past this concept has been widely applied to capture the full value of the different components of natural resources (Turner et al., 2003), and can be extrapolated to green infrastructure. In the case of natural resources, traditional use values, resulting from the use of the resource, have been complemented with new values which capture the less tangible values derived from natural resources (Merlo & Croitoru, 2005). The use values can be separated into direct use values such as recreational, mobility, production, land or experience values (Chaudhry, 2006; Vanslembrouck, Van Huylenbroeck, & Van Meensel, 2005); indirect use values such as values of environmental functions, health and avoided risks, indirect production functions or the effects on living conditions (Brauman, Daily, Duarte, & Mooney, 2007; Freeman, 1993) and option values coming from biodiversity and climate change (Costanza et al., 1997; Pearce & Moran, 1994). Non-use values refer to the value that is derived from the green infrastructure, independent of any contact with the resource itself or with the tangible services that it provides. Three non-use values can be distinguished: existence values (often very important in the case of biodiversity (Aldred, 1994; Kotchen & Reiling, 2000)); legacy values (the value other people in the future will attach to the investment (Bogaert, Van Hoof, & Le Roy, 2004; Hutsebaut, Ochelen, Cerulus, & Putzeijs, 2007)); and altruistic values (others might benefit from the investment (Vázquez Rodríguez & Carmelo, 2004)).

Economic valuation does not only concern the value of the produced good or service, but also the benefits and losses which accompany the production of the good or service. Therefore, not only the classical elements of economic value, related to the produced goods or services should be considered, but also the value generated by the production of the goods, in our case the creation of the green infrastructure. This is called the investment value, and it can be the costs for purchasing land, the costs for designing and constructing the green infrastructure or the income generated through the start-up and exploitation of the green infrastructure (Bos, Gaaff, Reinhard, & Rijk, 2008; De Nocker, Liekens, & Broekx, 2004).

Describing all the values will give a more full assessment of the green infrastructure project (see Fig. 1, left hand side).

The values will be influenced by the project definition, including the objectives of the research. In Fig. 1 this is shown by the circle at the left hand side. This means, for example that only those values are selected which fit to the project definition, while all others are considered irrelevant or 'ceteris paribus'. For example, in the case at hand, only those values are selected that inform the public about the value of a green infrastructure. Although intrinsic values (namely the value which lies 'in' (the existence of) the good

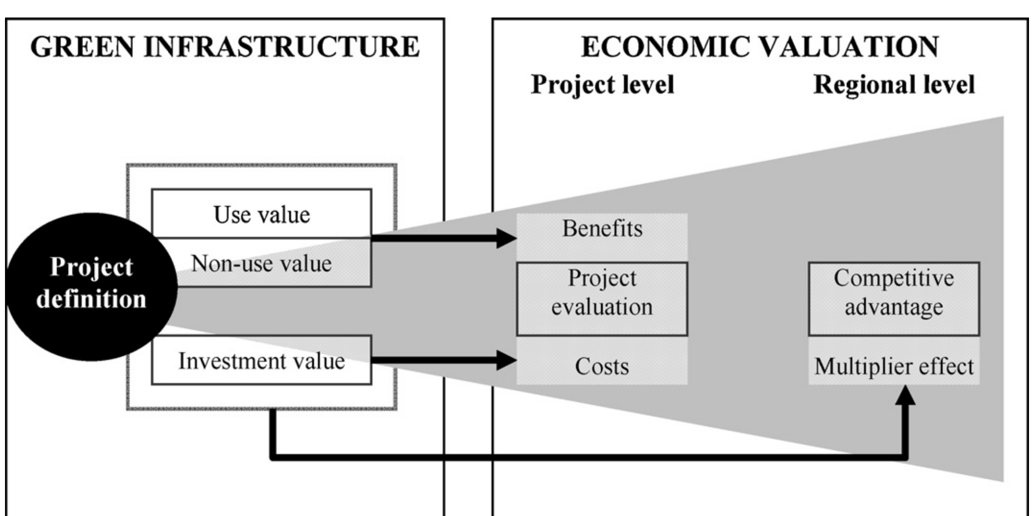


**Fig. 1.** The value framework.

itself, independent of the human perception on- and qualification of the good (Hutsebaut et al., 2007)) are very important, they are in most cases hard to measure (Crowards, 1997; Nunes & van den Bergh, 2001) and depend on relative scarceness. They can therefore not easily be used to convince the public about the value of the infrastructure and fall outside the scope of the research.

### 2.2. Economic valuation of green infrastructure

Green infrastructure is considered to be an integral part of urban economy and a key challenge for urban planners lies in the identification of green investments with the greatest economic benefits and to demonstrate these benefits at a regional level. The economic valuation of the green infrastructure should therefore happen to our opinion at two distinguished levels (see Fig. 1, right hand side): on the one hand the project level, estimating the direct benefits of the creation of the infrastructure and on the other hand, the regional economy level assessing the indirect value for the development of the region.

At site or project level the evaluation is done through cost–benefit analysis (CBA). In CBA it is analysed to what extent the benefits of the project (use and non-use values) outweigh the costs (in this case the investment value) and therefore the main criterion for evaluation is economic efficiency. In a first step, all costs and benefits should be selected and expressed in monetary values, for which a range of measurement tools can be used, such as: shadow pricing, contingent valuation, hedonic pricing, market pricing, travel cost method, etc. (de Groot, Wilson, & Boumans, 2002). This monetisation is critical in the analysis, particularly when environmental effects are studied (Butt, Morse, Guy, & Lester, 1998; Diakoulaki & Grafakos, 2004). Each method is particularly suited for measuring particular values and differ in time and budget requirements. One of the possible alternatives is applying benefit transfer, i.e. adjusting benefit estimates based on primary data collected at a different study site and applying it at a new policy site. The method is increasingly popular in the literature, since it is both faster and cheaper than carrying out new primary valuation studies (Czajkowski & Scasný, 2010). In a second step, the net present value of the project needs to be calculated. The present value of a sum of money (the reflection of the costs and benefits) in the future is its current equivalent, taking into consideration the opportunity value of this money (e.g. based on facilities for lending and borrowing) and some kind of risk assessment. The net present value (NPV) can be given as follows:

$$\mathrm{NPV} = \sum_{0}^{T} \frac{(b-c)_t}{(1+i)^t}$$

with $b$ being the benefits and $c$ the costs (including the investment costs), $T$ the total period considered and t the year in which a cost or benefit occurs. $i$ is the discount rate and reflects opportunity values and risk. In a last step project appraisal is carried out in which the consideration is made whether it makes sense to the expenditure commitment now, given the future benefits and costs in the future. Most often, several projects are compared with each other to find the best use of money. In the current case, the project is compared to not investing in any other alternative project. This makes the results very clear, specifically related to this one project, and leaves the possibility of reassessing the outcome when other alternatives arise.

At the regional economy level the effect of the green infrastructure on competitiveness is investigated using a multiplier analysis (MA). The underlying idea is that a particular economic activity affects the economic activities which are connected through input–output (I/O) relationships. Firstly, the production in one industry needs inputs created by other branches of the industry. Secondly, part of the wages earned by industry workers will be spent within the regional economy and will create an extra demand for goods and services. As such, the cost for the production of the green infrastructure will generate positive effects at the demand and supply side which will generate additional economic activities and will affect the economic competitiveness of the region as a whole. The role of nature, forest, landscape and natural heritage in the local economy has among others been described by Courntey, Hill, and Roberts (2006), Berends and Vreke (2002) and Bos and van Leeuwen (2001).

The combination of these two complementary methods will enable an investigation of (1) whether benefits outweigh costs at project level and (2) whether the marginal multiplier effects on the region outweigh the project level costs.

## 3. Case study and data

### 3.1. Description of the case

The framework has been tested on a green infrastructure investment called the ‘green cycle belt of Bruges’. Within the analyses we will compare the current situation (without a new green cycle belt) with the expected situation, having the new green cycle belt. No other alternatives will be looked at. Bruges is the capital city of the province West-Flanders in Belgium and is a famous historical attraction in Western Europe. The city has about 120,000 inhabitants and offers jobs to more than 70,000 people, many of them commuting daily to the inner city.

The green infrastructure that is studied is a planned bicycle route that will connect the inner city of Bruges with surrounding municipalities and will create a belt around the city for cyclists to move from one side to the other. Main objective of this green investment is to stimulate tourists to cycle around Bruges as well as to give an incentive to commuters to take the bike instead of a car or bus. The bicycle route will have a functional influence up to 15 km around Bruges. People involved are those living around the route, commuters, local holiday-makers, employers, etc. The route will be integrated in the landscape and will be accommodated by places to picnic and rest, recreation facilities, access to historical monuments, pathways unlocking natural sites, etc. Side objectives relate to the enhancement of public health through physical activity and through safer cycle tracks and crossings; to the integration of the cycle track into landscape; to improve air quality through reduced $CO_2$ emission and more catching of small dust.

The infrastructure project is developed by the Flemish Land Agency and is part of a more global land consolidation project (landinrichtingsproject). It is financed by the Flemish Government, the province of West-Flanders, the city of Bruges as well as surrounding municipalities like Beernem, Oostkamp, Damme, Zuienkerke, Zedelgem and benefits from European co-financing. Also some non-governmental agencies are involved, such as Regionale Landschap Houtland (a multi-stakeholder organisation aiming at nature and landscape protection) and Natuurpuntvzw (a nature conservation organisation).

### 3.2. Data

As a first step, it is necessary to define the number of people involved or concerned.

A first target group are the people who will commute to work or school by bike instead of car when the project would be realized. A realistic estimate is that people living in a distance of less than 7 km of the centre of Bruges can be potential bikers and thus users of the infrastructure (this amounts to 70,000 people). Of course not the full population within this circle should be considered as only employees who are commuting to Bruges have been taking into account (creating a pool of commuters of about 8400 people). Of those commuters concerned, it is known from previous surveys that about 42% (or 3556) come to work by bike (POM, 2007). For the students a similar calculation was done. Approximately 8000 students are coming from communities at cycling distance and go to Bruges every day. In the past 46% of them have been biking to Bruges, resulting in an amount of 4307 potential students commuting by bike.

A second target group are people who bike as a recreation. Within the region of the Brugse Ommeland, around 1.5 million cycling tours are made every year on a biking network of 900 km. Since the green cycle belt is about 34 km long, we assume that 56,000 tours are made on the route of the green infrastructure investment.

For both target groups, the assumption is made, based on meetings with stakeholders that with the realization of the green infrastructure an increase of 5% of bikers (178 employees, 188 students) and tours (2800 biking tours for recreation) can be expected. Benefits (reduced car cost, health, air quality) are therefore based on a 5% increase in the number of bikers. As no existing information is available on this estimate other scenarios are dealt with in a sensitivity analysis.

Second, choices have to be made regarding data collection: one can choose for extended primary data collection which is time and money consuming or look for secondary data. Because of lack of time and resources we took the second option. Where possible, local or regional data has been used with respect to the number of commuters, share of commuting by bike, number of accidents on road, wages, and so on. For more technical data the benefit transfer method has been used, after extended collection of corresponding studies. In Flanders some general recommendations, see different costs and benefits in the results section, exist on amount and prices to be used for non market values (e.g. air quality).

## 4. Results

### 4.1. Step 1: Selection of the costs and benefits and monetization

The following costs and benefits, at project level for the CBA as well as at regional level for the I/O analysis, were distinguished and estimated. Appendix A provides an overview of the effects measured and the local or other sources used to find value estimates.

*Project investment costs – regional investment benefit* – Most of the investment costs consists of the construction of the bicycle road itself. A smaller part is allocated to landscape development, nature development and the improved access to sites of cultural heritage. The present value could be determined easily because they were mentioned in the initial development plans (Gellinck, 2009).

The indirect investment benefit has been calculated using the official I/O tables of the Flemish region (Federaal Planbureau, 2010). Each type of investment will be linked to a certain sub-sector of the industry leading to multipliers ranging from 1.19% to 2.02%. Because these multipliers are for the Flemish region and not specific for the fringe of Bruges, it is not sure that these benefits will occur in the fringe of Bruges. However, they will occur in the region of Flanders and will therefore create a positive effect on the economy.

*Regional excess burden* – The excess burden is an indirect cost caused by an increase in taxes, needed to execute the investment project. The amount of taxes is estimated to equal the subsidies given by the Flemish government used to pay for the investment. To determine the exact excess burden it is necessary to undertake a thorough analysis of the tax system, which requires quite some work and time. A good proxy to be used is finding an excess burden in literature for a country in the same region. According to Jongeneel, Polman, and Slangen (2008) and Parry (2003), the excess burden in the Netherlands and the UK equal 30% of the total taxes.

*Project maintenance costs – regional labor benefits* – The costs for maintaining the bicycling road were estimated using the annual district expenditure on maintenance of bicycling roads of €1250 per km per year as stated in the Decree on Mobility (Flemish Government, 2009). The maintenance of the other measures are estimated by multiplying the average amount of green a worker can maintain by the total size of the green investment (in ha). This means that three full time laborers will be needed, each costing about €39,000 per year (Goeminne, 2009). Lastly, also some coordination costs need to be considered, namely two part time laborers during the period of the Interreg Project (namely 48 months) at the Flemish Land Agency, costing in total €53,960 annually.

The indirect labor benefits are due to the part of these wages that are spent locally and thus will influence economic activity. This indirect labor benefit for the I/O analysis will amount to 25% of the gross wage in the first year, after which it will decrease annually by 5% to become stable at 5% (Jongeneel et al., 2008).

*Regional costs of land use change* – Because of the intended project, some farmers will have to give up their land. This means, on the one hand a loss of the land itself and on the other hand a certain loss in income for these farmers. Because the farmers will be compensated for the land loss by the government, the net indirect cost will be zero. The same holds for private persons who 'sold' some of their land to the government for the green investment project (in fact they were expropriated and received compensation). Valuing the loss in income from giving up land is more difficult. Not only today, but also in future farmers will be limited in their production capacity. In the case of the project in Bruges, about 8 ha of farmland will be lost. To value this loss we used the average net added value a farmer can produce from one ha land in Flanders per year. Data were available for Flemish farmers between 2000 and 2009 and by using a linear regression an estimation could be made for the coming years. The obtained values can then be discounted to receive one economic loss value for the total of 8 ha over the whole period considered.

*Avoiding costs by not-commuting by car* – The benefit of commuting by bike will be a function of the avoided car costs (€0.34/km), the cost of biking (€0.046/km) and avoided congestion costs (€0.35/km) (De Ceuster, 2004). The average daily distance of a cyclist is estimated to be 11.8 km for 220 working days per year or 180 school days per year (Westtoer, 2009). A correction on the number is made for those people who use now the bus and for whom consequently no avoided car cost (or very little if we should also estimate the bus costs) can be taken into consideration.

*Project and regional recreational benefits* – The benefits associated with recreational biking can be calculated using a travel cost method (looking at parking costs, bike rental, fuel costs and bike repairing costs) together with calculating the expenditure a tourist makes during the bike ride. Both elements have been calculated by Westtoer (2008) and they found that total expenditure by cycle tourists sums up to €10.94 per person by time. This amount is then multiplied by an estimated number of cyclists on the new bike routes around Bruges, based on a 5% increase of average recreational cyclists per year per km bike route around Bruges (Westtoer, 2009).

The regional recreational benefits were calculated by multiplying the expenditures of tourists by the multiplier for the tourist sector in the I/O tables of Flanders of 1.76 (Federaal Planbureau, 2010).

*Health effects from cycling* – It has been proven in previous studies that cycling (being a sport) improves the health of an individual: people commuting by bike to work have a 40% lower chance of dying at a young age (Andersen, Schnohr, Schroll, & Hein, 2000). This improved health will have a twofold impact on society:

health care cost can be reduced and short-term absence from work is reduced which means an economic saving. Physical inactivity has been quantified related to health care costs (Bull et al., 2004; Katzmarzyk, Gledhill, & Shephard, 2000). For example, health care cost can be decreased by 1.5% (Wang, McDonald, Champagne, & Edington, 2004) for each person who cycles frequently (commuters to work, school as well as recreational cyclists). In Belgium, sick leave share is 5.19% (Statistics Belgium, 2009). Using benefit transfer, we estimate that costs from sick leave can be decreased by 0.8% (TemaNord, 2005; van Amelsvoort, Spigt, Swaen, & Kant, 2006). Average costs from sick leave are estimated by multiplying a decrease of 0.8% of sick leave people multiplied by the average annual wage. A correction factor is used to correct for all the people who are already doing some kind of sport, therefore the share of active employees in Belgium was used (namely 58%).

*Environmental effects* – A green infrastructure will have many different environmental effects on the region, such as production and regulating services. Within the case, the production of services such as food, drinking water and building materials, is expected to be very limited. Therefore this will not be calculated. The regulating services are very numerous and a selection needs to be made in order to be able to analyse the case (de Groot, 2006). Those services were chosen that are most typical for the case at hand: those that relate to the modal shift from car to biking traffic and the regulating services of green elements. The investment will improve the air quality surrounding due to lower emission of carbon oxides ($CO_2$) and small dust particles ($PM_{10}$) on the one hand and to a higher catch of these small dust particles and nitrogen oxides ($NO_x$) by plantings on the other hand.

The value of lower emissions was calculated based on an average emission of a car of 153 g $CO_2$/km (MIRA, 2007) and of 37 mg $PM_{10}$/km (Van Zeebroeck & Nawrot, 2008). The average commuting distance avoided is similar to the distance cycled used before (namely 11.8 km). As before, it is assumed that not all new cyclists used a car before the investment, and therefore figures need to be adapted (only 75% for working commuters and 74% of school commuters). One ton emission of $CO_2$ costs society €50 (Liekens et al., 2010) while one ton of $PM_{10}$ costs society €300 (Kampman, Vermeulen, & Dings, 2001).

The value of the higher catch depends on the catch potential of the new trees or green elements multiplied by the amount of plants. Within the project an average extra catch of 22 kg $PM_{10}$ per km per year (Oosterbaan & Tonneijck, 2006) and of 205 kg $NO_x$ per km per year (Ruijgrok et al., 2006) is assumed. In total 11.5 ha of new trees will be planted. This catch is valued with unity prices of €30/kg for $PM_{10}$ and €6.5/kg for $NO_x$ (Liekens et al., 2010).

*Improved traffic safety* – Due to better cycling circumstances, a decrease in number of accidents can be assumed. To estimate the value of this benefit, the average number of accidents between 2006 and 2009 with cyclists on the roads which will be adapted by the investment program, is calculated (Politie Brugge, 2009). The value of an avoided accident can be calculated based on the risk value, direct and indirect costs an injured will incur (e.g. the value of a person dying amounts to €2 million while the value of a minor injured is €20,000 (De Brabander & Vereeck, 2003; Nellthorp, Sansom, Bickel, Doll, & Lindberg, 2001)). Within the region were the investment program will be carried out, not one person died or was heavily injured while riding a (motor)bike during the period 2006–2009. Only about ten minor injuries occurred each year. Therefore the avoided number of accidents will be quite low in absolute terms. The exact number of avoided accidents is difficult to approximate because no statistical connection has been proven between the type of infrastructure and the number of accidents (Van Hout, 2007; Van Hout, Hermans, Nuyts, & Brijs, 2005). Based on general traffic safety information, we assume that the decrease will be between 33% (which is the drop in accidents on roads without and with biking accommodation) and 75% (which is the drop in accidents on roads with a single direction biking path and a double direction biking path) (Statistics Belgium, 2011). Therefore several scenarios have been developed, with a drop of 50% as reference scenario.

Besides the included aspects, one might think of other costs or benefits related to the project at hand. For example, there might be an impact of a change in the landscape on the value of surrounding houses (Cheshire & Sheppard, 1995; Geoghegan, 2002; Irwin & Bockstael, 2002). However, the change in landscape due to the implementation of the cycle belt is rather limited, especially in those areas were the cycle belt is located on previously existing short cuts used by bikers.

### 4.2. Step 2: Calculating the TEV of the green investment

After defining and monetizing all relevant costs and benefits, the net present value of the investment was estimated. As described before, the net present value will depend on the used time horizon ($T$) and the discount rate ($i$).

The time horizon most often used for land consolidation projects is 20 years (European Commission, 2008), which is applied in the current project. As the actual time horizon should be equal to the economic life expansion of the project (Gauderis, Scheltjens, Debisschop, Hörchner, & Notteboom, 2006), some investments will be depreciated in only 10 years (such as plants, trees or hedges) while for others a rest value will be calculated after 20 years (e.g. roads have an economic life expansion of 30 years). Further, it is observed that some studies apply far longer time horizons, equal to the time that society may benefit from the green infrastructure, i.e. the lifespan of trees (van Delft et al., 2007).

In many evaluations on the costs of green investments a discount rate between 2% and 7% is used, based on the height of the market risk (Ecorys, 2008; van Delft et al., 2007; Willis, 1999). Because the market risk within the project is quite low and because in literature some statements can be found that benefits should not or very lowly be discounted (Brouwer, 2000), a rather moderate value of discounting is used (3%).

This leads to a calculation of the net present value, meaning the value the investment represents today, in the following manner:

$$\mathrm{NPV} = \sum_{0}^{20} \frac{(b-c)_t}{(1+0.03)^t}$$

The results are given in Table 1.

### 4.3. Step 3: Appraisal of the green investment

It seems that the project is profitable in a direct way based on the CBA. The payback period, based on the CBA analysis, is 14 years, well below the used time horizon of 20 years. When integrating additional indirect effects based on the I/O, there is a positive impact on the regional economy.

As to control for the robustness of the results, to deal with unexpected circumstances and to consider the many assumptions that had to be made, a sensitivity analysis was performed on the CBA. Within this analysis variation was allowed for the discount rate and time horizon, the amount of cyclists, the green plantings, health cost, environmental quality and number of accidents. The size of the variation is based on the assumptions made and the calculation method of the benefit and cost at hand.

For the variation in discount rate, the results showed that even with a higher discount rate of 5% the project remained profitable. When the discount rate reached a level of 6.2%, the project created a zero cost benefit result. However, if the increase in cyclists (recreational and commuters) is not 5% as assumed in the above example,

**Table 1**
Net present value of the green infrastructure project (for more information on the used benefits and costs, see text).

| | Cost benefit analysis (CBA) | | |
|---|---|---|---|
| | Rest value after 20 years (€) | Cost (not discounted) (€) | Time horizon and discount rate |
| Building the cycle road | 1,632,651 | 4,897,953 | 30 years at 0% |
| Landscape, nature development, cultural heritage amendments | 0 | 1,757,670 | 10 years at 0% |
| *Total investment costs* | | 5,022,972 | |
| | Annuity (€/year) | Discounted cost (€) | |
| Cycle road/year/km | 1250 | 674,136 | 20 years at 3% |
| Structural maintenance | 117,000 | 1,740,665 | 20 years at 3% |
| Coordination (not discounted) | 53,960 | 215,839 | |
| *Total maintenance costs* | | 2,630,639 | |
| *Total direct costs* | | 7,653,611 | |
| | Annuity (€/year) | Discounted benefit (€) | |
| Avoiding costs by not-commuting | 413,910 | 6,157,933 | 20 years at 3% |
| Recreational benefits | 33,049 | 491,483 | 20 years at 3% |
| Environmental effects | 38,084 | 608,894 | 20 years at 3% |
| Health effects from cycling | 47,041 | 699,847 | 20 years at 3% |
| Improved road safety | 95,834 | 1,402,623 | 20 years at 3% |
| *Total direct benefits* | | 9,360,780 | |
| Total CBA | | 1,707,169 | |
| | Input output analysis (I/O) | | |
| | Original value | Discounted indirect value (€) | Multiplier |
| Excess burden (on the subsidized part of the investment) | 4,839,817 | −1,451,945 | 30% |
| Land use change | | −135,513 | |
| Labor (expenditure by people employed in the project) | 2,630,639 | 251,230 | 5–25% |
| Investment (based on the regional multiplier) | 6,655,623 | 4,845,501 | 1–2.02% |
| Recreational consumption | 491,483 | 376,449 | 1.76% |
| Total I/O | | 3,885,723 | |
| Total economic value | | 5,592,892 | |

but only 2.5%, the project will become unprofitable: it will have a negative net present value (NPV) based on the CBA of −1.6 million euro. Shifts in the type of green infrastructure will have an impact on environmental benefits as well as on the health effects. However, the total impact on the NPV of the project will be limited, remaining positive even when no area of trees or other plants is estimated. Lastly, the effects of improved road safety can be very different from what was estimated. As described before, one person dying on the new road would have a tremendous effect (extra loss of €2 million) rendering the project unprofitable according to the CBA.

The objective of this paper, to show the positive effect on a regional scale of investing in green infrastructure, is demonstrated clearly by the multiplier analysis. The regional additional effects are more than twice as high as the project effects. Most of the regional value is created by the multiplier effect of the investments in the project. Building a new road means economic activity within the building sector, which means in turn more production of building materials as well as machineries. This creates an extra impulse in society of between 0% for activities that do not require previous production activities (multiplier of 1), mainly land acquisition, and 100% for activities that do require a lot of produced goods, such as general building activities, of the initial investment (multiplier of 2).

## 5. Discussion and conclusion

Increasing urbanization has put a pressure on land use in many Western European regions (Tzoulas et al., 2007). The current article has focused on Bruges, Flanders as an example, but the idea brought forward can be used in other urbanized regions as well. In fact, the article shows that economic valuation can be used to convince stakeholders of a certain choice in landscape planning in urban regions. In the case of green infrastructure, the study shows to stakeholders that investing in green infrastructure does not only contribute to the environment but that it also creates direct and indirect positive effects for the region as a whole. Thereby greater public support can be created for policy actions (Broussard, Washington-Ottombre, & Miller, 2008). In the case at hand, the Flemish Land Agency has spread the results of the study to the public and have used them as a pilot study for a major conference held in the centre of Bruges in 2010.

The contribution of this paper and the proposed model to existing valuation studies lies within the combination of the costs benefit and multiplier analyses. Many economic valuation methods have limited utility for policy-makers and other stakeholders, because they only indirectly reflect the flow of multiple benefits and costs (McPherson, 1992). With the suggested combination, of cost benefit and multiplier analyses, the less tangible benefits that are generated at site level are completed with the indirect economic benefits created through the production of the green infrastructure. This model can be the basis for a well motivated analysis that can convince critical stakeholders and can create more public willingness to accept incorporation of green infrastructure, or other natural resources, into land use plans. The model can help policy makers to balance issues of community growth, environmental protection and quality of life (Broussard et al., 2008). Moreover, it may reveal unexpected or not straightforward economic benefits.

Convincing the public and other stakeholders about the value of ‘green’ areas for society is however characterised by different problems. One major issue remains that exact values of the effects created are difficult to estimate, because they are a combination of use, non-use and investment values. In our analysis, often benefit transfer was used. Because of the combination of methods, data collection and the complexity of the different values, there is the necessity to communicate also the restrictions and assumptions which are to be taken into account in order to fully understand the evaluation result. A clear handbook providing potential users with possibilities of how to generate values for the different effects and with an indication of possible benefit transfer values from literature (indicating their sensitivity) would be a useful tool for our method.

Not only data will be limiting for the exact values taken into consideration in the analysis, also the objectives of the evaluation will limit or define the choice of benefits and costs. This will have an impact on the results. For example, if more benefits were to be included, such as psychological, stress reduction, and emotional benefits, the outcome would most probably even be more positive. However, if more costs were to be included, such as the losses for the automobile industry if everybody was to shift to using a bike, might make the investment not acceptable. However, by starting the choice of benefits and costs from the objectives of the evaluation and of the project (in this case the project aimed at more biking in a green environment) then a correct choice of benefits and costs can be guaranteed.

Moreover, it is worth noting that economic valuation certainly is not the only valuation method for investments in green infrastructure. Because many of the values that are created are not economic to start with (e.g. health effect, landscape improvement, traffic safety) one might think of other methods. However to come to an overall conclusion on the desirability of such a project, it will be necessary to put all benefits and costs into a common measure. Therefore, economic valuation gives a good answer and helps to evaluate the total of a project and not just separate aspects.

But as the application shows, we may conclude that the model and methodology presented to value the effects of green infrastructure projects could be a useful tool for project developers to show policy makers and stakeholders concerned the real value of green infrastructure projects. We therefore recommend further development of the tool and handbook.

## Acknowledgements

The data used in this article were collected within the VALUE Interreg project (Valuing Attractive Landscapes in the Urban Economy), subsidized by the European Commission.

## Appendix A. Data on the costs and benefits related to the values which they reflect (in order of appearance in the text, Section 4.1)

| Type of value | Name | Measurement | Data source | Data use |
|---|---|---|---|---|
| | *Project investment costs and regional investment benefits* | | | |
| Investment value | Building the cycle road | Investment cost, discounted over 30 years | Gellinck (2009) | CBA |
| Investment value | Landscape, nature development, cultural heritage amendments | Investment cost, discounted over 10 years | Gellinck (2009) | |
| Indirect use value | Investment related benefit | Investment cost (sum of the above two costs), multiplier between 1% and 2.02% | Federaal Planbureau (2010), Gellinck (2009) | I/O |
| | *Regional excess burden* | | | |
| Investment value | Regional excess burden | Based on Flemish subsidy part of the investment costs, multiplier of 30% | Gellinck (2009), Jongeneel et al. (2008), Parry (2003) | I/O |
| | *Project maintenance costs and regional labor benefits* | | | |
| Investment value | Maintenance of the cycle road | Estimated cost per year per km | Vlaamse Overheid (2009) | CBA |
| Investment value | Structural maintenance of the landscape elements | Reference cost per year for maintenance of green elements in Bruges | Goeminne (2009) | CBA |
| Investment value | Coordination of the project | Coordination costs, as in the budget | Gellinck (2009) | CBA |
| Indirect use value | Labor related benefit: expenditure by people employed in the project | Coordination costs, multiplier of 5% to 25% | Gellinck (2009), Goeminne (2009), Jongeneel et al. (2008) | I/O |
| | *Regional costs of land use change* | | | |
| (Negative) non-use value | Land use change | Loss of net added value per ha | Oskam and Slangen (1998), Peerlings (1993) | I/O |
| | *Avoiding costs by not-commuting by car* | | | |
| Direct use value | Avoiding costs by not-commuting | Function of the avoided car costs, cost of biking and avoided congestion costs | Westtoer (2009), De Ceuster (2004) | CBA |
| | *Project and regional recreational benefits* | | | |
| Direct use value | Recreational benefits | Travel cost method and expenditure estimates | Westtoer (2009, 2008) | CBA |
| Direct use value | Recreational consumption | Expenditures of tourist, multiplier of 1.76 | Federaal Planbureau (2010), Westtoer (2009, 2008) | I/O |
| | *Health effects from cycling* | | | |
| Indirect use value | Health effects from cycling | Decrease in health care cost and in sick leave cost | Statbel (2009), van Amelsvoort et al. (2006), TemaNord (2005), Wang et al. (2004) | CBA |
| | *Environmental effects* | | | |
| Indirect and option value | Environmental effects | Lower emission of carbon oxides and small dust particles, higher catch of dust particles and nitrogen oxides | Liekens et al. (2010), Van Zeebroeck and Nawrot (2008), Oosterbaan and Tonneijck (2006), Ruijgrok et al. (2006), Kampman et al. (2001) | CBA |
| | *Improved traffic safety* | | | |
| Direct use value | Improved road safety | Decrease in the number of accidents, due to better cycling circumstances | Politie Brugge (2009), Van Hout (2007), Van Hout et al. (2005), De Brabander and Vereeck (2003), Nellthorp et al. (2001) | CBA |

## References


Aldous, D. E. (2007). Social, environmental, economic, and health benefits of green spaces. In T. A. Lumpkin, & I. J. Warrington (Eds.), *Proceedings of the international symposium on horticultural plants in urban and peri-urban life* (pp. 171–185). Leuven: International Society Horticultural Science.

Aldred, J. (1994). Existence value, welfare and altruism. *Environmental Values*, *3*(4), 381–402.

Andersen, L. B., Schnohr, P., Schroll, M., & Hein, H. O. (2000). All-cause mortality associated with physical activity during leisure time, work, sports, and cycling to work. *Archives of Internal Medicine*, *160*(11), 1621–1628.

Banzhaf, H. S. (2010). Economics at the fringe: Non-market valuation studies and their role in land use plans in the United States. *Journal of Environmental Management*, *91*(3), 592–602.

Berends, H., & Vreke, J. (2002). (*The role of forest and nature in Achterhoek and Kempen, an economic valuation method tested in two areas. Alterra-rapport 487*) *De rol van bos en natuur in de Achterhoek en in de Kempen, een economische waarderingsmethode getest in twee gebieden*. Wageningen: Alterra Reseach Instituut voor de Groene Ruimte., p. 106 (in Dutch).

Bogaert, S., Van Hoof, V., & Le Roy, D. (2004). (*Economic valuation of parcs*) *Economische waardering van parken*. Brussels: Ministerie van de Vlaamse Gemeenschap – Afdeling Bos en Groen., p. 151 (in Dutch).

Bomans, K., Steenberghen, T., Dewaelheyns, V., Leinfelder, H., & Gulinck, H. (2010). Underrated transformations in the open space – The case of an urbanized and multifunctional area. *Landscape and Urban Planning*, *94*(3–4), 196–205.

Bos, E., Gaaff, A., Reinhard, S., & Rijk, P. (2008). (*Societal cost–benefit analysis of walking on farm land with indicative cases. Rapport 4. 07. 01*) *Maatschappelijke kostenbatenanalyse van wandelen op boerenland met indicatieve cases 'het Land van Wijk en Wouden' en 'de Hoeksche Waard'*. Den Haag: LEI., p. 66 (in Dutch).

Bos, E., & van Leeuwen, M. (2001). (*Development of instruments for estimating regional–economic effects of land consolidation projects: Illustration based on the case of 'het Kuindermeer'). Rapport 4. 01. 02*) *Ontwikkeling van een instrumentarium voor het bepalen van regionaal-economische effecten van landinrichtingsprojecten: Illustratie aan de hand van de case 'het Kuindermeer'*. Den Haag: LEI., p. 44 (in Dutch).

Brauman, K. A., Daily, G. C., Duarte, T. K., & Mooney, H. A. (2007). The nature and value of ecosystem services: An overview highlighting hydrologic services. *Annual Review of Environment and Resources*, *32*, 67–98.

Broussard, S. R., Washington-Ottombre, C., & Miller, B. K. (2008). Attitudes toward policies to protect open space: A comparative study of government planning officials and the general public. *Landscape and Urban Planning*, *86*(1), 14–24.

Brouwer, R. (2000). Environmental value transfer: State of the art and future prospects. *Ecological Economics*, *32*(1), 137–152.

Bull, F. C., Armstrong, T. P., Dixon, T., Ham, S., Neiman, A., & Pratt, M. (2004). Physical inactivity. In M. Ezzati (Ed.), *Comparative quantification of health risks: Global and regional burden of disease attributable to selected major risk factors* (pp. 729–881). Geneva: World Health Organization.

Butt, E. P., Morse, G. K., Guy, J. A., & Lester, J. N. (1998). Co-recycling of sludge and municipal solid waste: A cost–benefit analysis. *Environmental Technology*, *19*(12), 1163–1175.

Chaudhry, P. (2006). Recreational use value of Chandigarh city's urban forestry. *Current Science India*, *91*(11), 1440–1441.

Cheshire, F., & Sheppard, S. (1995). On the price of land and the value of amenities. *Economica*, *62*, 247–267.

Coley, R. L., Sullivan, W. C., & Kuo, F. E. (1997). Where does community grow? *Environment and Behavior*, *29*(4), 468–494.

Costanza, R., dArge, R., deGroot, R., Farber, S., Grasso, M., Hannon, B., et al. (1997). The value of the world's ecosystem services and natural capital. *Nature*, *387*(6630), 253–260.

Courntey, P., Hill, G., & Roberts, D. (2006). The role of natural heritage in rural development: An analysis of economic linkages in Scotland. *Journal of Rural Studies*, *22*, 469–484.

Crowards, T. (1997). Nonuse values and the environment: Economic and ethical motivations. *Environmental Values*, *6*(2), 143–167.

Czajkowski, M., & Scasný, M. (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), 2409–2416.

De Brabander, B., & Vereeck, L. (2003). (*Valuation of human life in investments on traffic safety: Review of research methods and proposal for the Flemish Support of Traffic Safety in the case of increased mobility*) *De waardering van een mensenleven bij investeringen in verkeersveiligheid: Overzicht onderzoeksmethoden en een voorstel voor Vlaanderen*. Diepenbeek: Steunpunt Verkeersveiligheid bij Stijgende Mobiliteit., p. 64 (in Dutch).

De Ceuster, G. (2004). (*Internalising of external costs of traffic in Flanders*) *Internalisering van externe kosten van wegverkeer in Vlaanderen*. Leuven: Studie uitgevoerd in opdracht van de Vlaamse Milieumaatschappij, MIRA, MIRA/2004/04, Transport & Mobility. (in Dutch).

de Groot, R. S., Wilson, M. A., & Boumans, R. M. J. (2002). A typology for the classification, description and valuation of ecosystem functions, goods and services. *Ecological Economics*, *41*(3), 393–408.

de Groot, R. S. (2006). Function-analysis and valuation as a tool to assess land use conflicts in planning for sustainable, multi-functional landscapes. *Landscape and Urban Planning*, *75*(3–4), 175–186.

De Nocker, L., Liekens, I., & Broekx, S. (2004). (*Wet nature around the river Schelde. An exploitation of costs and benefits*) *Natte natuur in het Schelde-estuarium. Een verkenning van de kosten en baten*. VITO, Mol. (In Dutch).

de Vries, S., Verheij, R. A., Groenewegen, P. P., & Spreeuwenberg, P. (2003). Natural environments – Healthy environments? An exploratory analysis of the relationship between greenspace and health. *Environment and Planning A*, *35*(10), 1717–1731.

Diakoulaki, D., & Grafakos, S. (2004). *Multicriteria analysis, final report on work package 4. ExternE-Pol. Externalities of energy: Extension of accounting framework and policy applications, Athens*.

Ecorys. (2008). (*Guide for cost–benefit analyses in the social domain*) *Handleiding voor kosten-batenanalyses in het sociale domein*. Rotterdam: Ecorys., p. 90 (in Dutch).

European Commission (2008). Guide to cost benefit analysis of investment projects. European Union – Regional Policy, p. 259.

Federaal Planbureau. (2010). Regionale input–output data (regional input–outputdata). In Flemish Community (Ed.), *Flemish Environmental IO model* (in Dutch).

Freeman, A. (1993). *The measurement of environmental and resource values: Theory and methods*. Washington, DC: Resources for the Future.

Fuller, K., Monson, M., Ward, J., & Mathews, L. G. (2005). Can nature drive economic growth? *Review of Agricultural Economics.*, *27*(4), 621–629.

Gauderis, J., Scheltjens, T., Debisschop, K., Hörchner, K., & Notteboom, T. (2006). De opmaak van een standaardmethodiek MKBA voor socio-economische verantwoording van grote infrastructuurprojecten in de Vlaamse zeehavens (Development of a standard method for socio-economic account of large investment projects in the Flemish harbours). In opdracht van Vlaamse overheid, Departement Mobiliteit en Openbare Werken, Afdeling Haven-en Waterbeleid. Resource Analysis, Antwerpen, p. 206 (in Dutch).

Gellinck, L. (2009). Veldgebied Brugge, Inrichtingsproject landinrichting Randstedelijk Gebied Brugge (Land consolidation project – Bruges), Eindvoorstel van inrichtingsplan, Groene fietsgordel Brugge, p. 139 (in Dutch).

Goeminne, H. (2009). Personal communication. Deliverd to Vandermeulen, V., Brugge.

Geoghegan, J. (2002). The value of open spaces in residential land use. *Land Use Policy*, *19*, 91–98.

Hartig, T., Evans, G. W., Jamner, L. D., Davis, D. S., & Garling, T. (2003). Tracking restoration in natural and urban field settings. *Journal of Environmental Psychology*, *23*(2), 109–123.

Hutsebaut, E., Ochelen, S., Cerulus, T., & Putzeijs, B. (2007). (*Environmental benefits or costs – Valuation studies in Flanders*) *Milieubaten of milieuschadekostenwaarderingsstudies in Vlaanderen*. Brussel: Vlaamse Overheid, Departement Leefmilieu, Natuur en Energie. (in Dutch).

Irwin, E., & Bockstael, N. (2002). The problem of identifying land use spillovers. Measuring the effects of open space in residential property values. *American Journal of Agricultural Economics*, *83*, 698–704.

James, P., Tzoulas, K., Adams, M. D., Barber, A., Box, J., Breuste, J., et al. (2009). Towards an integrated understanding of green space in the European built environment. *Urban Forestry & Urban Greening*, *8*(2), 65–75.

Jongeneel, R., Polman, N., & Slangen, L. (2008). Cost–benefit analysis of the dutch nature conservation policy: Direct, indirect effects and transaction costs of the ecological main structure in the Netherlands. In *XIIth Congress of the European Association of Agricultural Economics* Ghent.

Kampman, B., Vermeulen, J., & Dings, J. (2001). (*Gasoline, Diesel and LPG, balancing between ecology and economy*) *Benzine, Diesel en LPG, balanceren tussen milieu en economie; update van 'Optimale brandstofmix voor het wegverkeer'*. Delft: CE – Oplossingen voor milieu, economie en technologie., p. 164 (in Dutch).

Kansanen, P. H. (2004). The role of scientific environmental knowledge in decision-making in the City of Helsinki, Finland. *Boreal Environment Research*, *9*(6), 543–549.

Katzmarzyk, P. T., Gledhill, N., & Shephard, R. J. (2000). The economic burden of physical inactivity in Canada. *Canadian Medical Association Journal*, *163*(11), 1435–1440.

Kotchen, M. J., & Reiling, S. D. (2000). Environmental attitudes, motivations, and contingent valuation of nonuse values: A case study involving endangered species. *Ecological Economics*, *32*(1), 93–107.

Kuo, F. E., & Sullivan, W. C. (2001). Environment and crime in the inner city – Does vegetation reduce crime? *Environment and Behavior*, *33*(3), 343–367.

Liekens, I., Schaafsma, M., Staes, J., Brouwer, R., De Nocker, L., & Meire, P. (2010). (*Economic valuation of ecosystem services, a guide. Studie in opdracht van LNE afdeling milieu-, natuur- en energiebeleid*) *Economische waardering van ecosysteemdiensten, een handleiding*. VITO, Mol., p. 84 (in Dutch).

Matsuoka, R. H., & Kaplan, R. (2008). People needs in the urban landscape: Analysis of Landscape And Urban Planning contributions. *Landscape and Urban Planning*, *84*(1), 7–19.

McPherson, E. G. (1992). Accounting for benefits and costs of urban greenspace. *Landscape and Urban Planning*, *22*(1), 41–51.

Merlo, M., & Croitoru, L. (2005). *Valuing Mediterranean forests: Towards total economic value*. Oxfordshire: CABI Publishing., p. 406.

MIRA. (2007). R. Torfs, F. Deutsch, L. Schrooten, S. Broekx, J. Vankerkom, & C. Matheeussen, et al. (Eds.), *Milieurapport Vlaanderen – verspreiding van zwevend stof* (p. 95). Mechelen: Vlaamse milieumaatschappij (in Dutch).

Nellthorp, J., Sansom, T., Bickel, P., Doll, C., & Lindberg, C. (2001). Valuation conventions for UNITE, UNITE (UNIfication of accounts and marginal costs for transport efficiency). In *Work funded by 5th framework RTD programme* (p. 29). Leeds: ITS-University of Leeds.

Nunes, P., & van den Bergh, J. (2001). Economic valuation of biodiversity: Sense or nonsense? *Ecological Economics*, *39*(2), 203–222.

Oskam, A. J., & Slangen, L. (1998). The financial and economic consequences of a wildlife development and conservation plan: a case-study for the ecological main structure in the Netherlands. In S. Dabbert, A. Dubgaard, L. Slangen, & M. Whitby (Eds.), *The Economics of the Landscape and Wildlife Conservation*. CAB International.

Oosterbaan, A., & Tonneijck, A. (2006). (*Small landscape elements as catchment of fine dust and ammonia. Alterra onderzoeksrapport*) *Kleine landschapselementen als invangert van fijn stof en ammoniak*. Wageningen: WUR. (in Dutch).

Parry, I. W. H. (2003). On the costs of excise taxes and income taxes in the UK. *International Tax and Public Finance*, *10*(3), 281–304.

Pearce, D., & Moran, D. (1994). *The economic value of biodiversity*. London: IUCN and Earthscan Publications.

Peerlings, J. (1993). *An applied general equilibrium model for Dutch agribusiness policy analysis*. University of Wageningen.

Politie Brugge. (2009). Number of light injured cyclists and motorcyclists on municipal routes, 2006–2008.

POM. (2007). Enquête woon-werkverkeer "ik Kyoto" (Survey Cycling Commuters "I Kyoto") (in Dutch).

Ruijgrok, E. C. M., Smale, A. J., Zijlstra, R., Abma, R., Berkers, R. F. A., Németh, A. A., et al. (2006). (*Basic figures for the valuation of nature, water, soil and landscape. Aid to social cost–benefit analyses*) *Kentallen Waardering Natuur, Water, Bodem en Landschap. Hulpmiddel bij MKBA's*. Rotterdam: In opdracht van Ministerie van LNV, Witteveen+Bos. (in Dutch).

Schipperijn, J., Ekholm, O., Stigsdotter, U. K., Toftager, M., Bentsen, P., Kamper-Jorgensen, F., et al. (2010). Factors influencing the use of green space: Results from a Danish national representative survey. *Landscape and Urban Planning*, *95*(3), 130–137.

Seeland, K., Dubendorfer, S., & Hansmann, R. (2009). Making friends in Zurich's urban forests and parks: The role of public green space for social inclusion of youths from different cultures. *Forest Policy and Economics*, *11*(1), 10–17.

Seymour, M., Wolch, J., Reynolds, K. D., & Bradbury, H. (2010). Resident perceptions of urban alleys and alley greening. *Applied Geography*, *30*(3), 380–393.

Statbel. (2009). *Lonen en arbeidskosten*. Available at http://statbel.fgov.be/nl/statistieken/cijfers/arbeid_leven/lonen/index.jsp, accessed September, 16th.

Statistics Belgium. (2009). (*Wages and labour costs*) *Lonen en arbeidskosten*. Available at http://statbel.fgov.be/nl/statistieken/cijfers/arbeid_leven/lonen/index.jsp accessed 16.09 (in Dutch)

Statistics Belgium. (2011). (*Road accidents and victims*) *Verkeersongevallen en –slachtoffers*. Available at http://statbel.fgov.be/nl/statistieken/cijfers/verkeer_vervoer/verkeer/ongevallen_slachtoffers/ (in Dutch)

Taylor, A. F., Kuo, F. E., & Sullivan, W. C. (2001). Coping with add – The surprising connection to green play settings. *Environment and Behavior*, *33*(1), 54–77.

TemaNord. (2005). *CBA of Cycling*. Copenhagen: Nordic Council of Ministers., p. 556.

Turner, R. K., Paavola, J., Cooper, P., Farber, S., Jessamy, V., & Georgiou, S. (2003). Valuing nature: Lessons learned and future research directions. *Ecological Economics*, *46*(3), 493–510.

Tzoulas, K., & James, P. (2010). Peoples' use of, and concerns about, green space networks: A case study of Birchwood, Warrington New Town, UK. *Urban Forestry & Urban Greening*, *9*(2), 121–128.

Tzoulas, K., Korpela, K., Venn, S., Yli-Pelkonen, V., Kazmierczak, A., Niemela, J., et al. (2007). Promoting ecosystem and human health in urban areas using Green Infrastructure: A literature review. *Landscape and Urban Planning*, *81*(3), 167–178.

United Nations. (2010). World urbanization prospects, the 2009 revision. Department of Economic and Social Affairs, Population Division, Population Estimates and Projections Section.

van Amelsvoort, L., Spigt, M., Swaen, G., & Kant, I. (2006). Leisure time physical activity and sickness absenteeism; a prospective study. *Occupational Medicine (Oxford)*, *56*(3), 210–212.

van Delft, A., Schot, M., Slingenberg, A., van Veen, M., Verkennis, A., Buter, E., et al. (2007). (*Cost benefit analysis of green–blue streams. End report*) *Kosten–Baten analyse groenblauwe dooradering Hoeksche Waard Eindrapportage*. Rotterdam: Ecorys & Witteveen+Bos. (in Dutch).

Van Hout, K. (2007). (*Riscs related to cycling. Facts, figures and conclusions*) *De risico's van fietsen. Feiten, cijfers en vaststellingen*. Diepenbeek: Steunpunt Verkeersveiligheid., p. 93 (in Dutch).

Van Hout, K., Hermans, E., Nuyts, E., & Brijs, T. (2005). (*Cycle routes in Flanders. A risc analysis based on road and environmental characteristics*) *Doortochten in Vlaanderen. Een risicoanalyse op basis van weg- en omgevingskenmerken*. Diepenbeek: Steunpunt Verkeersveiligheid., p. 110 (In Dutch).

Van Zeebroeck, B., & Nawrot, T. (2008). (*Cars and health. End report. In opdracht van Vlaams Instituut voor Wetenschappelijk en Technologisch Aspectenonderzoek – viWTA*) *Auto en gezondheid – Eindrapport*. Leuven: Transport & Mobility Leuven., p. 146 (in Dutch).

Vandermeulen, V., Gellynck, X., Van Huylenbroeck, G., Van Orshoven, J., & Bomans, K. (2009). Farmland for tomorrow in densely populated areas. *Land Use Policy*, *26*(4), 859–868.

Vanslembrouck, I., Van Huylenbroeck, G., & Van Meensel, J. (2005). Impact of agriculture on rural tourism: A hedonic pricing approach. *Journal of Agricultural Economics*, *56*(1), 17–30.

Vázquez Rodríguez, M., & Carmelo, L. (2004). Altruism and the economic values of environmental and social policies. *Environmantal & Resource Economics*, *28*(2), 233–249.

Vlaamse Overheid (2009). Decreet betreffende het mobiliteitsbeleid (decree on mobility policy – Flemish Government). In: Belgisch Staatsblad, March 11th 2009 (in Dutch).

Wang, F., McDonald, T., Champagne, L., & Edington, D. (2004). Relationship of body mass index and physical activity to health care costs among employees. *Journal of Occupational and Environmental Medicine*, *46*(5), 428–436.

Westtoer. (2008). Blits – Onderzoek fietsnetwerk Brugse Ommeland (Research on the cycle network of Bruges). Ruimte voor Recreatie, Strategisch Beleidsplan voor Openluchtrecreatie voor de Provincie West-Vlaanderen, 2009–2018, Brugge, p. 251 (in Dutch).

Westtoer. (2009). (*Report on tourism and recreation in Bruges – Edition 2002–2007*) *Trendrapport toerisme en recreatie Brugse Ommeland – Editie 2002–2007*. Brugge: Westtoer., p. 114 (in Dutch).

Willis, R. (1999). Guidelines on costing environmental policies. EC, DG XI.