Theoretical discussion on economic valuation of greeness: from ecosystem services to green infrastructures

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THEORETICAL DISCUSSION ON ECONOMIC VALUATION OF GREENNESS: FROM ECOSYSTEM SERVICES TO GREEN INFRASTRUCTURES

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Abstract

Considering the current concern about greenness and the protection of nature, this paper discusses firstly the potential of economic valuation in order to understand the value of natural greenness, i.e. biodiversity and the value of manmade greenness such as green infrastructure. Economic valuation aims to estimate the cost of ecosystem services degradation and helps promote a better understanding and valuation of biodiversity in the management of effective policies for "green" protection. In the second part of the paper, economic valuation techniques, in particular stated preferences techniques, are applied to green infrastructure project.

Keywords: economic valuation, ecosystem services, biodiversity, green infrastructure, stated preferences valuation

Résumé

En prenant en considération les inquiétudes au sujet de protection de la nature, cette contribution examine le potentiel de l'évaluation économique pour comprendre la valeur des espaces verts naturels, c'est-à-dire la biodiversité et la valeur des espaces verts créés par l'homme comme les infrastructures vertes. L'évaluation économique a pour objectif d'estimer le coût de la dégradation des services écosystémiques. Ensuite, les techniques d'évaluation économique, en particulier les techniques de préférences déclarées, sont appliquées à un projet d'infrastructure verte.

Mots-clés: évaluation économique, services éco-systémiques, biodiversité, infrastructure verte, évaluation des préférences déclarées

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Introduction

During the past two decades, the public's growing interest concerning environmental issues has risen in line with the awareness of environmental degradation and worrying disconnection of our children with the nature, which can affect the health and well-being of the future generation as Richard Louv described in his 2005 book *Last Child in the Woods*.

This paper will focus on the application of economic valuation techniques on ecosystems services (ES) and green infrastructure (GI) in order to understand the value of natural greenness, i.e. biodiversity and the value of manmade greenness. Biodiversity, which is expressed through ES, provides human society with a large variety of goods such as food, clean air and water, fossil fuels, healthy soil, etc. Green infrastructure is "strategically planned and managed networks of natural lands, working landscapes and other open spaces that conserve ecosystem values and functions and provide associated benefits to human populations" according to the Conservation Fund's Green Infrastructure Leadership Program.

After having described the different valuation techniques applicable in the framework of a cost-benefit analysis, the paper will focus more particularly on applied research. The second part of the paper aims to give an overview of the cost-benefit analysis conducted in order to develop an integrated assessment framework of ES for the VOTES case study and to identify the environmental externalities of the VALUE investments at the neighbourhood scale through the use of stated preference techniques.

I. Techniques of economic valuation

In spite of a growing understanding of ES over the last decades, explicit quantitative values are still lacking (Balmford et al., 2002). Consequently, these services are not taken into consideration in land use and land-management decisions (Nelson et al., 2009).

In a context of increased urbanization combined with the effects of climate change, the level of biodiversity is expected to be reduced, and from the point of view of the ES, which can be defined as a conceptual linkage between biodiversity and human well-being, the loss of biodiversity is not only an environmental problem for itself, but is also a major issue for society's sustainable development. Thus, it is necessary to identify adaptations of ecosystem use and management that will minimize the biodiversity loss while maintaining the production of ES for the society. To achieve this goal, ES must be valuated, but this valuation needs to consider a broad set of goals that include ecological sustainability and social fairness, along with the traditional economic goal of efficiency. Participatory approaches should be used in all ES valuation steps. Indeed, local stakeholders and end-users have a central role in the valuation process, as they are the direct beneficiaries of the provision of services. Moreover, biodiversity management must be focused onto human needs to deliver more integrated policy and management at a landscape-scale and be more firmly directed towards human well-being.

The economic assessment aims at developing a cost-benefit analysis integrating key attributes (services, variables) of the ecosystem and making them square with economic values. Any costs-benefits analysis of ecosystems is complex and needs methodological precautions. Because several ES are not quantifiable in economic terms, a rigorous selection of the quantifiable services must be performed beforehand. The implementation of such a model must be carried out using a systemic approach, which considers the ecosystems of the study area as a whole but distinguishes between the different categories of ES. Four categories are defined as provisioning, regulating, habitat and cultural services.

Two possibilities are known to valuate ES. The first is linked to direct prices which mean that ES have explicit prices or are traded in an open market (Daily et al., 2003). Usually, market prices can be used in some cases but in most of them, we need to use a range of "indirect valuation methods" due to the problem of missing markets. This introduces the second possibility: indirect valuation, also known as non-market valuation. It is represented by several techniques of indirect economic valuation. These techniques are emerging since the 70s but it is innovating to apply them to ES while considering spatial heterogeneity. The following methods will be used for the economic valuation of ES considered as important in the VOTES project: (1) contingent valuation (CV) is a stated preference technique based on a hypothetical market in which people have to manifest their demand function for ES, (2) hedonic pricing relies on the proposition that the value an individual places on a service is based on the attribute it possesses, (3) choice modelling (CM) is also a stated preference technique based on a choice of different scenarios according to people's preferences, (4) replacement/restoration cost assesses the value of an ES by evaluating how much it costs to replace it after it has been damaged, (5) travel cost evaluates individual preferences for non-market goods where consumption is commensurate with the cost of travel (Heal, 2000; De Groot, 2006; Yung, 2004). According to authors, different techniques are taken into account while some are more appropriate to certain ES.

In monetary terms, the main aim of a cost-benefit analysis is to compare two situations: one with a project carried out and the other without a project. Usually, cost-benefit analyses compare two scenarios of a plot and aim at evaluating the financial differences between the net benefits earned with a project and the net benefits earned without a project (Salverda, 2004). For example, in the costs-benefits analysis of forest conservation, the net benefits of the forest will be compared through time with the net benefits of another more profitable land use on the area, such as intensive agriculture.
Indicators of costs and benefits are measured for each category of ES. Examples of the quantifiable indicators of the agricultural thematic layer include the production of annual crops, soil deterioration, pesticides and fertilizers use. For urban areas, indicators such as public infrastructure costs (e.g. Halleux et al., 2007) can be evaluated. Timber production and other recreation values could be quantified for forestry areas (Watson et al., 2000; Tol, 2005).

Within most economic valuation techniques, participation with local communities and/or stakeholders is fully integrated as methods are often based on people's "Willingness To Pay" (WTP). It aims at establishing the maximum amount of money that people would be willing to pay for improvements in the quality/quantity of ES provided by biodiversity (Martin-Lopez et al., 2007). The social assessment already completed for this project, benefits us with some crucial premises before working with people's preferences. However, reliance on individual preferences to construct social values has serious pitfalls. The first is that people's WTP might change according to the type and population size of species being evaluated as well as their use VS non-use. Moreover, response rates, survey mode and valuation methods have a crucial role in the variation of WTP, but are too often poorly discussed within the literature. The second pitfall is linked to the fact that prices given by people often reflect the distribution of income. The third one points out the fake assumption of fixed and given tastes and preferences; preferences do change over longer time frames (an entire industry – advertising – is devoted to change them) and sustainability is an inherently long-run problem (Costanza, 2010). Last, if individual values are accurately measured, how to aggregate these into a social value? Awareness of these difficulties is a key to get appropriate value from people's preferences.

Finally, a distinction between the collective (and/or public authorities) and the individual costs and benefits generated by the particular policies currently implemented is to be considered. The focus is placed on the public sector because the aim of the VOTES framework is to allow for evaluating the implementation of different policies. Taking this into account, the aim of a spatial economic valuation of ES provides vital information for regional ecosystem management and sustainable development. However, little attention has been focused on the spatial visualisation and mapping results for valuation of ES. Hence, this situation hindered the efforts of the local government and stakeholders to implement policies with limited funds and powers due to lack of space dimension about on where it is more important to concentrate. Putting theory into practise will need locally based information (Daily et al., 2003). As argued by Treich (2006), a cost-benefit analysis of public decisions also makes it possible to define good practices to apply in the private sector.

II.   Stated preferences techniques applied to green infrastructure

1.   Description of the research project

The research project called VALUE, Valuing Attractive Landscapes in the Urban Economy, is funded through the European Union Interreg IVB programme for North West Europe. It aims to demonstrate the economic value of GI at the site scale, showing how to target investments to maximise the competitive benefits to communities (Allin, 2010). To serve this purpose, the Economic Development Agency of the Province of Liege in collaboration with the University of Liege is developing a cycle and pedestrian path in the Pré-Javais District, near the city centre, on the left side of the Vesdre River in Verviers linking the centre of Verviers to the suburbs (Fig. 1).

Figure 1: Masterplan of a cycle and pedestrian path alongside the Vesdre River
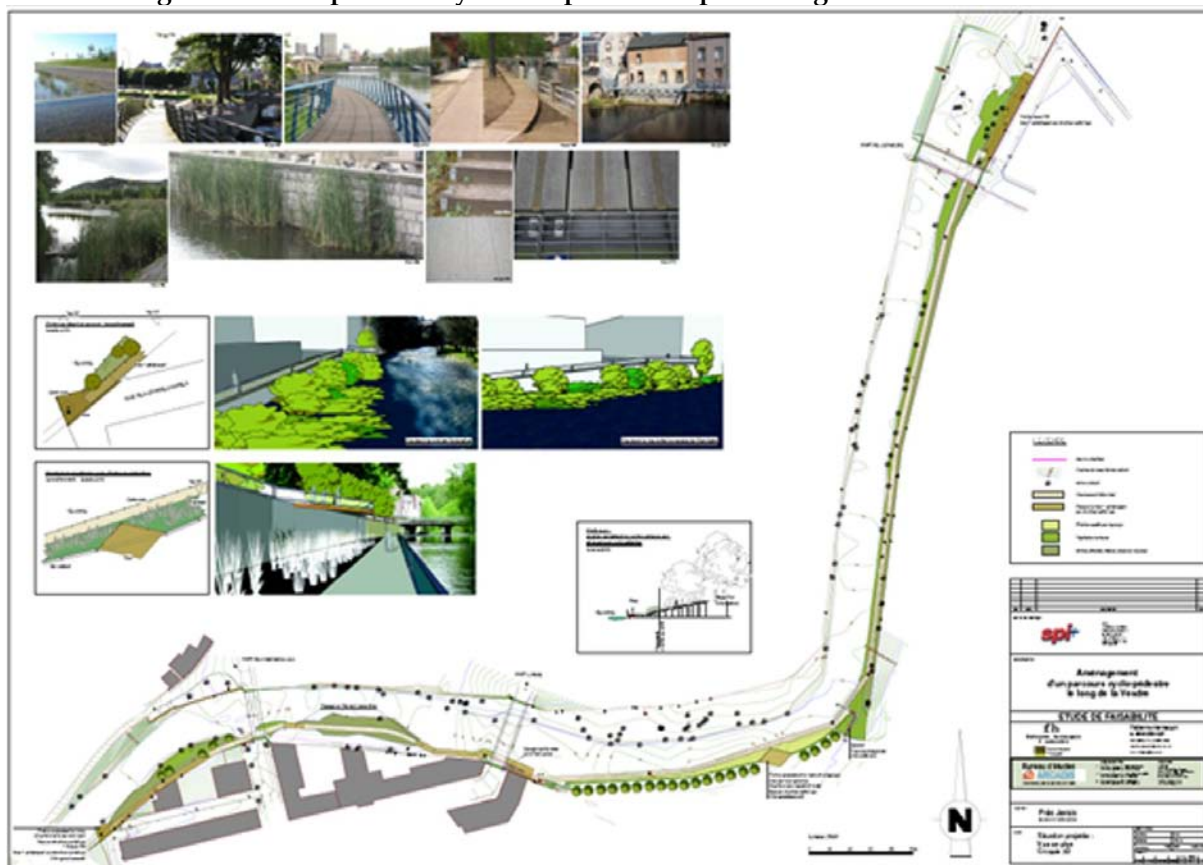
Source: Economic development agency of the Province of Liege, 2009.

The city of Verviers was an important industrial and commercial centre, located in the Province of Liege, at the south border of the Herve County. The Vesdre River flows through Verviers. The city took off throughout the 18th and 19th century, when the modern woollen industry became wealthy on the bank of the Vesdre's waters. The slump of the 30's and the increased competition between the developed countries and the "Third World" in the 50's caused the decline of the woollen industry in Verviers (Statbel, 2009). The investment pursues the objective of connecting the different routes of the "autonomous network of pathways for slow traffic" to the city of Verviers, for example the route 38 (Vaux-sous-Chèvremont - Hombourg), restoring the main river functions and enhancing the relation between the river and the local population.

This project aims to analyse the valuation of a GI programme, namely a greenway called a cycling and pedestrian path, in Wallonia. GI is a comprehensive concept, which encompasses "managed and natural green areas in rural and urban environments, including woodlands, gardens and formal parks; green corridors such as bridleways, railway and road verges and cycle paths; street trees; waterways and open countryside.

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The collection of data will be through face-to-face interviews. A questionnaire has been developed including four parts. The first section of the questionnaire describes the project and asks questions about the respondent's environment. The second section of the questionnaire is the contingent valuation (CV) part, and the third addresses the choice modelling (CM) part. The fourth section asks the respondent a few socio-demographic questions.

2. Contingent valuation method

CV is a stated preference method which aims to ask people their maximum willingness to pay (WTP) or their minimum willingness to accept (WTA) in compensation for a specific change of the quality of their environment. This method is contingent on the hypothetical scenarios and the description of the change presented to respondents. Hence, CV allows us to estimate use and, in particular, non-use values. Finally, the method is based on respondents' answers of a questionnaire instead of the observation of respondents' behaviours (Pearce, 2002; Mogas, 2005; Terra, 2005).

To apply the contingent valuation method, we proceeded as described below:

Firstly, we defined the valuation problem of the urban GI. This includes specifying the services or goods which are being valued and who the relevant population is. Currently, from the "Grande Rames" Street to the "Marie-Henriette" park, there is no access to the river, because all houses turn their backs to the river. The objective is to create a cycle and pedestrian path on the river bank or on the collector between the "Dardanelle" Bridge and the "Epargne" Bridge to restore the basic river functions in allowing people to have an access to it for walking and cycling. The Economic Development Agency of the Province of Liege, which is in charge of creating the path, will also build two pontoons: one at the beginning of the "Grande Rames" street and the other one in the "Marie-Henriette" park. It is planned to encourage the development of a natural vegetal cover. Maintenance will be low and focus on the management of invasive plant species and the vegetation of the "Marie-Henriette" park will be improved. The cycling and pedestrian path with a surface of natural plant as it is planned will resemble Figure 2.

Figure 2: Reference state

Source: Fabian De Smet, LEPUR-ULg, 2010.

Secondly, we needed to make decisions concerning the survey: how will the survey be conducted, how large the sample size should be, who will be surveyed. The answers to the survey questions depend on given background information, complexity of the question and visualisation support available. We chose to undertake the survey through face-to-face interviews, because it gives us more flexibility to present the background information, to ask complex questions, to use visual aids and respondents are more likely to complete a long survey in personal interviews than in another context. The sample is composed of housing units located no further than 150 m away from the River Vesdre on the selected part of the river, namely the Pré-Javais district. The method of compilation of the sample size is based on land registry. For each plot, the number of habitations is known. Hence, there

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are 867 homes. A randomly selection of 10% of the sample was carried out, which means 87 households will be surveyed.

Thirdly, focus groups were organised in order to design the survey. The aim of the focus groups was to determine which background information was needed, how to present it, which visual aids could be used, and to help in developing more specific questions. For the WTP question, different elicitation formats can be used: dichotomous, open-ended, payment card and bidding game (Terra, 2005). The dichotomous choice was chosen for the Verviers case study, because it allows guiding the respondents in determining a price in the valuation process and it gives enough flexibility to allow the respondent to adjust the starting value to the maximum price that he/she is willing to pay. The payment vehicle used to determine the WTP of the respondents would be a local tax paid by the citizens of Verviers in order to develop and maintain the GI (Bengochea-Morancho, 2005).

The CV gave us the opportunity to measure the use and non-use value of the investment done in Verviers through the maximum WTP of the respondent. However, this technique has been subject to criticism because of the difficulties of getting reliable or accurate estimates of the WTP (Mogas, 2005). Consequently, the cost-benefit analysis were supplemented by the CM technique, which allows to confirm the results obtained in the first instance and to complete the analysis by asking the respondents to state their preferences among alternative scenarios. It is important to highlight that the same attribute levels, elicitation question and costs bids were used for both techniques.

3. Choice modelling method

CM is also a stated preference method based on a survey. In the CM method, respondents are presented with a series of choice sets, each containing alternative goods. An alternative is a combination of several attribute taking on a value, usually called a level. For each choice set, respondents are asked to choose their preferred alternatives (Pearce, 2002, Mogas, 2005). For the Verviers case study, one choice set has been developed with three alternatives: the barren path scenario, the natural vegetal development and the structured vegetal development. The option of the initial stage (which consisted of no change and no payment) was included in the questionnaire. For each scenario, except for the initial stage, a picture had been drawn:

- The barren path scenario (Fig.3) intends to create a cycle/pedestrian path where there will be no vegetation but a surface of gravel on the river bank and along the path.

**Figure 3: Barren path scenario**

Source: Fabian De Smet, LEPUR-ULg, 2010.

- The natural vegetal development, namely the situation of reference, (Fig. 2) corresponds to the initial change planned by the VALUE project and analysed through CV. This scenario encourages the development of a natural vegetal cover. Maintenance is low and focuses on the

management of invasive plant species. The vegetation of the "Marie-Henriette" park will be improved.

- The structured vegetal development (Fig. 4) seeks to create a cycle and pedestrian path with structured and controlled vegetation. This scenario aims to embellish the paths with the help of flowering plants in tubs.

Figure 4: Structured vegetal development
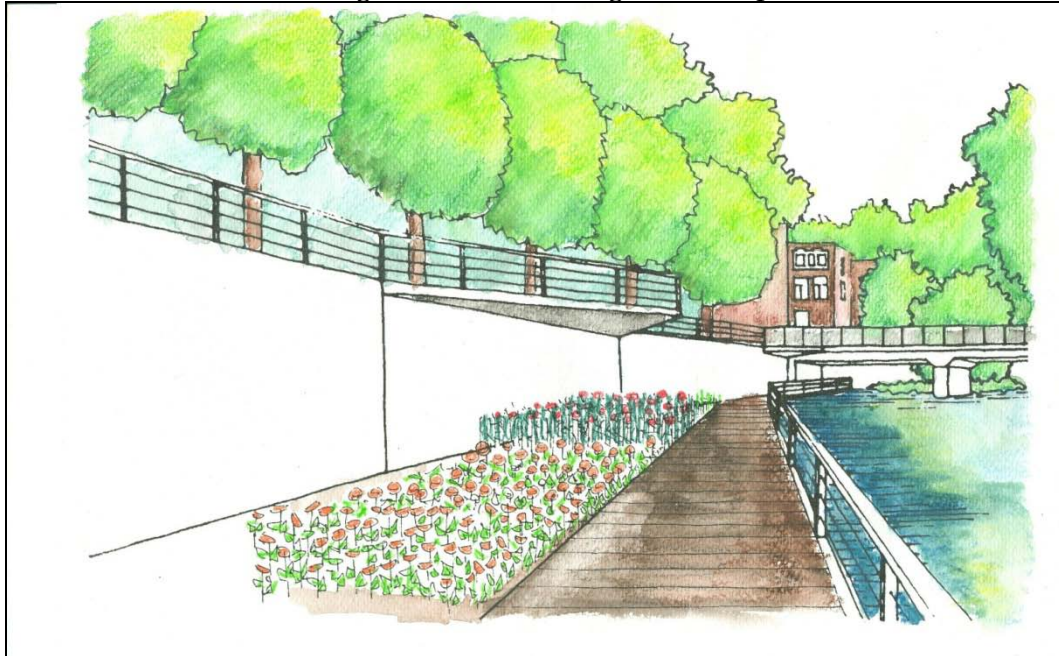
Source: Fabian De Smet, LEPUR-ULg, 2010.

The attributes and levels used in the CM analysis have been described in Table 2. In the CM analysis, the payment vehicle was used as an attribute. These attributes have been developed with the help of either the focus groups results or of the complementary interviews carried out with local stakeholders and communities, such as urban officers and green space officers of the city of Verviers.

Table 1: Attributes and levels used in the CM analysis

Attribute	Description	Levels
Degree of transparency and luminosity	Structure and composition of vegetation	Low (abundant vegetation) Medium (less abundant vegetation) High (no vegetation)
Structure of green space	Different types of green spaces to develop with the creation of the cycling / walking path.	Barren Unstructured (natural) Structured
Safety and security of the GI	Help to guarantee the security of the path	Low (nothing) Medium (lighting and closing time) High (CCTV, lighting, closing time)
Maintenance of the GI	Measures to help guarantee the cleanliness of the site.	Frequency of bin collection, cleaning-up and management Low Medium High
Cost	Costs of the creation and maintenance path per person and per year.	Low (≤ 25€ per year) Medium (= 25 € per year) High (≥ 25 € per year)

Source: SEGEFA-ULg, 2010.

It is important here to highlight that the two different valuation techniques applied to the Verviers case study will be analyzed through the same questionnaire. Hence, the questionnaire encompasses the CM question aiming to ask the choice preferences of the respondents and the CV question with the objective to know the WTP of the respondents. The same attributes have been used for the two questions and to determine the attributes, focus groups with local businesses and residents and a pre-test have been run.

4. Comments and observations

We are currently administering the questionnaire to the selected sample, which means that we are not in position to discuss the results in depth. However, we can make a few comments and observations.

Firstly, the data which has been collected will be statistically analysed in order to highlight the existing correlations - for example between the alternative chosen by the respondents and their socio-demographic characteristics - and to draw valuation conclusions.

Secondly, the two techniques yield complementary results. The CV method has been chosen to proceed with the valuation of green open spaces in Verviers because it allowed us to measure both use and non-use values of the GI. By adding a CM part to the questionnaire, the CM gives us the opportunity to estimate both marginal values (an additional use to the attribute) and discrete values (a given scenario of GI) (Mogas, 2005).

Thirdly, the negative answers are categorized as zero valuation if the respondents are not able or not willing to pay anything and as a protest bid if the respondents have difficulties evaluating the good in monetary terms or disapprove the concept (Pearce, 2002).

III.   Conclusions

This paper aimed at studying the techniques of cost-benefits analysis which are used to demonstrate the economic value of ecosystems services and green infrastructure. The techniques of economic valuations detailed and applied to ecosystems services in the first part are used in the second part of the paper to focus the research on stated preference techniques. This part of the paper deals with the economic valuation of a green infrastructure at the site scale where a cycling path is developed along the Vesdre River linking the centre of Verviers to the suburbs using two valuation methods: contingent valuation and choice modelling. It has been illustrated in this paper that the two valuation methods are complementary and provide an overview of the attributes preferences of the respondents by offering the respondents multi-attribute choices and an estimation of the welfare by asking the respondents about their willingness to pay or to accept the change.

IV.   Bibliography

Allin S., Henneberry J., 2010, "Baseline Analysis of Existing Economic Valuation Tools for Application to Green Infrastructure Investments. Valuing Attractive Landscapes in the Urban Economy – Work Package 1, Action 1.2, Final Report". *Sheffield, Department of Town and Regional Planning, University of Sheffield.*

Association Européenne des Voies Vertes, (200?), "The European Greenways Observatory", Retrieved 8/12/2010 from http://www.oevv-egwo.org/templates/home.php?page=1&lng=en.

Balmford A., Bruner A., Cooper Ph., Costanza R., Farber S., Green R.E., Jenkins M., HEfferiss P., Jessam V., Madden J., Munro K., Myers N., Naeem Sh., Paavola J., Rayment M. Rosendo S., Roughgarden J., Trumper K. and Turner R.K., 2002, "Economic reasons for conserving wild nature", in *Science* 297:950-953.

Bengochea-Morancho A., Fuertes-Eugenio A., Saz-Salazar S., 2005, "A comparison of empirical models used to infer the willingness to pay in contingent valuation", in *Empirical Economics*.

Daily G. C., Söderqvist T., Aniyar S., Arrow K., Dasgupta P., Ehrlich P.E., Folke C., Jansson A., Jansson B.-O., Kautsky N., Levin S., Lubchenco J., Mäler K.-G., Simpson D., Starrett D., Tilman D., Walker B., 2003: "The Value of Nature and the Nature of Value", in *Science Magazine*, 289(5478):395-396.

De Groot R., 2006, "Function-analysis and valuation as a tool to assess land use conflicts in planning for sustainable, multi-functional landscapes", in *Landscape and Urban Planning*, 75:175-186.

European Greenways Association, 2009, "Voies vertes – Déclaration of Lille", Retrieved 21/12/2010 from http://www.aevv-egwa.org/site/1Template1.asp?DocID=21&v1ID=&RevID=&namePage=&pageParent=.

Halleux J.-M., Lambotte J.-M. and Bruck L., 2007, "Urban sprawl and collective service: the overcosts for water infrastructures", in *Revue d'Economie Régionale et Urbaine*, 1:21-42.

Heal G., 2000: "Valuing Ecosystem Services", in *Ecosystems*, 3:24-30.

Conservation Fund's Green Infrastructure Leadership Program, 2011, "What is Green Infrastructure?", Retrieved 08/04/2011 from http://www.greeninfrastructure.net/content/definition-green-infrastructure.

Louv R., 2005, *Last Child in the Woods. Saving our Children from Nature Deficit Disorder*. Chapel Hill, N.C.: Algonquin Books of Chapel Hill.

Martín-López B., Montes C., Benayas J., 2007: "Influence of user characteristics on valuation of ecosystem services in Doñana Natural Protected Area (south-west Spain)", in *Environmental Conservation* 34(3): 215-224.

Mogas J., Riera P., Bennett J., 2005, "Accounting for Afforestation Externalities: A Comparison of Contingent Valuation and Choice Modelling", in *Wiley InterScience*, 15:44-58.

Mogas J., Riera P., Bennett J., 2006, "A comparison of contingent valuation and choice modelling with second-order interactions", in *Journal of Forest Economics*, 12:5-30.

Moons E., Saveyn B., Proost S., Hermy M., 2008, "Optimal location of new forests in a suburban region", in *Journal of Forest Economics*, 14(1).

Natural Economy Northwest, 2009, "The Economic Value of Green Infrastructure" (http://www.naturaleconomynorthwest.co.uk/), 80p.

Nelson E., Mendoza G., Regetz J., Polasky S., Tallis H., Cameron D.R., Chan K.M., Daily G.C., Goldstein J. Kareiva P.M., Lonsdorf E., Naidoo R., Ricketts T. and Shaw M.R., 2009, "Modeling multiple ecosystem services, biodiversity conservation, commodity production, and tradeoffs at landscape scales", in *Frontiers in Ecology and the Environment*, 7(1):4-11.

Pearce D., Özdemiroglu E., 2002, "Economic Valuation with Stated Preference Techniques. Summary Guide", in *DTLR Transport Local Government Regions*, 93p.

Salverda M., 2004, "Analyse Coûts-Bénéfices Concepts-Clefs, ressource pédagogique préparée pour l'ICRA".

SPF Economie, Statbel, 2009.

Terra S., 2005, "Guide de bonnes pratiques pour la mise en œuvre de la méthode d'évaluation contingente", Direction des études économiques et de l'évaluation environnementale, Série Méthode (http://www.ecologie.gouv.fr), 05-M04, 77p.

Tol R.S.J., 2005, "The marginal damage cost of carbone dioxyde emissions: an assessment of the uncertainties", in *Energ. Policy,* 33:2064-2074.

Treich N., 2006, "Introduction à l'analyse coût-bénéfice", *Conférences ICSI-LERNA*, Université de Toulouse.

Waston R.T., Nobler I.R. and Bolin B., 2000, *Project-based activities, IPCC special report on land use, land use change and forestry*, Cambridge, UK: Cambridge University Press, pp. 375.

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