SSD

SCIENCE FOR A SUSTAINABLE DEVELOPMENT

VALUATION OF TERRESTRIAL ECOSYSTEM SERVICES IN A MULTIFUNCTIONAL PERI-URBAN SPACE

"VOTES"

C.M. FONTAINE, R. DE VREESE, I. JACQUEMIN, J. LAMBRECHT, A. MAREK,
D. MORTELMANS, N. DENDONCKER, G. DEVILLET, L. FRANÇOIS, A. VAN HERZELE

ENERGY

TRANSPORT AND MOBILITY

AGRO-FOOD

HEALTH AND ENVIRONMENT

CLIMATE

BIODIVERSITY

ATMOSPHERE AND TERRESTRIAL AND MARINE ECOSYSTEMS

TRANSVERSAL ACTIONS

.be

SCIENCE FOR A SUSTAINABLE DEVELOPMENT

(SSD)

Terrestrial Ecosystems

FINAL REPORT

VALUATION OF TERRESTRIAL ECOSYSTEM SERVICES IN A MULTIFUNCTIONAL PERI-URBAN SPACE

"VOTES"

SD/TE/05

Promotors

Nicolas Dendoncker [a,b]

Louis François [c]

Ann Van Herzele [e,f]

Guenaël Devillet [d]

Authors

Corentin M. Fontaine [a,b]

Rik De Vreese [e]

Ingrid Jacquemin [c]

Jesse Lambrecht [e]

Allyson Marek [d]

Dieter Mortelmans [e]

Nicolas Dendoncker [a,b]

Louis François [c]

Ann Van Herzele [e,f]

Guenaël Devillet [d]

a Department of Geography, University of Namur (FUNDP)

b Namur Center for Complex Systems (naXys), University of Namur (FUNDP)

c Laboratory of Planetary and Atmospheric Physics (UMCCB), University of Liège (ULg)

d Service d'Etude en Géographie Economique Fondamentale et Appliquée (SEGEFA), University of Liège (ULg)

e Human Ecology Department, Vrije Universiteit Brussel (VUB)

f Research Institute for Nature and Forest (INBO)

D/2013/1191/4
Published in 2013 by the Belgian Science Policy
Avenue Louise 231
Louizalaan 231
B-1050 Brussels
Belgium
Tel: +32 (0)2 238 34 11 – Fax: +32 (0)2 230 59 12
http://www.belspo.be

Contact person: Christine Mathieu
+32 (0)2 238 34 93

C.M. Fontaine*, R. De Vreese, I. Jacquemin, A. Marek, D. Mortelmans, N. Dendoncker, G. Devillet, L. François, A. Van Herzele. ***Valuation Of Terrestrial Ecosystem Services In A Multifunctional Peri-Urban Space (The VOTES project).*** Final Report. Brussels: Belgian Science Policy 2013– 95 p. (Research Programme: Science for a Sustainable Development)

TABLE OF CONTENT

SUMMARY

1. RESEARCH CONTEXT

The on-going environmental degradations, acknowledged by many international reports and scientific studies (MEA 2005, TEEB 2010), do not only threaten Nature but also endanger Human Kind. Most importantly, the loss of biodiversity results from complex interactions between natural and socio-economic causes among which climate and land use change are paramount. As a result, the ability of ecosystems to support human wellbeing and sustainable growth, thanks to the services they provide, has been reduced substantially.

Amongst the causes of ecosystems degradation, many have been formally acknowledged by decision makers. A major contributing factor is the failure of current decision-making to recognise the social and environmental values of ecosystems, beside the usual monetary measures, in spite of the many services provided by ecosystems to human wellbeing (MEA 2005, TEEB 2010). These contributions are not fully recognized because they are still not yet comprehensively recorded. Therefore, one necessary step to halt further degradation is to ensure that future policies consistently include non-monetary values of nature in policymaking processes.

In order to do so, existing (and new) tools and methods need to be adapted (and developed) for assessing systematically, quantitatively and qualitatively the values of ecosystem services in a given landscape. Furthermore, they need to be accessible by and comprehensive for policy makers, at both local and regional levels. These tools and methods should allow capturing the current values of natural capital as well as monitoring its potential changes in the future.

The task is tremendous and will be achieved only when sufficient scientific work gathering enough interdisciplinary teams will be completed. The VOTES project (Valuation Of Terrestrial Ecosystem Services in a multifunctional peri-urban space) is only one piece of the gigantic puzzle building sustainable development.

The project aimed to address the lack of ecosystem service identification and integration into policy processes by quantitatively valuating ecosystem services for a case study area in central Belgium (part of the river Dyle's catchment) under the context of climate and land use change. Scenarios developed in two other projects (i.e. the SSD-funded MULTIMODE and EC-funded ECOCHANGE projects), taking into account climate and socio-economic changes, project large amount of change in land use over the coming decades. This is especially the case in peri-urban areas where the pressure from urban development is the highest. Consequently, the size and distribution of the agricultural, natural and forest ecosystems are expected to vary dramatically, hence affecting the ecosystem services they provide. Moreover, changes in land management practices within land cover classes are expected to impact the provision of ecosystem services. This suggests the need for an integrative, multi-ecosystem approach to look at changes in ecosystem services.

The benefits of using ES valuation to decision makers are, first, to provide decision makers and stakeholders with a clearer picture of the: [1] previously less visible costs to society from damage to our natural capital and, [2] the economic benefits from managing it well. Second, to explore how the natural environment can help to deliver policy objectives in new ways that could reduce inefficiencies and create multiple public benefits at a time when we all have to do more with less.

The importance of ES in international policy is also underlined by two commitments made by EU leaders in March 2010. The first is the 2020 headline target:

"*Halting the loss of biodiversity and the degradation of ecosystem services in the EU by 2020, and restoring them in so far as feasible, while stepping up the EU contribution to averting global biodiversity loss*"

The second is the 2050 vision:

"*By 2050, European Union biodiversity and the ecosystem services it provides – its natural capital – are protected, valued and appropriately restored for biodiversity's intrinsic value and for their essential contribution to human wellbeing and economic prosperity, and so that catastrophic changes caused by the loss of biodiversity are avoided.*"

Also, on the national level, the concept of ecosystem service valuation increasingly appears in policy documents (e.g. MINA 4[1], MIRA[2], NARA[3] in Flanders).

The lack of consideration for the value of ES in current decision-making is recognised as one of the main reasons leading to an intense competition over well-located available land (TEEB 2010). Land Use Change (LUC) is a human-induced factor widely identified as having a dramatic impact on ecosystem structure and processes and hence on the services they provide (Turner *et al.* 1997; Lambin *et al.* 2001; MEA 2005). However, previous studies that tried to value ES were either conducted at a broad scale using simple 'benefit transfer' approaches which do not allow for analyses of change in value under new land use conditions or were conducted at a fine scale, over small spatial and temporal extents and only focusing on a single ecosystem (Nelson *et al.* 2009) and ignoring potential trade-offs between the provisions of different services. Arguably, this lack of a holistic approach is precisely why maximizing specific ecosystem services such as food production in Belgium and Europe has had such a detrimental impact on the environment.

Therefore, the VOTES framework explicitly refers to the spatial and temporal dimensions of ES in the valuation process of this 'natural capital'. The spatial distribution of land uses (patterns) affects the amount of ES available in the study area at a given point in time. Changes of the land use patterns through time may modify strongly the quantity and the quality of ES in that area.

In order to address these complex spatio-temporal dimensions, we propose a looping stepwise procedure starting with valuations of ES at present. The social, biophysical and economic valuations are based on current land use patterns. Subsequently, scenarios of LUC are simulated and used to explore potential losses (and/or gains) of ES in the future of the study area. Among these, a focus is put on developing a sustainable development scenario, in order to anticipate future challenges for ES, relating to more sustainable landscape management and decision-making. Buckling-up the participatory loop, key stakeholders are confronted with the indicator trends in order for the local community to debate and gain insights on the potential consequences of a set of decisions about sustainable landscape management and use.

---

[1] www.milieubeleidsplan.be

[2] www.milieurapport.be

[3] http://www.inbo.be/content/page.asp?pid=BEL_NARA_NARA2009download

2. OBJECTIVES

The overall aim of this project was to develop a framework for exploring the consequences of land use change for multiple ecosystem services including food and timber production, carbon sequestration, biodiversity and cultural ecosystem services. The work was structured around a series of questions that form the specific objectives of this project:

[1] To assess the current value of key ecosystem services in the study area and how the current relationships between ecosystem services are mediated by land use;

[2] To identify current trade-offs and synergies between ecosystem services in a spatially explicit way;

[3] To explore how the current value may change in relation to future land use change;

[4] To explore how the current trade-offs may change in relation to future changes in ecosystem services;

[5] To suggest policy instruments for including ecosystem services in decision-making processes at the European, federal and regional scale taking into account the three pillars of sustainable development and involving stakeholders and local communities.

To achieve these objectives, a network of 4 expert research groups from the Flemish and French communities of Belgium constituted the multi-disciplinary team providing complementary expertise in the fields of natural and human sciences – in particular: human and physical geography, landscape ecology, human ecology, economics and policy analysis.

3. MAIN CONCLUSIONS

In this project, we presented a conceptual framework developed for the valuation of ecosystem services (ES) in a tightly integrated manner, grounded in participatory modelling. After Costanza (2000), de Groot *et al*. (2002) and Nelson *et al.* (2009), we argue that valuation of ES must be applied equally to the three dimensions of sustainable development: people, nature and economics. In addition, we stress the importance of using the spatial and temporal dimensions of ES as well because the distribution of land uses (i.e. spatial patterns) affects the amount of ES available in a given area and at a given point in time. We use an integrated DVM-ABM to model the spatio-dynamic evolution of ES in case study in central Belgium.

Based on this unified – but not simplistic – representation of ES valueS, we aim to derive appropriate guidelines to include ES valuation in extant policy measures for our case study, such as into Strategic Environmental Assessments (SEA). SEA is a major tool for policy makers to promote sustainable development by integrating environmental considerations into strategic decision-making for a wide range of actions and development sectors (Treweek et al. 2005). Cases studied by Slootweg and van Beukering (2008) provide evidence that valuation tools of ES can be integrated in the SEA process, providing information much wanted by decision-makers. Moreover, in all cases studied, valuation of ES resulted in major policy changes or decision-making on strategic plans (Slootweg and van Beukering 2008). Integrating the VOTES methodology within SEA will improve the quality and relevance of these assessments, providing strong arguments to carry out environmentally friendly scenarios (versus technical scenarios) while increasing the attention towards ES within development and planning discussions.

By making our valuation framework participatory and, although the main aim of this participatory approach was to improve the quality of the valuation, it could be a first step towards greater appropriation of the ES concept by the various stakeholders involved in the project, from citizens to local decision makers. Graphic tools if well-chosen and properly applied have the capacity to facilitate stakeholder interaction. But at the same time it should be recognised that the same tools influence the content of the interaction: the knowledge that stakeholders bring to the table (Van Herzele and van Woerkum 2008) and the type of arguments that are exchanged (Van Herzele and van Woerkum 2011). Thus the tool actively participates and shapes the social interaction.

Our framework is being initially implemented in a study area of 4 municipalities belonging to the peri-urban belt of Brussels (two on each side of the main regions border). Nonetheless, it should be generic enough to be implemented elsewhere.

Some authors argue that the uncertainties related to the concept of ES and their valuation are so large (e.g. different values for different actors, values may change through time …) that there is a need for a change in scientific posture when studying ES (Barnaud and Antona 2011). For Funtowicz and Ravetz (1994), when societal and scientific uncertainties are strong, scientists need to give up their role of experts and rather elicit a phase of dialogue between researchers, decision-makers and citizens. In such a post-normal posture, the key point is the quality of the interaction leading to decision-making.

In the framework proposed in this paper, uncertainties are large and in many cases, impossible to quantify. This is especially due to the scenario-based approach taken. Such an approach prevents to account for potential changes in values that may arise from changes in the offer of ES in the future. Nonetheless, the approach has the merit to already provide indications on the directions of change in the provision of ES for the future of the studied area. This is a necessary step when one targets a sustainable management of the local landscape. Besides, vectors of change in the importance of ES were also derived from that point, although with caution since it is based on a strong assumption of stable human preferences, which is debated by, among others, Costanza (2000) or Hein et al. (2006).

Whilst our framework is indeed participatory, it does not always confront the point of views of actors. For example, in the social assessment, we interviewed each stakeholder separately. Barnaud and Antona (2011) argue that the point of views of all stakeholders should rather be confronted from the start of a project to build a collective consensus on what ES should be prioritized and favour the emergence of win-win solutions later on in the project by anticipating potential trade-offs and synergies collectively, as well as distributional issues. Likewise, stakeholders are only partly involved in the development of the scenarios (i.e. for the building of the normative storyline). Therefore, the coupled DVM/ABM model developed in this project, whilst very efficient at deriving precise indicators of ES and ES change, may perhaps appear as a black-box to some stakeholders. To prevent this, a companion modelling approach could be implemented (Bousquet *et al.* 1999). Such an approach assumes a completely transparent modelling process, in which stakeholders participate in every step of the development of the multi-agent systems. However, the development of biophysical indicators of ES and ES change alone require a quite complex modelling of vegetation processes and land use interactions (e.g. erosion occur because of a certain combination of land covers along a hill slope). The challenge is thus to make this calculation transparent enough for decision-makers without jeopardizing the scientific precision of the model. In addition, this approach requires being much more flexible on the timeframe than we were and is much more time demanding for stakeholders' contribution. In that sense, the interviews did not request too much of stakeholders' time. With this first positive contact, the door is open for further, deeper and longer collaborations and should help tightening the links between local practitioners and scientists.

Building on this mutual trust, we should be able to question the outcomes of the valuation with stakeholders, and suggest improvements to the methodology. Indeed, the framework proposed should not be seen as a one-off method but rather as the first step of an iterative process towards participatory valuation of ES, integrated with SEA, by taking into account the three pillars of sustainable development within their spatial, temporal, community and decisional context.

4. ADDED-VALUE FOR SUSTAINABLE DEVELOPMENT

This proposal is clearly aligned with the SSD–call 5 strategy and objectives and is highly relevant to Belgian policy on land use, sustainable development and the environment. More specifically, it links with the strategy to support decision making in relation to trans-sectorial problems at different levels of authority (i.e. municipal, regional and federal) through the development of practical oriented policy instruments. In addition, the project will be integrated with extant European and Belgian research by building strong synergies with two ongoing projects (SSD-funded MULTIMODE and EC-funded ECOCHANGE projects). Some members of the MULTIMODE follow-up committee have expressed a strong interest for the VOTES project and agreed to join its follow-up committee. The VOTES project will ensure coherency in research, give added value to these projects, and promote Belgian research internationally. From a broad thematic point of view, this transversal research project will address several research areas including biodiversity, agri-food, and climate. There is an obvious link with climate change, as one of the drivers of land use change and change in ecosystem processes. More specifically, this project is clearly related to the research subject ‘Evaluation of Belgian ecosystem services within the context of climate change’, as a case study within the cluster ‘feasibility of evaluating services rendered by Belgian ecosystems’. It aims at answering several of the questions suggested, e.g. which are the most important ecosystems services, which methodologies are best suited to quantitative valuation… It will also address the issue of distribution (i.e. ecosystems services for who?) and knowledge transfer. Last but not least, combining an integrated valuation framework with an SEA (an ex ante instrument) based on scenarios and the principles of sustainable development is expected to bring new valuable outcomes for science, policy-making and society.

5. KEYWORDS

Ecosystem Services Valuation; Socio-Ecological System; Land use change; landscape dynamic modelling; participatory modelling; stakeholders interviews; Grounded Theory; sustainable development scenario; policymaking guidelines

FINAL REPORT

1. INTRODUCTION

The on-going environmental degradations, acknowledged by many international reports and scientific studies (MEA 2005; TEEB 2010), do not only threaten Nature but also endanger Humankind. Most importantly, the loss of biodiversity results from complex interactions between natural and socio-economic causes among which climate and land use change are paramount. As a result, the ability of ecosystems to support human wellbeing, thanks to the services they provide us, has been reduced substantially.

1.1 ON THE CONTEXT OF SCIENCE & SOCIETY

The concept of Ecosystem Services (ES) establishes a link between biodiversity and human wellbeing (MEA 2005; TEEB 2010) in a cascade flow from the natural to the human world (Haines-Young and Potschin 2010). The natural environment, in its broadest sense, offers numerous amenities, which can be used to the benefit of people. For example, a good soil quality (an ecosystem structure) allows an efficient food production (an ecosystem service), which can contribute to a better diet (a benefit to Humankind). Therefore, the loss of biodiversity is not only an environmental problem but also a major issue for society's sustainable development and human well-being (MEA 2005; TEEB 2010, Haines-Young and Potschin 2010).

Amongst the causes of ecosystems degradation, many have been formally acknowledged by decision makers. A major contributing factor is the failure of current decision-making, and Society in general, to recognise the social and environmental values of ecosystems – beside the usual monetary measures of economically productive land: agro-ecosystems, wood logging… for which there is an existing market –, in spite of the many and various services provided by ecosystems to human wellbeing (MEA 2005; TEEB 2010). These contributions are not fully recognized because they are still not yet comprehensively recorded. Therefore, one necessary step to halt further degradation is to ensure that future policies consistently include the values of nature, beside the classic economic concerns, within policymaking processes.

Indeed, despite its inherently anthropocentric characteristic (see e.g. de Groot *et al.* 2002; Fisher *et al.* 2009), ES are mostly and too often modelled on the basis of biophysical or economic indicators only (Nelson *et al.* 2009). The social and cultural aspects of the value of these services are therefore largely ignored. However, Costanza (2000) argues that, in order to conduct appropriate valuation of ES, one must address the question: who votes? Is it *Homo economicus*, *Homo communicus* or *Homo naturalis*? Costanza further argues that in doing valuation of ES, one needs to consider a broader set of goals that include ecological sustainability and social fairness, along with the traditional economic goal of efficiency. Ergo the word 'valuation' used in this report and applied equally to the three dimensions of sustainable development. Thus, economic, biophysical and social valuations are measurements performed in the sense of defining the 'relative worth', 'utility' or 'importance' of ES for the end-user community.

1.2 ON THE IMPORTANCE OF STAKEHOLDERS PARTICIPATION

The strategic individual and collective decisions taken in order to meet a sustainable land development may vary from place to place, from community to community (Hein *et al.* 2006; Costanza 2000). Therefore, some authors argue that it is crucial to confront the point of views of scientific and non-scientific actors (aka "stakeholders": policy-makers, private landowners, end-users citizens ...) in order to assess the sustainability of local ecosystems through the services they can provide to the local community (Barnaud and Antona 2011). The confrontation and the exchange of ideas between scientists and non-scientists are crucial for the emergence of creative processes that, eventually, will allow the elaboration of ecosystem management plans that satisfy all parties to a large extent. A participatory phase is also crucial to identify the relevant indicators that will help monitor these plans and will make sense to the stakeholders involved to embrace another management standpoint (Cowling *et al.* 2008).

A participatory approach can serve many purposes and there are various styles of interaction among the actors involved (see Van Herzele *et al.* 2005 for a review). Rather than seeking so-called transformative outcomes, such as raising awareness or sense of ownership, the objective of participatory modelling and valuation in this study is largely instrumental in nature. That is, using participation as a tool for enhancing the quality of the valuation, including the identification of relevant indicators and future trends. Through taking account of local knowledge about the environment in which people live, work and spend their leisure time, the valuation of ES – and subsequently their management – will be more sensitive and responsive to local conditions and needs, drawing on a multiplicity of values.

However, participatory approaches that aim to value ES have seldom been implemented (see, as counter-examples: Kaplowitz and Hoehn 2001; Wilson and Howarth 2002; Castoldi and Bechini 2010). Three important caveats are to be drawn from this gap.

First, a sustainable management and use of ecosystems requires an integrated approach in which local stakeholders and end-users have a central role as they are the direct beneficiaries of this provision of services. Second, focusing biodiversity management onto human needs would deliver more integrated policy and management at a landscape-scale and be more firmly directed towards human wellbeing (Haines-Young and Potschin 2010). Thus, the links between ecosystems, the services they provide and the benefits that people enjoy from them must be set out clearly as part of the valuation process. Third, despite an increasing awareness for sustainable landscape management, policy designers still lack dedicated tools to evaluate and monitor ES. Therefore, the insights on ES processes gained through valuation must help to incorporate appropriate indicators in policy documents.

In the "Methodology and Results" section of this report, we present a starting point for addressing these caveats with a framework for the Valuation Of Terrestrial Ecosystem Services in a peri-urban landscape (VOTES). With the VOTES framework, we aim at structuring a methodology that is applicable for valuing the ES available in a given area through a set of indicators that are both meaningful for local actors and scientifically sound. The framework is meant to be applicable to any areas, but examples from a study area in central Belgium are used throughout to illustrate the methodology.

1.3 ON THE METHODOLOGICAL CHALLENGES

The lack of consideration for the value of ES in current decision-making is recognised as one of the main reasons leading to an intense competition over well-located available land (TEEB 2010). Consequently, the size and distribution of the agricultural, semi-natural and forest ecosystems are expected to vary dramatically. Land Use Change (LUC) is a human-induced factor widely identified as having a dramatic impact on ecosystem structure and processes and hence on the services they provide (Turner *et al.* 1997; Lambin *et al.* 2001; MEA 2005). Other authors further insist that LUC affects all types of ES (Foley *et al.* 2005; Metzger *et al.* 2006; Quetier *et al.* 2007; Schröter *et al.* 2005). However, previous studies that tried to value ES were either conducted at a broad scale using simple 'benefit transfer' approaches which do not allow for analyses of change in value under new land use conditions or were conducted at a fine scale, over small spatial and temporal extents and only focusing on a single ecosystem (Nelson *et al.* 2009) and ignoring potential trade-offs between the provisions of different services. Arguably, this lack of a holistic approach is precisely why maximizing specific ecosystem services such as food production in Belgium and Europe has had such a detrimental impact on the environment.

Therefore, the VOTES framework explicitly refers to the spatial and temporal dimensions of ES in the valuation process of this 'natural capital'. The spatial distribution of land uses (patterns) affects the amount of ES available in the study area at a given point in time. Changes of the land use patterns through time may modify strongly the quantity and the quality of ES in that area.

In order to address these complex spatio-temporal dimensions, we propose a looping stepwise procedure starting with valuations of ES at present. These social, biophysical and economic valuations are based on current land use patterns and allow defining an appropriate set of meaningful indicators. Subsequently, scenarios of LUC are simulated and used to explore potential losses (and/or gains) of ES in the future of the study area. Scenarios provide plausible narratives or pathways to the future, which have the strength of being understandable by a broad range of stakeholders (Cowling *et al.* 2008). Among these, a focus is put on developing a sustainable development scenario with the contribution of key stakeholders, in order to anticipate future challenges for ES, relating to more sustainable landscape management and decision-making. Scenario narratives are crucial benchmarks for exploring potential changes (temporal dimension) of land use patterns (spatial dimension) and hence to identify potential shifts (trends) of indicators from the current situation (Rounsevell and Metzger 2010; Murray-Rust *et al.* 2011). Buckling-up the participatory loop, key stakeholders are confronted with the indicator trends in order for the local community to debate and gain insights on the potential consequences of a set of decisions about sustainable landscape management and use.

1.4 ON THE OBJECTIVES

The overall aim of this project was to develop a framework for exploring the consequences of LUC for multiple ES including food and timber production, carbon sequestration, biodiversity and cultural ES. The work was structured around a series of questions that form the specific objectives of this project:

[1] To assess the current value of key ecosystem services in the study area and how the current relationships between ecosystem services are mediated by land use;

[2] To identify current trade-offs and synergies between ecosystem services in a spatially explicit way;

[3] To explore how the current value may change in relation to future land use change;

[4] To explore how the current trade-offs may change in relation to future changes in ecosystem services;

[5] To suggest policy instruments for including ecosystem services in decision-making processes taking into account the three pillars of sustainable development and involving stakeholders and local communities.

To achieve these objectives, a network of 4 research groups from the Flemish and French communities of Belgium constituted the multi-disciplinary team providing complementary expertise in the fields of natural and human sciences – in particular: human and physical geography, landscape and human ecology, economics and policy science.

In summary, with the VOTES framework, we aim at [1] incorporating inputs from stakeholders and end-users in a three-pillars valuation of ES (see sections 2.1 and 2.2); [2] doing a holistic and integrated valuation of ES with a sustainable development stance accounting for land use change (see sections 2.2 and 2.3); and [3] developing suggestions to policy-makers for integrating ES valuation and monitoring in policy developments (see section 2.4). The framework is meant to be applicable to other study areas, but examples from a study area in central Belgium are used throughout to illustrate the methodology.

1.5 ON THE CASE STUDY AREA

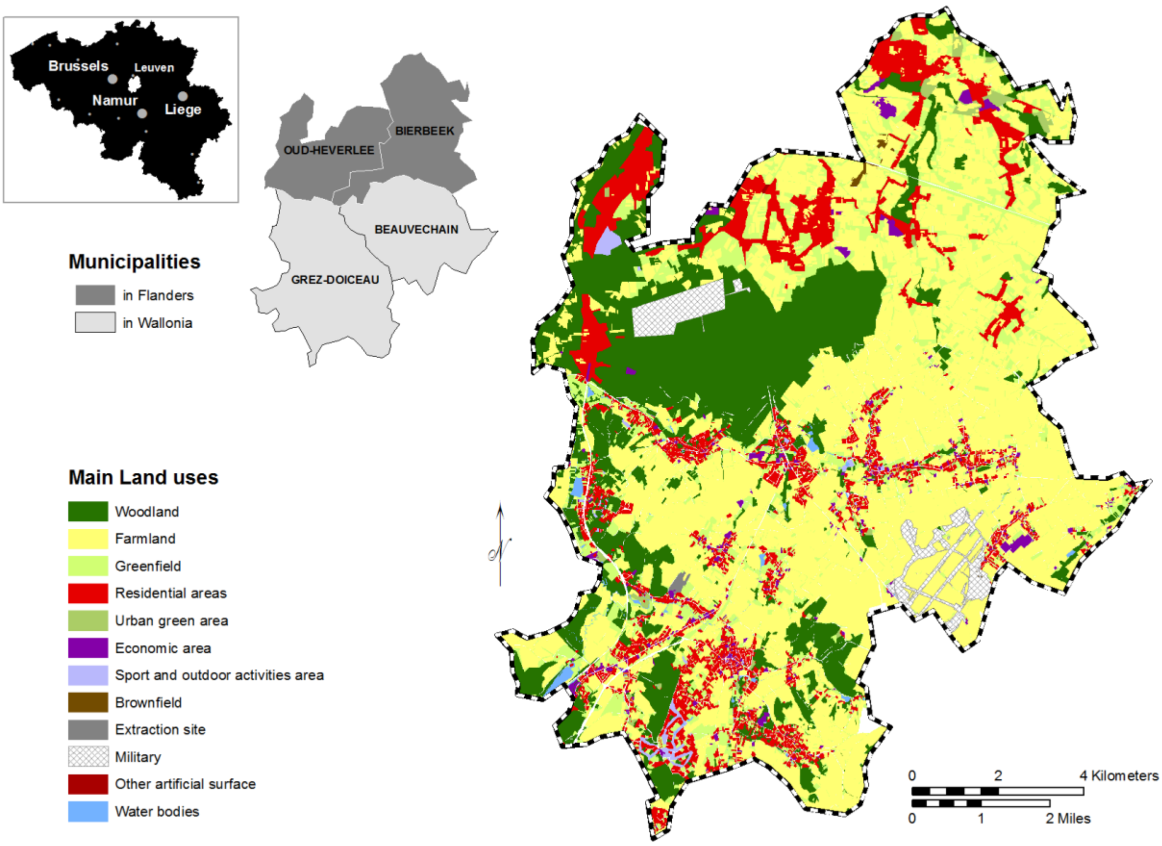
As we propose a novel holistic and multi-temporal approach to the valuation of ES, we decided to focus on a relatively limited spatial extent yet showing a range of ecosystems and management issues. The study area consists of four contiguous municipalities mainly belonging to the river Dyle's catchment in central Belgium, covering a total area of about 164 km^2 (see Figure 1). Two municipalities are located in the Flemish Region (Flanders: Oud-Heverlee and Bierbeek) and two in the Walloon Region (Wallonia: Beauvechain and Grez-Doiceau).

The area displays a wide range of ecosystems (types of natural and semi-natural land use include grassland, forest, intensive agriculture, organic agriculture (though limited in area), orchards, a network of ponds, streams and rivers, gardens and parks …). It notably contains the 'Meerdaalwoud-Heverleebos' forest complex (the largest dark-green patch on Figure 1) for which an economic valuation study has been performed (Moons *et al.* 2000). The study area mostly covers the loamy plateau of central Belgium, allowing large agricultural parcels exploitation, besides the east bank of the river Dyle characterised by sandy-loam slopes. The valley bottom includes a series of wetlands that are currently designated as Natura 2000 sites.

The area has a strong peri-urban character, being located between the larger cities of Leuven, Brussels and Wavre-Louvain-la-Neuve. The pressure from residential development (and related activities, such as commercial, infrastructure, leisure …) is the highest, leading to an intense competition for the use of limited land surfaces. Housing is dispersed and leads to fragmented natural habitats. Increased urbanization combined with the effects of climate change is likely to increase pressures on local ES (Reginster and Rounsevell 2006), hence emphasizing the need for carefully designed policies focusing on preventive and adaptive measures.

By using municipal boundaries to delimit the study area we intend to engage with stakeholders involved at that level of authority, recognizing that although the causes of ES losses are often regional or even global, solutions are best designed at the local and individual scales (Cowling *et al.* 2008). We believe that the case study provides a representative example of a situation that also occurs elsewhere, and hope that the findings of our study may be applied to other areas in Belgium and beyond.

Figure 1: The main land uses in the four municipalities included in the Case Study Area for the VOTES project



2. METHODOLOGY AND RESULTS FOR AN INTEGRATED PARTICIPATORY THREE-PILLARS VALUATION FRAMEWORK

In order to meet our objectives (i.e. of participation, integration, and policy suggestions), we have developed the VOTES framework which originality is to do an integrated valuation of ES in a spatially and temporally explicit way, proceeding stepwise (see Figure 2).

First, we need to assess current values of ES and how these are mediated by land use (see section 2.1). This step requires [1] identifying with the participation of stakeholders and end-users what ES they value currently and to which extent they benefit from them (see 'Social valuation' subsection); [2] identifying the land uses relating to these ES (distinguishing vegetation cover, soil type, management practice, slope …) and identifying the related ecosystem processes that can be modelled in practice (see 'Biophysical valuation' subsection); and [3] identifying what ES can be estimated in monetary terms (see 'Economic valuation' subsection).

The resulting current key services valued (socially, biophysically and/or economically) are tabulated (see subsection 2.2a). This allows [1] synthesizing the three-dimensional valuation exercise and [2] deriving a set of appropriate (multi-dimensional) indicators relating to the benefits local people may gain from these services. This table of ES is the spine of the VOTES framework.

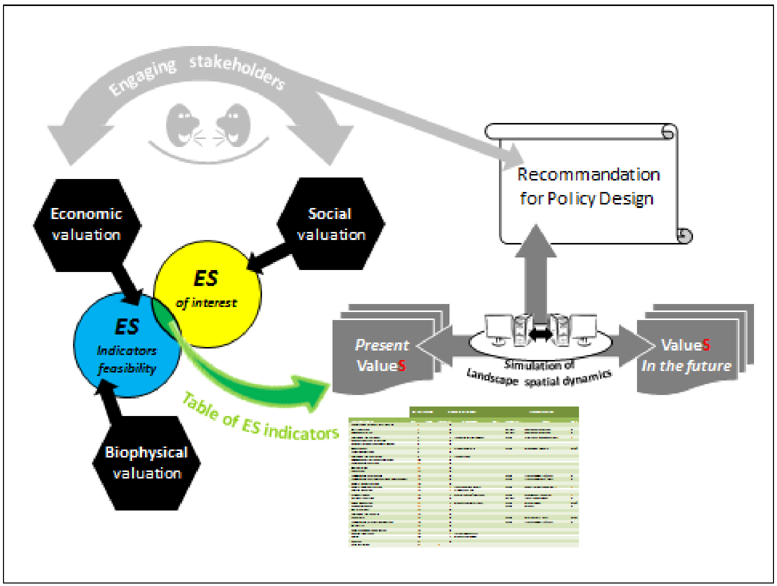
Second, we need to identify current trade-offs and synergies between ES. This identification should not only be done with the set of indicators, but especially through the land uses that are offering these ES. Only with a spatially explicit way services 'hot spots' and 'holes' can be located in the study area (see subsection 2.2b). The spatial identification is also critical because future landscape management plans are to be drawn from the current situation. Therefore, local decision-makers are to be informed at best on local potentials (i.e. spots with large variety of services) and weaknesses (i.e. spots where there is a lack of service).

Third, we need to explore how land use may change in the future and what could be the consequence for ES provision, with the analysis of indicators' evolving trend. This step requires modelling and simulations of the complex interactions between natural and socio-economic drivers leading to these changes, in a temporally explicit way (see subsection 2.2c). This is where scenarios come into play.

Subsequently, this step requires going back to the stakeholders and end-users in order to confront their impression about potential changes in their area (see subsection 2.3). The aim is to identify what changes are perceived as a threat and what changes are perceived as an added-value (compared to the current situation).

Finally, we want to suggest policy instruments for including ES and indicators into decision making in order to better account for ES values in socio-economic activities and policymaking processes (see subsection 2.4).

Figure 2: The VOTES framework illustrated



2.1 ASSESSING CURRENT VALUES OF ECOSYSTEM SERVICES

a. Social valuation

Given the tight interconnections between social and ecological systems, several authors (Folke 2006; Cowling and Wilhelm-Rechman 2007; Cowling *et al.* 2008) stress the need to study the social dimension of ES functioning before the biophysical aspects of ecosystems are studied. Therefore, a social assessment for ES in an area should provide knowledge on the needs, values, norms and behaviours of individuals, institutions and organisations in the study area (Cowling and Wilhelm-Rechman 2007; Cowling *et al.* 2008). The social assessment identifies the owners and beneficiaries for ecosystem functions that deliver ES. The social assessment does not only indicate respondents needs, values, norms and behaviours, but also gives an insight in respondents' frameworks to value ES. The way respondents view nature is closely related to their valuation framework. And so, assessing key ES stakeholders views on nature can give a better insight in this framework.

Therefore, the aim of the social valuation phase is: [1] to identify institutions, organisations and individuals who can affect and/or who are affected by these services; [2] to gather information on what local actors (individuals, policy-makers, civil servants, elected representatives, landlords, local NGOs …) value in their living environment and why it is important to them; and [3] to better understand the mental framework used by different groups of people when valuing ES.

Social values and perceptions play an important role in determining the importance of the functions of (semi-)natural ecosystems for human wellbeing (de Groot *et al.* 2002). The challenge linked to the social valuation of ES is to deal with a variety of stakeholders who may have different views, values and interests. Empirical evidences are collected through face-to-face interviews including open discussion, structured ranking and map description. An open discourse reflects the social and decisional contexts of individual's ES valuation, including perceived trade-offs and synergies between specific ES. A ranking exercise is a particularly suited tool to explore criteria that different groups of people find relevant when evaluating different options or items (Chambers 1994; Leeuwis 2004; Raymond *et al.* 2009). The ranking exercise serves a double purpose (see also Leeuwis 2004). First, it encourages a respondent to discuss why a service may be important or not. By doing so, we gain insight into the mental framework that different people apply when evaluating ES. Second, it allows deriving a classification of ES by order of importance for the local community. The synthetic ranking is to be used together with the two other valuation pillars when defining the set of meaningful indicators.

Method

i. Selecting respondents

The first main component of the social valuation phase is the identification of potential interviewees. Stakeholders, end-users and beneficiaries of ecological functions that deliver services are identified based on an integrated assessment (document and map analysis, interviews with informants ...). This requires a preliminary identification of potential ES and the selection of a number of land use or land management changes with clear effect on ecosystem values (and relations between them) in the study area. A mix of natural resources management experts with good local knowledge can provide relevant information for identification and recognition of relevant ES at the local scale (Slootweg and van Beukering 2008). This includes, for example, nature and forest managers, people in charge of the design and implementation of agri-environmental measures or landscape development in the study area, municipal civil servants responsible for environment and/or land use planning.

Hein *et al.* (2006) define stakeholders within ES valuation research as "any group or individual who can affect or is affected by the ecosystem services". The key is to select interviewees who represent a broad spectrum of viewpoints. Through purposive sampling information-rich cases for study in depth can be selected (Barbour 2001; Kuzel 1999).

For the VOTES project, we selected 38 interviewees (20 French speaking, 18 Dutch speaking), being in a position to shape actions and opinions' regarding land use or land management changes or who might be affected by these changes (either as gainers of losers). The 38 semi-structured interviews, lasting between 45 minutes and 2 hours, took place at the respondents' homes or offices. With the consent of the interviewees, the interviews were audio-recorded and transcribed for analysis. Two respondents objected to recording, the analysis of their interviews is based on detailed notes. Respondents were selected by the project team based on the team's knowledge of the area; lists of local politicians and contact persons of associations as announced on websites; and snowball sampling (asking respondents to provide details of other people relevant to interview). The selection included institutional and individual stakeholders: local politicians (mayors, aldermen, council members), civil servants in charge with nature management (in broad terms; local and regional levels), spatial planning and/or tourism, farmers, members of environmental NGOs and citizens actively utilising or experiencing nature and landscape (including people active in the cultural sector). In particular with regard to institutional interviewees it is important to cover different sectors (agriculture, forest and nature conservation, flood protection …) because often each of them tend to overlook the effects their plans may have on ES linked to other sectors (Slootweg and van Beukering 2008). Some respondents are members of multiple categories of respondents. In all cases, but especially for respondents with multiple roles, respondents were asked to focus on their personal experiences as a citizen living or working in the municipality. The respondents who are not residing in the study area have been working in the area for several years.

ii. Conducting interviews

The second main component of the social valuation phase is the valuation of ES per se. The frameworks used by the respondents for ES valuation are assessed using semi-structured interview techniques. The interview design is based on work by Bryan *et al.* (2010), Cast *et al.* (2008) and Raymond *et al.* (2009) and is structured in 3 parts:

(1) *Open-ended questioning:* what the interviewee values in the environment and why; what views he/she has on nature; what role the respondent plays, has played or will play in land use management; and what changes he/she has seen in the past and is expecting to see in the future.

(2) *ES-based prompting:* what listed services are important to the interviewee and why. The list is a compilation of most common ES (after MEA 2005, TEEB 2010) evenly separated in three laymen themes (see Table I): production (10 ES), regulation (11 ES) and culture (11 ES). For each listed ES, the interviewee is asked to indicate the importance they attribute to the specific ES and to justify the choices made. This discussion gives more insight into the framework used by the interviewees to value ES.

(3) *Map prompting:* where are, to the respondents' view, the most important ES located in the municipality he/she lives. This mapping exercise gives more insight on the effective use of the environment by the interviewees.

Table I: Ranking table of ecosystem services in social valuation.

	Totally unimportant	Rather unimportant	Neutral	Fairly important	Very important	Comments
1. "Provisionning Services"	**Goods and services provided in the environment**					
Wood production						
Biofuel						
Pollinisation						
Food/fodder						
Regional products						
Hunting						
Berry/plant picking						
Empoyment in agriculture						
Employment in nature/landscape management						
Employment in recreation & tourism						
Real estate						
…						
2. "Regulating and supporting services"	**Result from the capacity to regulate climate, water and nutrient cycles, earth surface processes, biological processes**					
Natural water pufication						
Natural air purification						
Climate regulation						
Carbon storage						
Protection against floods						
Protection against erosion						
Regulating pests and diseases						
Protection against noise						
Habitats for plant and animal species						
Conservation of typical local species						
…						
3. "Cultural services"	**Creating opportunities for recreation, learning, local identity, etc**					
Soft recreation						
Hard recreation						
Esthetics/Artistic inspiration						
Spirituality						
Therapeutic/Relaxation						
Social relations						
Education/Learning						
Opportunities for scientific research						
Good place to live						
Sense of place						
Historical landscape						
…						

iii. Synthesis and analysis

The interviews resulted in quantitative and qualitative information. The ES-based prompting part generated a quantitative ranking of the importance of ES to the respondents. The average importance for each listed ES is calculated over the entire set of interviews and steered the biophysical and economic valuation within the VOTES project. The qualitative results of the semi-structured interviews include the comments respondents provided when ranking the ecosystem services and the answers to the open questions. Results of such interviews are rich in content, thus complex to synthetize and analyse. Conversely, these more in-depth parts allow for questioning and probing about the reasons behind valuations linking the valuations with the interviewees' views on nature and their (environmental) values. Similar to Bryan *et al.* (2010), the interviews were transcribed at verbatim using Scribe Express software (NCH software 2010), and analysed following a grounded theory inspired approach (Strauss and Corbin 1998; Richards 2005; Mortelmans 2009), using NVivo software (NVivo qualitative data analysis software; QSR International Pty Ltd. Version 9 2010).

The goal of grounded theory, also named constant comparison analysis, is to develop an explanatory theory of basic social processes, studied in the environments in which they take place (Glaser and Strauss 1967). The social process under study is the view of nature implicitly and/or explicitly expressed by the respondents. We consider the respondents' view on nature as an important frame for the assessment of the importance of ES by the respondents. The research applied the Strauss and Corbin (1998) approach to grounded theory, as an iterative and inductive analysis technique. The interviews were analysed through three stages: [1] open coding (comparing, conceptualizing and categorization of data; also known as labelling), [2] axial coding (reassembling data into groupings based on relationships and patterns within and among the identified categories) and [3] selective coding (describing the central category in the data) to develop a theory describing the dimensions of respondents' views of nature (Strauss and Corbin 1998; Starks and Trinidad 2007).

Results

i. Social assessment of the importance of ecosystem services

For each listed ES, the average importance was calculated. Though not being statistically representative, this returns a common "community" ranking of ES (to the scale of the case study area) used as a basis for focusing on indicators relating to the most socially valued ES (see the 'Social Valuation' columns in Table V, page 47).

Respondents ranked ES on a scale from 'totally unimportant' (–2), over 'rather unimportant' (–1) and 'neutral' (0) to 'fairly important' (+1) and 'very important' (+2). The average importance for most ES is important or very important. Only 'hard recreation' (–0.95) and 'hunting' (–0.81) are commonly regarded as unimportant. 'Biofuel production' (–0.15), 'berry or plant picking' (0.18) and 'regulating pests and diseases' (0.22) are considered neither unimportant nor important. In general, cultural and regulating ES are ranked higher than provisioning services.

ii. Views on nature

Respondents' views on nature define an individual framework which respondents apply when assessing the importance of ES. Some respondents explicitly describe their view on nature when being asked what nature means for them. Other respondents describe their view on nature more implicitly when arguing their assessment of ES. To describe the views on nature applied by the respondents, we analysed all interviews using the grounded theory approach.

Two general remarks can be stated which are relevant for all respondents. Every stakeholder interviewed showed a positive stance towards nature and landscape in the study region. The respondents appreciated the attractive landscape they can live and/or work in. Moreover, we noticed that most respondents use landscape and nature as synonyms. However, some respondents made a clear difference between forest and nature. In line with the former observation, we will use nature and landscape as synonyms in the description below.

Based on the interviews, we noticed two dimensions which define the views on nature of the interviewees. The first dimension describes a nature versus culture continuum along which the views on nature can be situated. A second dimension describes the relation and balance between human beings and nature.

Dimension 1. Nature versus Culture

Statements on nature as compared to culture have three stances (see Figure 3). On the one hand respondents prefer primeval nature. At the other site of the spectrum, respondents prefer so-called cultural nature or cultural landscapes, which are dependent on and managed by humans. A specific stance has been formulated by a former chair of a cultural council:

> *R: All what is not culture, all what not really is concerning humans, what isn't culture is nature hey, that has naturally to do with uh, hey the, the fundamental instincts which uh thrive us. (...) All what is impulses, belongs to the nature, all what rather has been calculated and is rational, is culture.*

When situating the nature in the study area, several respondents (mainly with a "green" background) indicate there is ample real nature left in the region and define the nature in the area as "cultural nature" or cultural landscapes. This observation is not a normative one, as it is stated by respondents favouring primeval nature as well by respondents favouring cultural nature. A minority of the respondents adhere to the primeval nature stance, as they prefer nature (virtually) not influenced by men or because they attribute a higher aesthetical quality to "untouched" nature. The primeval nature view is mainly stated by respondents professionally or voluntarily active in nature, landscape and/or environmental management. However, other respondents involved in nature, landscape and/or environmental management refer to the high natural, recreational and aesthetical quality of the cultural landscape in the study area and opt for conserving and strengthening cultural landscapes. Apart from respondents active in nature, landscape and environmental management, respondents favouring cultural nature include (among others) farmers, politicians, landlords and residents.

The importance of cultural historic landscape elements such as hollow paths, hedgerows and historical farms in the area is stressed by several respondents. Most respondents confirm the importance of landscape elements for conserving or restoring historical landscapes. Opponents as well as proponents of this importance adhere both stances in the nature–culture dimension and both admit the landscape has been in constant evolution. The cultural historic elements are characteristic for the open, meadow landscapes in the Dyle floodplain or the agricultural fields on the plateau. The importance of agriculture for the cultural landscape in the study area is illustrated by a member of the local council and a farmer. Also respondents who prefer more natural landscapes confirm the importance of agriculture for the landscape.

When looking more concrete what the respondents describe as primeval nature or cultural nature, it was striking that the same forest area (Meerdaalwoud–Heverleebos) was considered both primeval and human influenced.

Dimension 2. Relation between Nature and Men

The second dimension of the respondent's view on nature is dealing with the relation between human beings and nature. Three fundamental opinions can be distinguished: '**nature for people**', '**people for nature**' and stating there is an '**unbalanced relation between humans and nature**'. Figure 4 summarises the concepts which define the relation between Nature and Men.

Figure 3: Stances and building concepts in the Nature versus Culture dimension

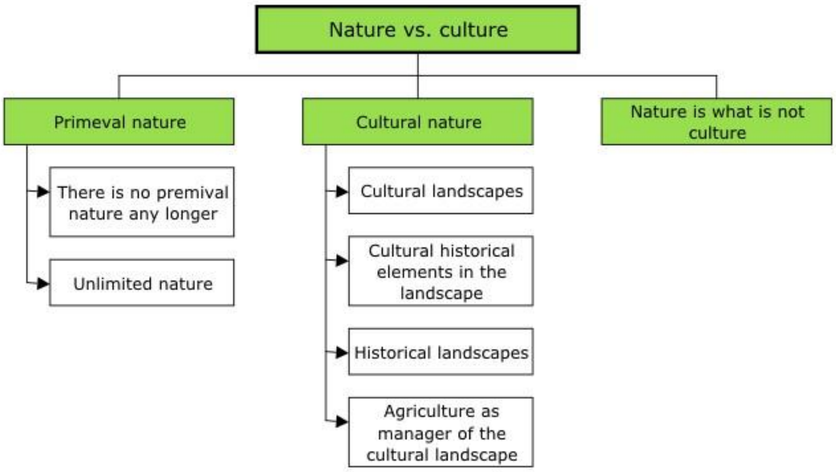
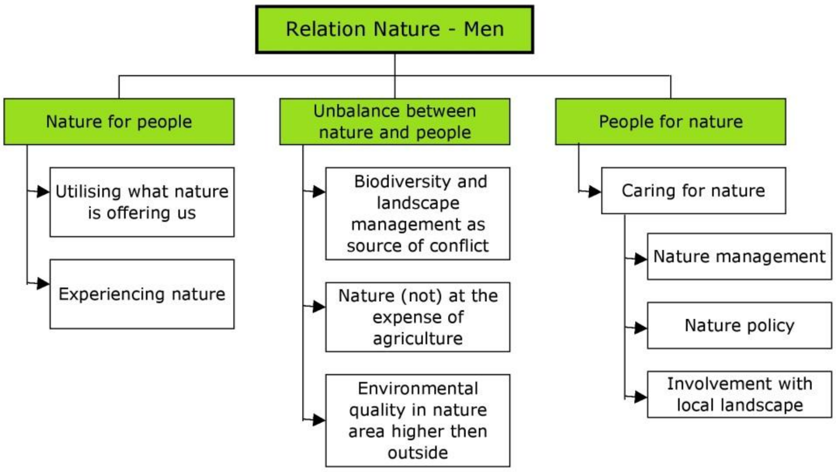


Figure 4 : Views on the Relation between Nature and People as the second dimension of the respondents' view on nature



❖ Dimension 2.1. Nature for People

The 'Nature for People' stance is revolving around two axes. Both axes are explicitly mentioned by a member of the local council:

> *R: At the end, with uh, nature or forest values it is a bit the same as as with animals eh. You have yield animals and domestic animals eh. And the same is eh, you have the people who deal with nature in an utilitarian way, eh so my foresters uh, people who who have, who have a need for nature, and on the other hand also, eh, those who simply enjoy nature eh*

Using nature for what it offers to humankind is a utilitarian approach to nature. Respondents refer to the role of land as a means of production for food, fruits, vegetables and timber. Producing these goods is done professionally by farmers as well as for hobby by some of the respondents in our sample. A farmer links his need for nature and land to his livelihood, which he contrasts with land use of hobby use by recreationists, hunters or members from nature conservancy NGOs.

R: I think, you havqiue to take into account eh, when you see now, the the the, the nature or the land, those those nature conservancy organisations en those those, what do we have around, and those hunters and those recreationists, that's all for their hobby eh. But, for us, it's our livelihood eh.

Most respondents see the role of pollination for the local landscape and agriculture as important or very important and recognise the positive impact nature elements have on pollination. A specific type of food production is the production of regional products, meaning products specific for the region, such as the 'Chardonnay Meerdael', a locally produced wine. Regional products are seen as a way to anchor visitors' landscape experience who then can take their experience home. Regional products are adding to the economic value of the landscape and provide an economic opportunity to farmers. This latter vision is discussed elaborately by some respondents active voluntarily in nature conservancy and environmental policy. Most respondents from several backgrounds acknowledge the importance of regional products, name several other regional products and/or indicate their personal consumption of regional products. Regional products are also linked to the concept of short food supply chain.

Another form of utilising nature is **experiencing nature and landscape**, the second axis in the nature for men category.

R: Using the landscape, what do you call "utilising the landscape"? Enjoying the landscape? That's also a use of the landscape. (Retired citizen)

Experiencing the landscape and nature is a central concept in most respondents' nature definition. They explicitly mention experiencing the landscape or refer to the beauty of the landscape. Nature and landscape elements are important assets to create a pleasant environment to live in. However, some respondents indicate the pleasing landscape present in the area is degrading due to increasing urbanisation. Respondents confirm natural assets in the study area create a local sense of place. A high majority of the respondents assess the contribution of the local forest area, the Dyle valley and the typical landscape elements to the local identity as important or very important. Some respondents claim they are proud on the landscape they are living and/or working in and state the need to stimulate local residents' and visitors' sense of involvement with the local landscape.

Respondents link experiencing the landscape with aesthetics and relaxation. All respondents agree with the importance of the natural and landscape elements for providing an aesthetical pleasing experience and most respondents indicate being outside in nature facilitates relaxation and coping with stress. The aesthetical aspects of the landscape positively contribute to the sense of involvement with the local landscape. Almost all respondents who are actively engaged in land management, professionally or in their leisure time, can detach themselves from their duties and relax in a natural environment. Few respondents mention the silence as an important asset for experiencing nature. Respondents active in nature management argue the landscape can play an important economic role in the region, by providing more opportunities for recreation and tourism. However, they state, this needs a shift in actual agricultural practices and land management, with a focus of increasing the quality of the landscape.

❖ Dimension 2.2. People for Nature

The descriptions above illustrate the Nature for People vision, which is centred on using and experiencing nature. The central theme in the opposite **People for Nature** vision is "caring for nature".

> *R: … I do find it more important that nature not has to take care of it. Hey, regarding water (purification) eh. Hm, we have to purify our water before it enters nature. It is not nature that has to do the work, I think.*

Caring for nature is implemented through policy and management. The policy component includes nature policy as well as integrating (caring for) nature in other policy domains. Respondents refer to environmental policy, forest and water management, spatial planning and/or agricultural policy as having important impacts on nature and landscape. Respondents who are rather policy-oriented (members of nature conservancy, professional nature managers, politicians, civil servants) spontaneously bring forward the importance of spatial planning for the conservation or enhancement of the landscape and/or nature in the study area. Respondents more into the use of nature in their daily lives (citizens, farmers), but also some respondents belonging to the former groups did not bring up the role of spatial planning (we did not explicitly ask respondents for their vision on this topic).

Respondents refer to "the main principles in nature management", illustrated by concepts such as biodiversity, ecosystems and species oriented management. Some respondents stress the importance of these principles, other respondents comply with the importance of the ecological principles, but they give higher importance to their personal nature/landscape experience, or more process oriented forms of nature management, resulting in a lower priority for the ecological theories.

> *R: When the forest is there for nature experience, there I can accommodate with. When it is only pure nature, with the main principles, which are also important, and through which we can contribute to whole the climate problems, I find that important, but that's another discussion.*

Almost all respondents from all backgrounds mention the important role farmers have in maintaining open landscapes. Farming is seen as an important land use to prevent urban sprawl and to limit urbanisation. Moreover, farmers participate in nature and landscape management, e.g. through applying agro-environmental measures or through having cattle grazing in nature reserves.

❖ Dimension 2.3. Unbalance between nature and people

The relation between humans and nature is not always harmonious. Respondents indicate an **unbalance between nature and human beings** in the study area. Two groups of unbalances are formulated by respondents: humans threatening nature and landscapes through urbanisation, over-recreation or impropriate agricultural practices on the one hand and developing nature at the expense of other actors in the society at the other. Respondents referring to an unbalance between nature and the society include mainly farmers and citizens. They refer on the one hand to the increasing damage caused by wildlife to crops and gardens and the lack of management of the nature. On the other hand, they are critical towards the development of new 'natural areas'. Some citizens regret the changing landscape due to nature development and farmers oppose to giving up their land for nature development.

> *R: That that, that's why I sometimes don't understand the green men, they then say "now we want foxes here", but we have been building the whole forest up to the forest edge. Yeah those foxes what do they do? They come to eat my chickens. (...) And now I sit I have here a couple of martens. Now again I have to take care that they do not get into the henhouse. I only mean, we don't have the space any longer to leave some animals here. (...) And then I say, men, there we have an unbalance.*

The counterpart of nature's unbalance with humans, humans having a negative impact on nature, is dominated by the concern of a high majority of respondents towards the urbanisation that has taken place in the area. Other concerns deal with the impact of agricultural practices on the nature and landscape. Topics mentioned are erosion as a result of inappropriate land management (but also the role farmers can play in preventing erosion is discussed) and the use of pesticides.

A majority of respondents (from all backgrounds) are referring to (potential) negative impacts of recreation on nature and the landscape. The negative impacts are mainly attributed to intensive forms of recreation using motorised vehicles and – to a certain extent – horseback riding and mountain biking, not only because of the impact of nature, but also because of the impact on other visitors' nature experience. The negative impacts are also attributed to the high numbers of visitors to the nature reserves in the study area.

Finally, respondents active in nature conservancy refer to an unbalance in environmental and nature quality: in dedicated nature reserves the quality has improved, but outside these areas, generalist species of the rural landscape have diminished.

Discussion

i. Links with other frameworks

The developed dimensions can be situated in existing frameworks. The 'Nature versus Culture' (Dimension 1) divide has been described by Buijs (2009), who integrated values, beliefs and values orientations into laymen's "Images of Nature". Accordingly, the anthropocentric–ecocentric divide described by Stern and Dietz (1994) and Gagnon Thompson and Barton (1994) has a parallel in the 'Nature–Men relation' (Dimension 2) described above. The Nature for People and the Unbalance relation stances are clearly anthropocentric, while the People for Nature vision fits within an ecocentric philosophy. Another traditional view on nature is based on a utilitarian use of nature versus experiencing nature. Both uses are described within the Nature for People view in the second dimension.

Concluding, our research confirms the statement that values and beliefs on nature are more complex than the frequently used one-dimensional distinctions (De Groot and Van den Born 2003; Buijs *et al.* 2006; Buijs 2009; Daugstad *et al.* 2006).

ii. Linking views on nature with ecosystem services

The respondents spontaneously referred to several ES when discussing their views on nature. A limited number of respondents, all active in nature management, explicitly mentioned "ecosystem services". The majority of respondents referred to one or more ecosystem service(s) before we introduced the list of ES. Within the Nature–Culture dimension, respondents referred to historical landscapes. ES are regularly discussed in the Nature for People stance within the second dimension. Provisioning services such as food/fodder production, wood production, pollination and regional products are mentioned as services provided by nature to men. Recreation is also mentioned by the respondents as being provisioned by nature. Respondents referring to "experiencing nature" during their discussion of the use of nature mentioned cultural ES such as recreation, aesthetics and relaxation. Within the People for Nature stance, caring for nature was an important concept, where respondents referred to the important role of farmers, and less frequently to the role of nature managers as producers of ES. This is clearly linked with the provisioning service of employment provided by nature.

The high frequency of ES within the Nature for People stance is not surprising, as an ES has been defined as "*the benefits people obtain from ecosystems*" (MEA, 2005). The ES concept is clearly an anthropocentric concept, as is the Nature for People stance.

iii. Comparing results from scoring ecosystem services and views on nature

When asked to score the importance of ES, the respondents ranked cultural and regulating ES more important than provisioning services. Within the developed theory for the respondents' view on nature however, provisioning services are more important than regulating ES. There is no clear explanation for this discrepancy. Most probably, the difference can be explained by the way the questions were framed during the interview. The whole interview was focussed on ES, nature and landscape in the municipality under study, but during the scoring exercise, the interviewers regularly stressed the need to focus on the municipality where the respondent is residing or working in. As the state of the provisioning services such as food production is less important in the urbanised study area, compared to adjacent areas where for example agricultural production is much more important, we received answers such as "*I don't think this service is important in our municipality, but personally I think this is an important aspect*".

Conclusion

Based on 38 semi-structured interviews with decision-makers and users of nature and landscape, the social valuation illustrated the importance of ES to the respondents. Without explicitly mentioning the ES concept, the respondents confirmed the fact that nature is servicing human beings in the peri-urbanised study area. When being asked to score the importance of 31 ES, only 2 of them were – in general – assessed as being unimportant (hunting and motorised recreation). All other ES were ranked as important of very important. Based on the interviews, we were able to develop a theory describing respondents' view on nature. This theory is axed around two dimensions, namely the 'Nature–Culture divide' and the 'relation between humans and nature' (Nature for People, unbalance between nature and people, and People for Nature). The anthropocentric concept of ES is mainly present in the Nature for People stance in the second dimension, while the caring for nature concept in the People for Nature stance is more ecocentric oriented.

The social valuation in VOTES illustrated the added value of a socially inclusive approach to scoring ES. The interviews provided a better insight in the framework (view on nature) behind respondents' ranking of ES.

b. Biophysical valuation

The ES valued by the interviewees are a derived product of the presence of biodiversity, including ecosystem structure, processes and functions, in the case study area (TEEB 2010). Hence, valuation of the physical and biological environment (dubbed "biophysical valuation") is an essential part of the VOTES framework that provides knowledge-based case for safeguarding ES (Heal 2000a). As summarized by Cowling *et al.*

(2008), this includes "knowledge on the types and location of the biophysical features that provide ecosystem services, **the spatial and temporal flows** of services in relation to beneficiaries, and the impacts of land and water transformation on delivery" (our emphasis). In other words, the biophysical state of a given landscape at a given time is the result of past complex interactions within the socio-ecological system. Ergo, measuring the biophysical value of *present* ES requires the modelling of the *past* land cover spatial dynamics. There are two prerequisites to the spatio-temporal modelling of the landscape: [1] matching biophysical features – i.e. the land use (LU) – to specific services, and [2] estimating ES provision in relation to each land use.

The crossed correspondence LU-ES can be embedded in a Dynamic Vegetation Model (DVM) accounting for the evolution of the natural environment, a key feature in the modelling and the dynamic simulation of a landscape evolution. DVMs are tools perfectly appropriate for the physical and biological valuation of ES. First, they provide the required spatio-temporal framework, since they are designed to simulate vegetation dynamics over spatial grids that may include up to several hundred thousands of grid cells. Second, they are process-oriented models that are able to describe both ecosystem structure and functions. Third, they provide a synthetic view of ecosystems and landscape units, since they are able to describe several types of vegetation (including competition of different plant types) or ecosystems over a very wide climatic range, and they integrate sub-modules for related physical or biogeochemical systems, such as surface energy budget, hydrology, soil biogeochemistry … which allows to valuate a large variety of ES.

The primary inputs to the DVM are climate and other environmental parameters (e.g. atmospheric CO_2). The model calculates all major water (evapotranspiration, run-off ...) and CO_2/carbon fluxes (photosynthetic assimilation, net primary productivity, autotrophic and heterotrophic respiration …). Ecosystem productivity (including wood production and crop yield) and carbon storage are thus direct outputs, which are the biophysical values of the corresponding ES. The model can provide these values at each time step and/or for any given time span (e.g. a year, a decade …). Other ES are not direct results of the DVM, but may be related to one or several model outputs through parameterised relationships (e.g. the DVM outputs crop productivity (NPP) which is then translated into crop yields).

There are, however, several caveats: [1] DVMs have been built for and are usually used over large spatial domains, such as continents or countries, [2] they do not generally include anthropogenic factors influencing land use change dynamics; and [3] some processes may be too simplified to allow a precise valuation of some ES. Therefore, some adaptations of an original DVM was required.

The objectives of the biophysical valuation are (1) to produce maps of ES indicators in the four municipalities of VOTES study area for the present (presented in this subsection), and (2) to project the evolution of these ES indicators into the future in response to climate and land use changes, in order to provide a biophysical valuation of these ES in the future (see section 2.2c 'Temporal dimension of ecosystems services', starting page 50).

Method

The DVM used in the VOTES project is an adaptation of the CARAIB model, a DVM originally designed to describe non-managed ecosystems dynamics over large spatial extent and at coarse resolution, with detailed representations of land-use, land cover and soil properties (Warnant *et al.* 1994; Gérard *et al.* 1999; Otto *et al.* 2002; Laurent *et al.* 2008; Dury *et al.* 2001). CARAIB is made of 5 different modules dealing with [1] soil hydrology,

[2] photosynthesis and stomatal regulation, [3] carbon allocation and biomass growth, [4] litter and soil carbon dynamics, and [5] vegetation cover (see Figure 5).

i. Dynamic Vegetation Model

The spatial resolution of the standard version of the model is 10'x10' in longitude and latitude. For the VOTES project, CARAIB was adapted so that the grid cells correspond to land parcels (~1-10 ha). Each grid cell is assigned one of the following four different classes of vegetation cover: [1] natural ecosystems, [2] managed grasslands, [3] crops and [4] bare soil/residential areas. Forests and wetlands are assimilated to natural ecosystems and are thus using the standard bioclimatic affinity groups (BAGs; Laurent *et al.* 2008) competition scheme of CARAIB. Managed grasslands, corresponding to meadows and pastures in the case study area, also use this standard competition scheme, but for only herb-type BAGs within a single layer corresponding the under-storey and with regular disturbances due to grazing. For crops, a specific module has been built-up and validated in the framework of the project. It includes all main crop species cultivated on the study area (sugar beet, winter and summer wheat, winter and summer barley, potatoes, maize, faba bean and rapeseed) and allows for crop rotation. Some parameters of the model (e.g. base temperature, growth degree-days required for emergence and maturity, specific leaf area, leaf C/N ratio …) have been taken from the WOFOST model (Supit et al. 1994; Boogaard et al. 1998). It has been validated over the period 2000-2008 for which both meteorological (from the Beauvechain meteorological station) and crop yield data (FAO statistics; Belgian Crop Growth Monitoring System [B-CGMS]) were available (Figure 6). Bare soil and residential areas are assumed to be devoid of vegetation. Gardens and parks are assimilated to grasslands or forests if their size is significant to avoid neglecting their contribution to vegetation productivity.

This adapted DVM allows building a look-up table matching a variety of land uses to specific vegetation dynamics, a crucial step before performing simulations of the landscape dynamics. Subsequently, the link vegetation-LU can be related to the link LU-ES, allowing the model output measures to be associated with specific services (see the "Biophysical Valuation" columns in Table V, page 47).

Figure 5: Overall structure of the CARAIB Dynamic Vegetation Model adapted for the VOTES framework

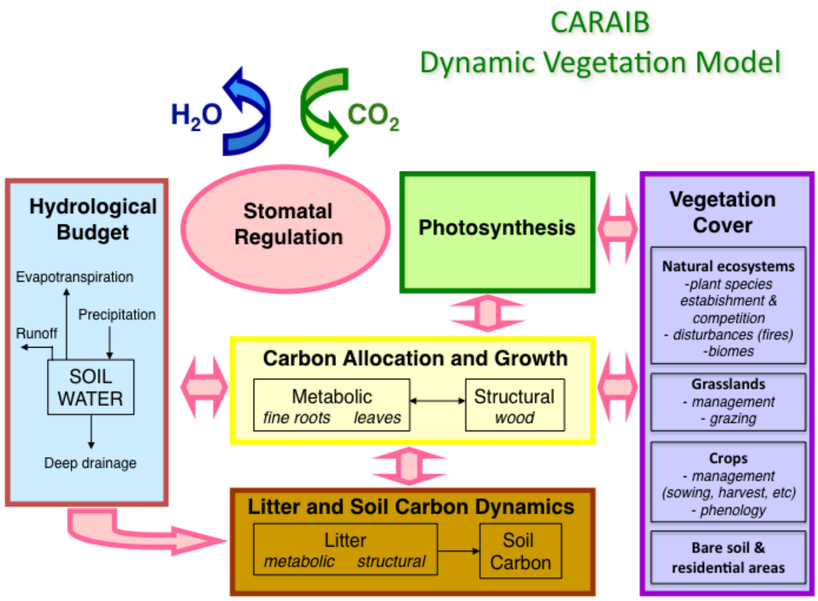
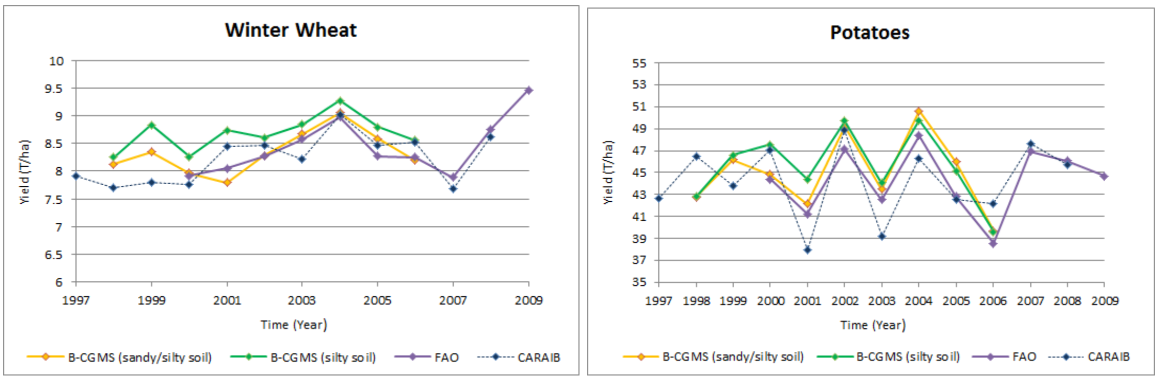


Figure 6: Variation of crop yields between 1997 and 2009 calculated by the model for the study area and comparison with observed data from FAO statistics and B-CGMS. Two crop types are illustrated, winter wheat and potatoes



ii. Land use data

The spatial distribution of land use and vegetation cover in the study area is extracted from different sets of data: [1] the maps used by the Regional Administration for monitoring farming activities and agro-environmental measures; [2] the map of land use and land cover in Wallonia (cross-referenced with EU Corine Land Cover classes by the authorities for legend key consistency); and [3] the zonal planning maps in Flanders (see Figure 1, page 15, for an combined and informative illustration).

iii. Climate data and trends

To construct climate trends, meteorological data were acquired from the meteorological station of the military airport located in Beauvechain. The time period covers 1985-2008, for which monthly data were available in digital format. Average climatological values of the monthly meteorological variables (minimum and maximum air temperature, precipitation, percentage of sunshine hours, air relative humidity and wind speed) were extracted in order to build a reference data set over this time period.

Subsequently, climate trends were simulated with the ARPEGE-Climat model (Gibelin and Déqué 2003; Salas y Mélia et al. 2005). For all the above meteorological variables, we calculated the anomalies in the ARPEGE-Climat simulations between any given month and the average monthly values for the reference period 1985-2008. These anomalies were then interpolated over the study area and combined with the monthly averages of the Beauvechain meteorological data to construct monthly time series.

Finally, the DVM was run in transient mode using these climatic scenarios as inputs in order to produce the useful outputs for the biophysical valuation: crop yields (from ecosystem productivity), carbon storage, run-off and soil loss. In addition, some simulations were also performed over the period 2000-2008 with direct inputs from Beauvechain meteorological station, mainly for the validation of the crop DVM submodel.

Results

Based on the social valuation ranking, efforts have been put in the most importantly valued ES and for which quantitative or qualitative indicators could be constructed. These indicators are mapped for the present in Figure 7.

The indicator used for the 'protection against flood' ES (ranked first) is the maximum monthly run-off, a direct output of the CARAIB model (Figure 7a). This indicator summed up over the area yields the total amount of water that will be delivered to the river system during the wettest months. It is thus a relatively direct indicator of the likelihood and severity of floods for the area. The spatial distribution shows that run-off is lower in forest areas (145 mm in 2010) than in urbanized areas which are exhibiting the highest values (340 mm in 2010). This acknowledges that the type of land cover can alter significantly run-off rates. Over the study area, recent urbanization and intensification of cultivation have strongly increased run-off and, hence, reduced the protection against floods provided by natural ecosystems. Run-off is also used to evaluate the 'natural water purification' service (rank: 14). It is assumed that water quality is lower during periods of high run-offs or floods.

The addition of a crop module in the CARAIB model, the most important adaptation of the model, allows mapping crop yield, an indicator for the 'food/fodder' ES (rank: 6) directly provided by the model (after conversion of crop net primary productivity into yield). The spatial variability of crop yield (see Figure 7b) mostly reflects the existence of various crop types on the area. The model also produces the yield for oilseed rape, which is the major crop producing biofuels in the area, so that this yield can be adopted as an indicator of the 'provision of biofuels' ES (rank: 30). Finally, the net primary productivity of forest trees is a direct indicator of the 'wood production' ES (rank: 24).

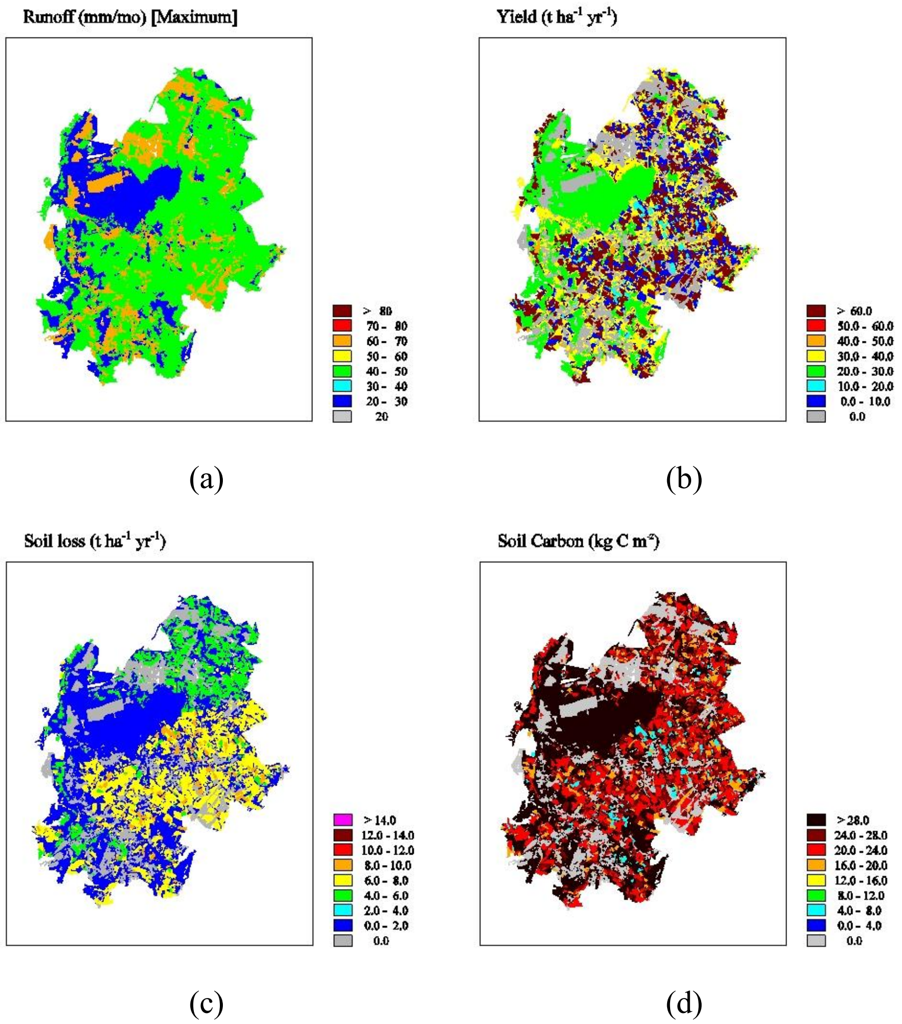
A suitable indicator regarding the 'protection against erosion' ES (rank: 8) was based on the 'universal soil loss equation'. Beside (changes in) run-off measurements, the equation requires information on the land cover, agricultural practices, and environmental inputs such as the soil texture (proportion of sand, silt and clay) in the study area, allowing soil loss calculation at the scale of an agricultural plot (Verstraeten et al. 2006). The spatial variability observed (Figure 7c) demonstrates that forest and urbanised areas are the least prone to erosion. Conversely, the most sensitive areas are located on the loamy plateau (East) and particularly in the southern part (mainly in Beauvechain) where the parcels are much larger and the farming management probably lore intensive.

Carbon cycle being modelled in CARAIB, carbon pools and fluxes are a direct output of the DVM. Therefore, the soil carbon stock (including the litter and the soil organic carbon) can be an interesting indicator for the 'carbon storage' ES (rank: 23). Once again, the spatial variation reveals the role of wooden areas, since forests contain a significantly larger amount of soil carbon compared to cultivated plots (Figure 7d).

Conclusion

The 'Meerdaalwoud-Heverleebos' forest complex always plays a positive role in the biophysical valuation of a series of the regulating ES in the study area, as one would expect. Conversely, farmed parcels present contrasting indicator values: higher for yield and carbon pool but lower for soil loss or run-off. Finally, urbanised areas reveal its "masking" effect on ES provisions: with the highest (bad) values for run-off, built-up plots not only reduce soil-loss to the lowest (best) values, they remove altogether the soil for efficient carbon sequestration or food production.

Figure 7 : Maps of the mean values (1991-2000) of all selected ES indicators



c. Economic valuation

In addition to their social and biophysical value, ES may also have an economic – but not necessarily monetary! – value to the local community. However, this value is rarely made explicit and therefore considerations related to the preservation of ES are rarely taken into account for landscape planning. Actually, ES are considered as free, open access and pure public services (ESA 2000, En Chee 2004). Hence, they are discarded by decision-makers when they have to choose between conservation and conversion (Pearce 2006, Turner and Daily 2008). In other words, they are excluded from economic priorities (TEEB 2010). Estimating the economic value of ES is complex and requires methodological precautions. In this study, we explore, adapt and develop a cost-benefit analysis (CBA) for the economic valuation of ES in the VOTES case study area.

Method

i. CBA & economic valuation

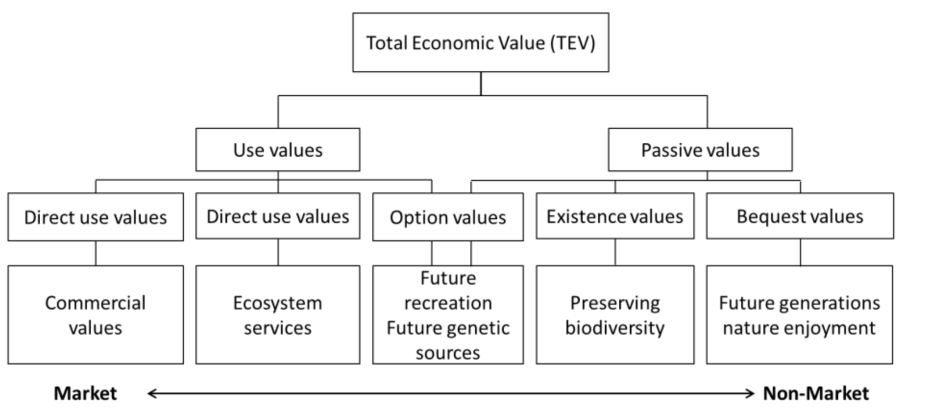
The principle of a classic Cost-Benefit Analysis (CBA) is to put in balance two states of the studied system, with and without a given attribute, and to measure the differences between the financial net benefits of each case, i.e. the profits gained by the community (Salverda 2004). For example, the economic valuation of the provisioning services of a forest versus those of an intensively cultivated field compares the wood/fibre production profits to the food/fodder production profits. The challenges involved in the CBA relate not only to the measuring of these profits, but also to the methods used for collecting the information, and for synthesizing it over the societal, temporal and spatial dimensions of the studied system. The CBA is most often used to compare the usefulness of a specific and well-defined project elaborated by officials in comparison of the current situation, or of another project. However, the aim of economic valuation within the VOTES project is to highlight the importance of ES as seen by shareholders today. Therefore, we suggest using the term 'economic valuation' instead of CBA in order to avoid any misunderstanding with a classic CBA.

ii. Economic valuation & measures: some principles

Measuring Total Economic Value

To get a complete estimate of all ES, the Total Economic Value (TEV) should be estimated. The Total Economic Value can be divided into two groups of values: use values and passive values (see Figure 8). The use values contain the direct (market-based and production uses; e.g. these can be material as wood production or immaterial as forest recreation) and the indirect uses (benefits from services supporting the production and consumption, such as regulatory functions; e.g. sequestering carbon dioxide, birds nursery and food chain regulation). Meanwhile, passive values are represented by the option value (value attached to the potential future benefits or potential uses of a resource in order to avoid its extinction; e.g. forests, as an increasing number of pharmaceutical and medical values are discovered), by the existence value (derived from the contentment of individuals to the potential future of environmental resources, even though they will never get to "use" it; e.g. fundraising the conservation of the Amazonian forest or species for which it is an habitat) and by the bequest value ("more to altruistic motives" some individual value the continued existence of a resource for the future possible benefit from its use by others unknown to them, or for their own future progeny). However, no study so far has estimated the TEV of ES yet (Loomis *et al.* 2000). Therefore, given the time and resource constraints of the project, only the use values was evaluated.

Figure 8: Fields of the Total Economic Value



Source: Adapted from Pearce and Moran (1994, p12).

Measuring profit

The techniques to be used are also specific to certain ES; they differ and are chosen to fit at best each ES.

Two main groups are known to valuate ES. The first one is linked to direct prices which mean that ecosystem services have explicit prices; these are only known when products are trade in an open market (Daily *et al.* 2003). For non-marketed products, indirect valuation methods are required. These methods exist since the 70's in economist cenacles but neither applied to ES valuation, nor considered spatial heterogeneity (Hanley 2010). The following indirect methods may be used indifferently but some may be better suited, depending on the ES considered (after Heal 2000; De Groot 2006; En Chee 2004). 'Indirect valuation methods' are represented by several techniques of indirect economic valuation which again are divided into two types of preferences.

- The first one is called 'revealed preferences' and results from an observation of a factual behaviour and includes the following techniques:
  - **Avoided Cost** highlights the cost incurred at the society in the absence of ES;

    Example: it is observed that the existence of plants which control natural flood will avoid property damages; if these plants did not exist existing, the authority would be obliged to construct artificial barriers to control flood.

  - **Replacement/Restoration Cost** assesses the value of an ES by evaluating how much it costs to replace it after it has been damaged;

    Example: it is observed that natural waste treatment by marshes could be partly replaced with artificial treatment systems, but at a high cost.

  - **Travel Cost** evaluates individual preferences for non-market goods where consumption is commensurate with the cost of travel.

    Example: the person X says he/she is ready to pay a travelling cost T to reach a fishing pond of quality Q.

- **Hedonic Pricing** relies on the proposition that the value an individual places on a service is based on the attribute it possesses;

  Example: housing prices at beaches usually exceed prices of identical inland home near less attractive scenery.

- The second type of preference is called 'stated preferences' and comes from a response to hypothetical questions. The following techniques are part of stated preferences:
  - **Contingent Valuation** is a stated preference technique based on a hypothetical market in which people have to manifest their demand function for ES;

    Example: the person X says he/she wants to go fishing in a pond weekly and is ready to pay a price P for that service in his/her municipality.

  - **Choice Modelling** is also a stated preference technique based on a choice of different scenarios according to people's preferences;

    Example: the person X says he/she is ready to pay a price (i) P, (ii) P+1 and (iii) P-1 for accessing a municipal pond with respectively (i) two type of fish & managed banks, (ii) three types of fish & non-managed banks and (iii) one type of fish & well managed banks.

  - **Benefit Transfert** which relies on secondary data. It implies the use of data acquired in a specific context for a particular project but applied to another context.

These measuring techniques are most often based on people's 'Willingness To Pay' (WTP), an approach aiming at establishing the maximum amount of money people are prepared to give for improvements in the quality or the quantity of ES provided locally (Martin-Lopez 2007). Therefore, the economic valuation undertaken in this study applied primarily to the level of individuals and/or stakeholders who benefit from the ES of the case study area. Notwithstanding, a synthesis of the results was performed to the level of the local community, keeping in mind a number of issues that have to be considered when working with individual preferences.

Measuring individual's values

The measure of economic values put on ES by individuals tightly relates to [1] one's own intrinsic characteristics and personal knowledge and [2] the collecting methods used for making the measure.

A first issue in measuring individual's values is the actual use of the service. For example, one's WTP for maintaining public walking paths might be well underestimated because one does not realize the landscape scenery is composed of hedges and isolated trees preserved along these public paths he/she does not use.

A second issue is the variability of the WTP numeric values that too often reflects the distribution of income/wealth amongst the individuals surveyed (Hanley 2010).

This relates to a third issue: the false assumption of fixed and given tastes and preferences. Individual's preferences do eventually change over time (the entire industry of advertising is devoted to change them) and sustainability is an inherently long-run challenge (Costanza 2000).

Last but not least, response rates, survey modes (e.g. long face-to-face interviews, on-street short questionnaires) and valuation options (e.g. choosing amongst fixed categories, giving a price freely, comparing to other prices) have a crucial role in the variation of WTP and are too often poorly discussed in the literature (Hanley 2010).

Community valuation

Assuming individual values were measured accurately, the question of how to aggregate them into a community value remains. This question not only relates to the way of averaging a weighed sum of private valuation, but equally to the way of taking into account public costs and benefits of e.g. particular policies aiming at managing the landscape.

The difference between the public nature of ES and their valuation through individual preferences has led to more deliberative forms of environmental valuation in which techniques assume social individuals. In fact, the technique (e.g. discourse-based method) is based on social preferences as citizen's juries instead of individual preferences. This valuation approach is based on principles of deliberative democracy and the assumption that public decision making should result, not from the aggregation of separately measured individual preferences, but from open public debates (Wilson and Howarth 2002).

iii. Economic valuation in VOTES

Given the time and resource constraints in the context of the VOTES project, only the part concerning the 'use value' within the TEV will be evaluated. As several ES are not quantifiable in economic terms, a selection of the quantifiable services had to be performed beforehand. Ideally, these ES should be important socially (cf. 'Social Valuation') and should have been also valued biophysically. To increase stakeholders' trust in the results, we decided to only use primary data (instead of using e.g. the method of benefit transfer which implies the use of data derived in a specific context but applied to another context).

Two techniques have been selected. The first refers to a classic indirect valuation using **revealed preferences**. The method used is the travel cost method which evaluates individual preferences for non-market goods where consumption is commensurate with the cost of travel. As individual preferences betray pitfalls while assessing the social value of ES, the second method refers to **deliberative valuation**. The experimental characteristic of VOTES must be highlighted as the study is based on testing methodology, interviews… The main objective is to raise people's awareness amongst stakeholders participating in the evaluation of the ES they use.

We detail below the two techniques of economic valuation, travel cost method and discourse-based method, used to evaluate three ES: 'soft recreation' (social rank: 3) via the travel cost method, 'quality of life' (social rank: 4) and 'conservation of biodiversity and wildlife' (social rank: 2) via the discourse-based method.

Evaluating soft recreation

Soft recreation includes non-consumptive forms of recreation: walking, observing nature (notably bird watching), cycling, running, picnic sites, viewpoints, and also the health and educational benefits of outdoors activities. This ES is classified as a 'cultural service'; hence, the only possible valuation is through an indirect method. The method used is the '**travel cost method**' (TCM), which evaluates individual preferences for non-market goods where consumption is commensurate with the costs of travel to acquire it (En Chee 2004). It allows gathering information on travel costs, on-site expenses and capital expenditure.

The method of travel cost has been developed by Harold Hotelling in 1947 within a research on the economic value of soft recreation in US national parks (Ward and Beal, 2000). The aim of the TCM is to estimate the WTP of people to visit a site depending on their travel expenses (fuel, distance, expenses, time …). An estimation of expenses linked to travel figures the value that people consent for these activities.

The advantages of the method consist in the simplicity of the method and results coming from the observation of a factual behaviour. The method only allows the valuation of use values; this doesn't hinder the research, as mentioned above, we do only calculate use values within VOTES. However, this kind of study is costly and difficult to carry out. TCM has been created and tested within conditions which are slightly different than the ones considered in VOTES as the methodology has initially been thought for sites such as national parks attracting large amounts of tourists. Travel costs for soft recreation are calculated within this study by adding the cost of travel and expenses made on site. TCM is applied at the scale of sites defined by the Meerdaalwoud, the largest natural area in the VOTES case study and repeatedly pointed out as of great importance by respondents during the social valuation.

Another factor considered is the '**opportunity cost**'. Actually, the consideration of costs linked to the time spent on site has been discussed by numerous authors. These costs are taken into consideration by authors when they considered that the time spent by people is a loss of public time. As peri-urban forests are more often visited by local people – this is qualified by a high number of visits with low travel costs – (Colson 2009), we will take into account these opportunity costs. The average cost of time spent in the forest, based on Colson's (2009) reflections, is 1€/hour.

Both methods area applied for possible comparisons with other studies, as recommended by Scherrer (2003) and Terra (2007).

The evaluation method for soft recreation ES has been built following seven steps:

1) Selection of ecosystem within the case study: focus on the woodland areas within our case study, i.e. the Meerdaalwoud which is the wood the most used for soft recreation;
2) Survey method: on site questionnaire (week-days and week-ends) through face-to-face interviews;
3) Writing and testing the questionnaire, divided in 3 parts:
    - Information about the respondent (city of origin, frequency, time spent on site, best spots, motivations);
    - Variables regarding transportation cost (number of km covered, way of transportation, cost, time of the journey, money spent for activities/accommodation, other place visited);
    - Socio-economic information (job, level of education, domestic revenue, age, marital status).
4) Performing survey with French and Dutch speaking interviewers;
5) Estimation of travel costs, expenses, and opportunity costs;
6) Calculation of the cost of 1 visit;
7) Calculation of the 'total use value' of the Meerdaalwoud.

Evaluating biodiversity and quality of life

Values given to biodiversity and quality of life (QoL) are dependent on individual perceptions and understanding, and may be more related to the iconic charismatic nature of, e.g. particular species concerning biodiversity ES. These ES are classified as cultural services. Hence, the only possible valuation is through an indirect method and more specifically, stated preferences.

❖ Discourse-based method

The method commonly used is based on stated preferences valuation, such as contingent valuation. However, reliance on individual preferences to construct social values betrays major pitfalls (see previous subsections on "Measuring individual's values" and "Community valuation").

In this project, we decided to focus on the discourse-based method instead of the contingent valuation method (CVM) in order to test whether the method may counter the disadvantages of CVM. Within this method, the valuation approach is based on principles of deliberative democracy. The objectives that VOTES aims to encounter are a 'fair' outcome which involves no envy by any individual of another (Holcombe 1983), reaching the goals of economic efficiency and social equity, and ensure free and open group deliberation about the value of ecosystem goods and services (Coote and Lenaghan 1997; Jacobs 1997; Blamey and James 1999).

Due to the exploratory aspect of this research, we couldn't find any study describing a step by step methodology. Hence, we developed ours based on partial guidelines referring to focus group, contingent valuation and group interviews (Wilson and Howarth 2002; Spash 2007; Allin *et al.* 2010). For this exploratory research, we adopt the following measures: valuation group discussions were recorded and transcribed; information and consent forms were signed by the participants; the research team, concepts (ES, economic valuation), topic, and aim of study were presented.

❖ Questionnaire design

A pre-group questionnaire was first designed and completed by participants. It provides socio-economic features for both groups; a first part brings together socio-economic information (gender, age, place of residence, job, level of study and marital status) and a second part tests the knowledge of participants about the ES.

Two questionnaires were written; one addressing each ES, i.e., conservation of biodiversity and the quality of life. During the interview, each ES was processed separately. An individual valuation on biodiversity was performed and answered by each participant; then, the same questions were asked by the moderator to the group of participants at the same time. The same methodology was processed concerning the other ES, QoL.

The questionnaire was divided in 3 parts:

- Knowledge of the participant concerning the ES;
- Participant's vision about scenarios for the future;
- Willingness to Pay for the ES.

The valuation was translated in monetary terms (€) or in workforce (h/per week).

Results

i. Evaluating soft recreation

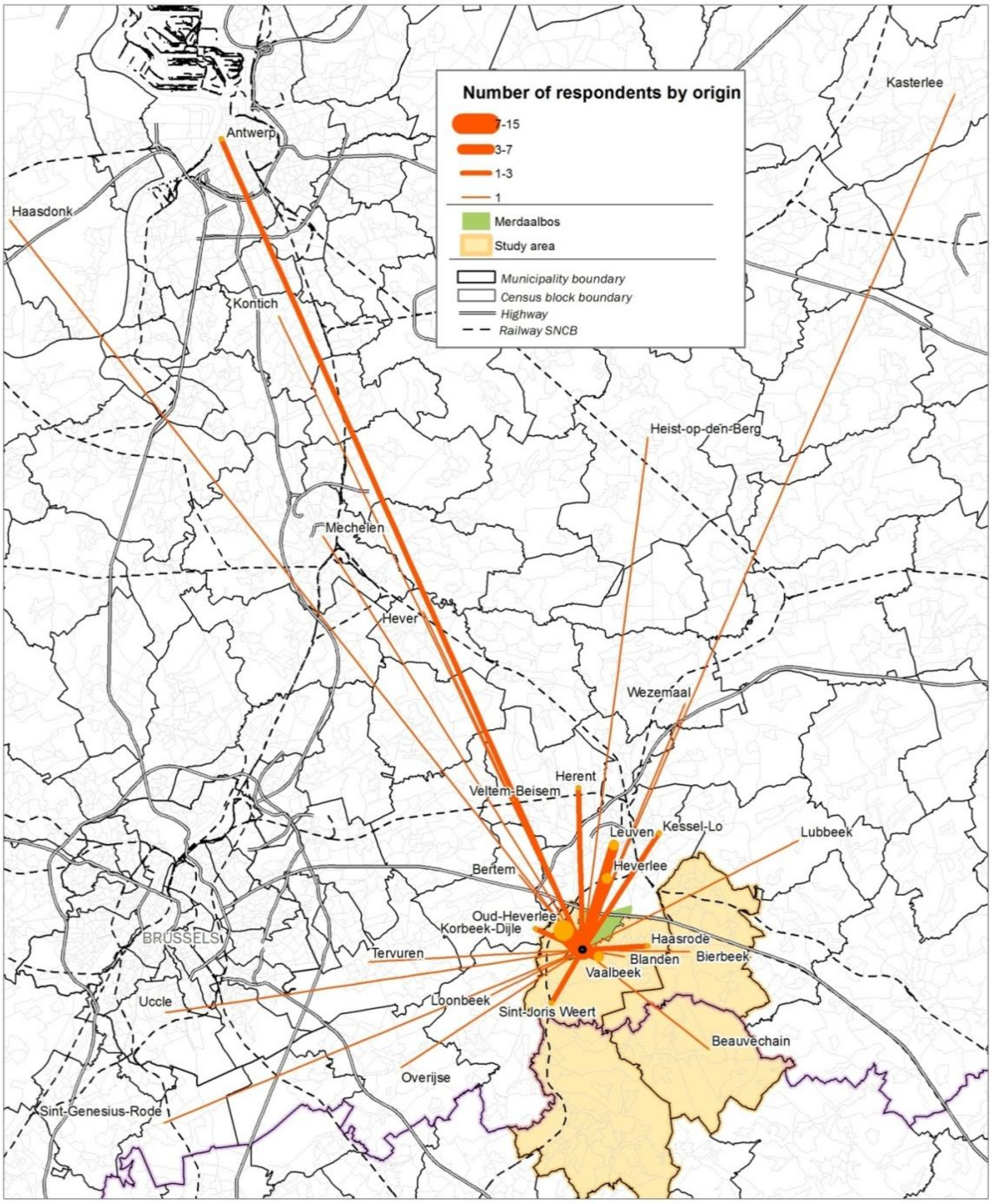
The questionnaire has been tested and 70 answers were gathered during a week of on field face-to-face survey.

Featured analysis of the sample

❖ Respondent's background

Most of the respondents come from the Flemish region (Figure 9). The majority of respondents live within municipalities adjacent to the study area while others come from greater distances such as Antwerpen, Haasdonk, Kasterlee …

Figure 9: Map of respondents' origin



❖ **Distribution by gender**

The majority (66%) of respondents are male (Figure 10a). The questionnaire has been mainly administered during winter (January-February). This suggests that males are more likely to go out for a walk during cold season.

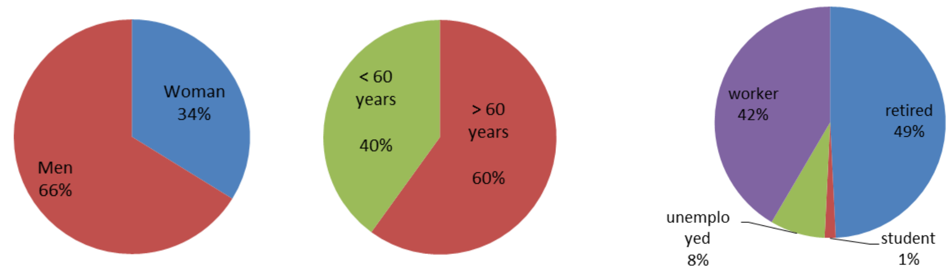
❖ **Distribution by age**

Only 40% of the people surveyed aged less than 60 years old (Figure 10b). Whilst this underrepresentation can be partly explained by the weekdays period chosen for the survey, older people are also more likely to answer our questions as younger people are often busy running or cycling and less likely to stop and take some time to answer questions.

❖ **Distribution by employment category**

As a question related to people's employment status (worker, student, retired, employed, social beneficiary), 42% of respondent are workers and 49% are retired (Figure 10c), which matches accurately with the distribution by age. This also highlights the fact that there were only few unemployed and no social beneficiary, which controverts with the idea that this category of person have more free time and could hence enjoy soft recreation more often.

Figure 10: Demographic indicators: (a) gender, (b) age threshold and (c) employment categories



(a) (b) (c)

Factors affecting travel costs

Amongst all variables questioned during the survey, the total cost of travel was shown being totally separated from several factors like level of studies, wage, sector of business …

However, travel costs are well correlated to others factors as demonstrated below.

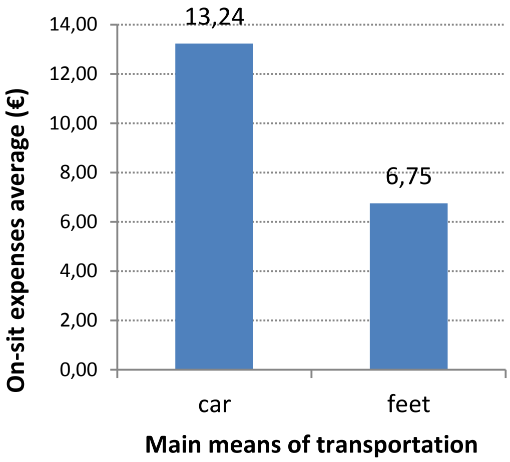
❖ **Link between expenses on site and ways of travel**

Respondents' answers have highlighted two main ways of transportation: travel on foot and by car. The possibilities to come by motorbike or by train were not represented at all, and cycling and bus were very low represented.

The cost analysed within Figure 11 refers to expenses on site only. In fact, travel costs were directly linked to the ways of transportation: people coming on foot are not paying anything to come to the site while the ones driving need to buy fuel, pay car maintenance …

People driving to the site are spending twice the amount of money paid by people coming on foot (Figure 11). Actually, people coming by car, i.e. from further away, are more likely to spend more time away from home and spend more money for food and/or drinks on site.

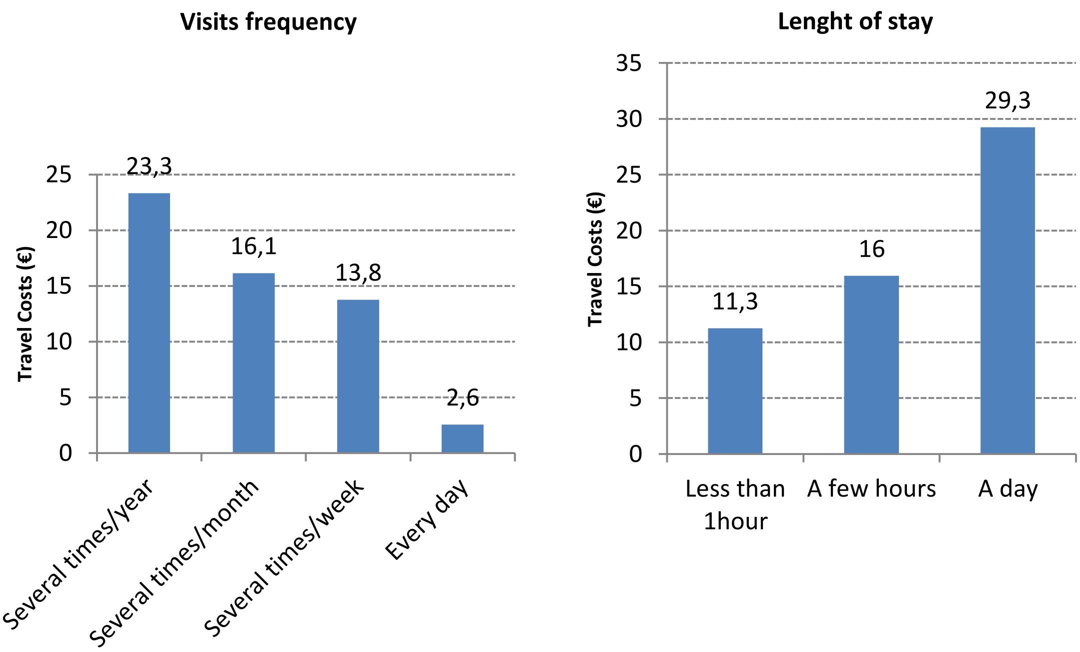
Figure 11: link between expenses on site and main ways of travel



❖ **Link between costs and time**

Respondents' answers demonstrate a clear correlation between costs and the frequency of visits, as well as the length of stay (Figure 12). Actually, people visiting the site every day spend the less money to travel to and on site, with an average of 2.60€, while people visiting the site only a few times a year spent more to travel and on site, with an average of 23.30€. At the same time, people staying on site for the day spend almost three times more money (average of 29.30€) than people visiting the site for less than one hour (average of 11.30€). This may be explained by the behaviour of people coming from a longer way who visit the site less often but probably stay longer in comparison with locals who go to the wood every day for a short time.

Figure 12: Relating travel costs, visit frequencies and length of the stay.



Unit cost per visit

Based on the questionnaires, we calculated an average amount of money that people spent when travelling to the site (see Table II).

The basic travel costs are based on the number of kilometres people claimed travelling according to their mean of transportation (the figure was double-checked with standard internet distance calculation such as Google Maps, Mappy …).

The unit price per kilometre is considered to be null when coming on foot while of 0.33€/km when coming by car. This amount is commonly used within administrations and businesses in Belgium to defray employees' travel costs. It takes into account fuel, tire wear, brake, car servicing …

The amounts of expenses on site were directly given by respondents.

Finally, the opportunity cost has been calculated based on the time people spent on site considering that 1 hour is worth 1 euro (see previous section "Factors affecting travel costs").

As a comparison point, the average value we obtain fall within the interval 2.50€-21.90€ that Moons *et al.* (2000) found when analysing travel cost within the Meerdaalwoud.

Table II: Unit cost per visit

Average of travel costs only	3.39 €
Average of travel costs and expenses on site (total costs)	14.34€
Average of total costs and opportunity costs	16.83€

Value of soft recreation according to TCM

If we consider that the Meerdaalwoud obtain an average of 1 million visitors per year, and that Meerdaalwoud comprises 2000ha of ground (Moons *et al.* 2000), the global value of soft recreation is estimated at an average of 16.830.000€ per year and 8.415€/ha per year.

ii. Evaluating biodiversity and quality of life

Two valuations groups were organised according to the geographical scope of the 4 municipalities: one in the Walloon region and the other in the Flemish region. People invited to participate at the group valuation were chosen on the basis of the ones interviewed during the social valuation. Group valuations were made up of an average of 8 people, one moderator involved to guide the discussion through general questions and one assistant moderator to take notes.

Featured analysis of the sample

❖ Distribution by origin and workplace

Most participants, either for the Walloon or the Flemish group valuation, live in the area being assessed and/or also worked within the same area

Table III).

Table III: Distribution by origin and workplace

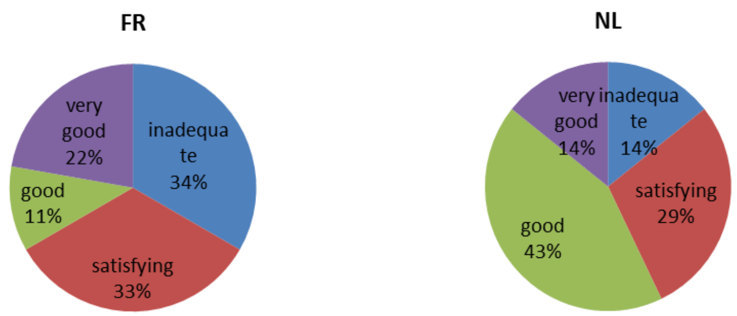
	Lives in…	Works in…
Grez-Doiceau & Beauvechain	89 %	67 %
Oud-Heverlee & Bierbeek	71 %	71 %

❖ **ES as seen by participants**

All participants in both groups considered themselves as direct users of ES. It means that they interact directly with services, e.g. walking in the wood, enjoying scenery views from the landscape …

Regarding the quality and quantity of ES (see Figure 13), Walloon participants estimated it globally poor (77%). Actually, 34% found it inadequate and 33% satisfying while only 33% assess the quality as good or very good. However, participants from the Flemish region determined the quality and quantity of ES as globally good (57%).

Figure 13: The perception of the quality of Ecosystem Services in general



Discussion about the valuation of ES

❖ **Individual questionnaire**

During the first part of the meeting, all participants were asked to answer individually two questionnaires; one concerning the conservation of biodiversity and the other dealing with the quality of life (QoL). From their answers, we obtained their willingness to pay (WTP) for both ES (see Table IV). It highlights that Walloon participants are not willing to pay individually (72.5%) in opposition to Flemish participants which are totally willing to pay individually (86%).

Table IV: Willingness to pay for Ecosystem Services on both sides

Participants WTP for…	FR	VL
Biodiversity	33 %	86 %
Quality of Life	22 %	86 %

❖ **Group discussion – FR**

The facts mentioned during both discussions about both conservation of biodiversity and quality of life were the same. Hence, we choose to analyse the two ES together.

During the discussion, no one took on the lead of the group, which allowed everyone to speak freely. In general, they put forward many arguments against the attribution of a value to ES.

- The economic value of ES is infinite due to all the services given by ecosystems;
- It is not possible to put a value on the "work" of ecosystems; it should be a citizen investment;
- The only people willing to pay are the ones concerned by an emergency situation;
- Using euros is difficult as it is not linear through time;
- Giving money will be useless if it's not properly managed; taxes are not-well managed by politicians for the moment;
- It is difficult to give a price for a feeling, e.g. good quality of life like feeling good in the environment where one's live.;
- They already give all their time working for the protection of ES.

However, after one hour of discussion all together, they were really willing to do something, on the contrary to what they were saying at the beginning. They finally came up to a consensus of 'substitution', i.e. the payment depends on the person: either monetary (0.5% of their monthly wage) or time working force (1 hour per week dedicated to the protection of ecosystem services).

However, they even went further in the discussion referring to the rehabilitation of a 'civil service' aiming at the protection of ES. They also suggested another valuation technique which could be a role-play of ES in which everyone should present what they would be willing to leave to their children such as a nature rich of biodiversity with numerous healthy ES.

- ❖ **Group discussion – NL**

Also in this session, the respondents were not keen to attach a monetary value to the selected ES. Two observations are contrary to the visions expressed by the Walloon respondents:

- During the discussion, Flemish respondents indicated they were against monetizing their contribution. With the Walloon respondents, we noticed the opposite tendencies, i.e. not willing to provide a figure during the individual evaluation, but during the deliberate discussion an agreement was reached on a minimal contribution;
- The Flemish respondents considered nature and landscape management, on the one hand, and creation of a good place to live, on the other (and additionally to other ES, also), as being public goods that should be managed by public bodies, using tax money. Some respondents were even suggesting they were willing to contribute with extra taxes, provided this creates a better living environment (in a broad sense). This is in contrast with the Walloon respondents, who were explicitly against (extra) taxes.

- ❖ **Resulting valuation**

While it is difficult to obtain a monetary value from group deliberation, we obtain the monetary value of 0.5% of their monthly wage or 1hour of work per week.

Conclusion

Most ES cannot be associated with market prices. Therefore, two indirect measurement techniques have been selected for the economic valuation: [1] revealed preferences, with travelling cost estimates, and [2] deliberative valuation, with focus group discussion and deliberation.

While the technique of travel costs has demonstrated good results, it is time-consuming. The method remains commonly used and based on stated preferences valuation which relies on individual preferences to construct social values. In order to discard its potential pitfalls, we insist on the importance of deliberative methods in which techniques assume social individuals.

Environmental economics literature is pleading for the use of deliberative valuation techniques to monetize public goods, instead of using economical quantitative techniques. However, respondents participating in our workshops were unanimously not supporting monetizing nature and ES, which is in line with critics against monetizing nature raised by some scholars.

The global value of soft recreation is estimated at an average of 16.830.000€ per year and 8415€/ha per year. The values of biodiversity and quality of life are both estimated at 0.5% of someone's monthly wage or one hour per week of someone's time spent in working for nature conservation and enhancing natural and semi-natural areas.

2.2 INTEGRATING ECOSYSTEM SERVICES DIMENSIONS

As Steffen (2009) argues, without improved knowledge of the dynamics of socio-ecological systems, it is almost impossible to design appropriate management tools or even the adaptive intervention experiments needed to inform policy and management. Therefore, it is crucial to bring altogether the knowledge gathered in the social, biophysical and economic valuations.

With the social valuation we identified through face-to-face interviews the owners and beneficiaries of ecological functions that actually deliver services, which are then valued within their social and decisional contexts. With the biophysical valuation we modelled the flows between ecological functions that actually deliver services, in order to identify the relationships between ES and the land use. With the economic valuation we indirectly estimated the prices of specific ES benefits through revealed preferences and groups deliberation.

a. Translating the Values of Ecosystem Services into Indicators

The social, biophysical and economic values are compiled into one integrated table (Table V), allowing identifying the ES of crucial importance to the local community that can be scientifically measured along either one or both of the other pillars, biophysics and economics. This integration should sketch out a holistic picture of the socio-ecological system studied, emphasizing the "human-in-the-environment" perspective that the Ecosystems Approach promotes (MA 2005; Rounsevell *et al.* 2010; Haines-Young and Potschin 2010). The aim is not to define a common artificial unit but to allow focusing on the conflicts and trade-offs between services, with respect to their providers and beneficiaries.

As an example, let us consider the ES 'protection against floods'. It is ranked first in the social valuation and has an average score of 1.7. Both the rank and the score can be considered and used as indicators of the social importance of this ES in the study area. From the biophysical valuation, we obtain information about run-off and soil water saturation (in mm/day and % of saturation respectively). These outputs can be turned into one qualitative indicator of the capacity of a parcel to retain water (e.g. high capacity; medium capacity; low capacity), which are aggregated at the scale of the river Dyle's catchment within the study area. 'Protection against floods' could have been valued economically with a method based on revealed preferences through insurance premiums that are correlated to the risk of floods. The added cost paid by households living in a floods prone area could be aggregated for the whole study area. Unfortunately, these data are sensitive and access has not been granted so far. Alternatively, a proxy measure could be based on flood hazard delineation. This approach requires combining information on terrain elevation and water run-offs with and without current land use, in order to produce two maps of 'average' floods levels. The spatial difference between both maps crossed with currently urbanised areas would return a proxy measure of the avoided damages. Nonetheless, this method requires too much resource, especially for run-off alternatives modelling with the DVM and for validating results.

Table V: Integration social, biophysical, and economic valuation of Ecosystem Services.

	Social Valuation		Biophysical Valuation		Economic Valuation	
Ecosystem Services investigated	**rank**	**average score**	**DVM output**	**measurement**	**Type of valuation**	**Method of valuation**
Protection against floods	1	1.7	Run-off, soil water amount	qualitative levels		
Conservation of typical local species	2	1.69			Stated preferences	Discourse-based valuation
Soft recreation	3	1.68			Revealed preferences	Travel cost method
Good place to live	4	1.66			Stated preferences	Discourse-based valuation
Aesthetics/Artistic inspiration	5	1.59				
Food/Fodder	6	1.58	Crop productivity	Crop yield (T/ha/yr)		
Education/Learning	7	1.58				
Protection against erosion	8	1.51	Run-off, vegetation type	Soil loss (T/ha/yr)		
Habitats for plant and animal species	9	1.49				
Pollinisation	10	1.38				
Therapeutic/relaxation	11	1.3				
Opportunities for scientific research	12	1.26				
Employement in nature/landscape management	13	1.24				
Natural water purification	14	1.24	Run-off	qualitative levels		
Sense of place	15	1.2				
Employment in agriculture	16	1.18				
Social relations	17	1.11				
Natural Air purification	18	1.08				
Historical landscape	19	0.99				
Regional products	20	0.99	Productivity	T/ha/yr		
Climate regulation	21	0.93				
Real estate	22	0.89				
Carbon storage	23	0.86	Ecosystem CO_2 exchange	gC/m²		
Wood production	24	0.78	Productivity & forest area	m³/ha/yr		
Employement in recreation/tourism	25	0.61				
Protection against noise	26	0.57				
Spirituality	27	0.54				
Regulating pests and diseases	28	0.22				
Berry/Plant picking	29	0.18	Shrubs productivity	T/ha/yr		
Biofuel	30	-0.15	Productivity & GDD5	T/ha/yr		
Hunting	31	-0.81				
Hard recreation	32	-0.95				

b. Spatial dimension: identifying current trade-offs and synergies

As can be gathered from the above example, ES may have different values and indicators depending on the level at which they are assessed. The geographical dimension of ES valuation complexity should therefore be taken into account. The challenge is to adequately match LU and ES with considerations for both their respective spatial extent (what is the scale to be used for identifying each ES) and their many-to-many relationships (one LU can contribute to several ES; one ES may relate to several LU). As an illustration, let's consider a small strip of land along an agricultural field covered with grass.

1) Standing alone, the parcel offers a niche for plants and animal species in a specific spot. Therefore, that particular LU may contribute, at the scale of the parcel, to the ES "Conservation of typical local species" (high social and environmental values; ranked second in Table V);
2) In combination with a variety of other LU applied to other parcels in the larger vicinity, the grass strip enhances the viewpoint scenery, at the scale of the landscape. Therefore, this combination of LU contributes to the ES "Landscape Aesthetics" (high social value; 5th in Table V);
3) Likewise, for the same combination of parcels and/or in combination with other agro-environmental measures (AEM) applied to the neighbouring parcels, the grass strip may contribute to water run-off mitigation, relating to the "Protection Against Floods" ES at the scale of a river catchment (high social and economic values; ranked first in Table V);
4) The grass strip may also be part of the ecological network of the entire case study area, provided it is well distributed amongst the other (semi-)natural land patches. Therefore, it may also contribute, at the scale of the community, to the ES: "Habitats for plant and animal species" (high environmental value; 9th in Table V).

In consequence, the contribution of different LU to the values of ES greatly depends on the spatial level(s) of the service: parcel, local neighbourhood, river catchment …

This can be illustrated with the third part of the interviews conducted during the social valuation. The *Map prompting* involved asking respondents where are the most important ES located in the municipality he/she lives. This mapping exercise gives more insight on the effective use of the environment by the interviewees. During the interviews, most respondents mentioned potential synergies or conflicts between different services and/or with urbanisation.

In a nutshell, the accumulated attention is put over the Meeedaalwoud area (Figure 14). Interestingly enough, the French-speaking respondents refers to the Meeedaalwoud as one large patch mainly offering recreation ES and habitat for local species ES. Conversely, the Dutch-speaking respondents were more selective on the spatial extent of ES provision they considered (see the number of subdivisions in Figure 15b), but the most cited ES were identical to the French-speaking respondents. Regarding conflicts and synergies (Figure 16), the most cited threat for ES provisioning is, as one would expect, urbanisation whilst ES positive interactions are seen to be within the leased dense area, most of them being protected to some level. Overall, it is important to stress that ES location almost never occurs within urbanised areas (to the exception of a few, amongst the smallest ones). This suggests that ecosystems present within villages are not seen by respondents as ES providers.

We believe the graphic synthesis is a crucial tool when performing participatory research because stakeholders can picture more easily the theoretical implications of such LU over such ES and express their own knowledge within the same communication framework (see section 2.3, page 62). The comparison of different views will help gaining insights. Moreover, when applied to a case study area, LU location in a landscape allows a spatial analysis of these values (concentration, dispersion, neighbourhood effects…).

Figure 14: Number of time a patch has been cited for provisioning one ES.

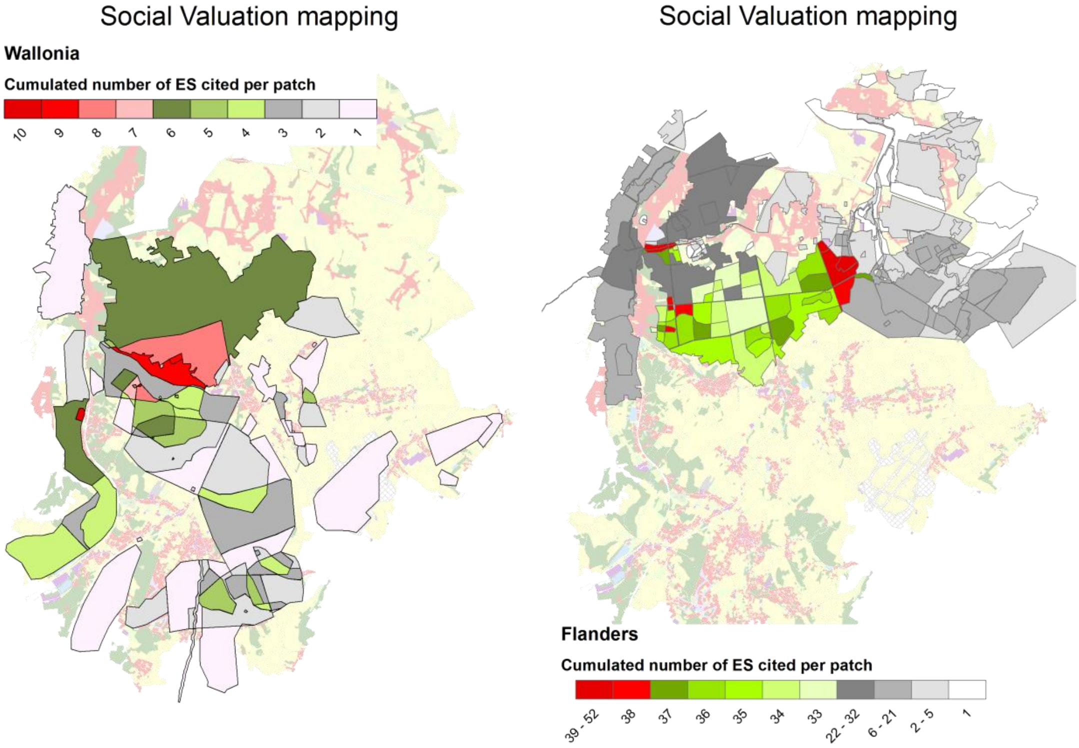


Figure 15: most popular ES per zone.

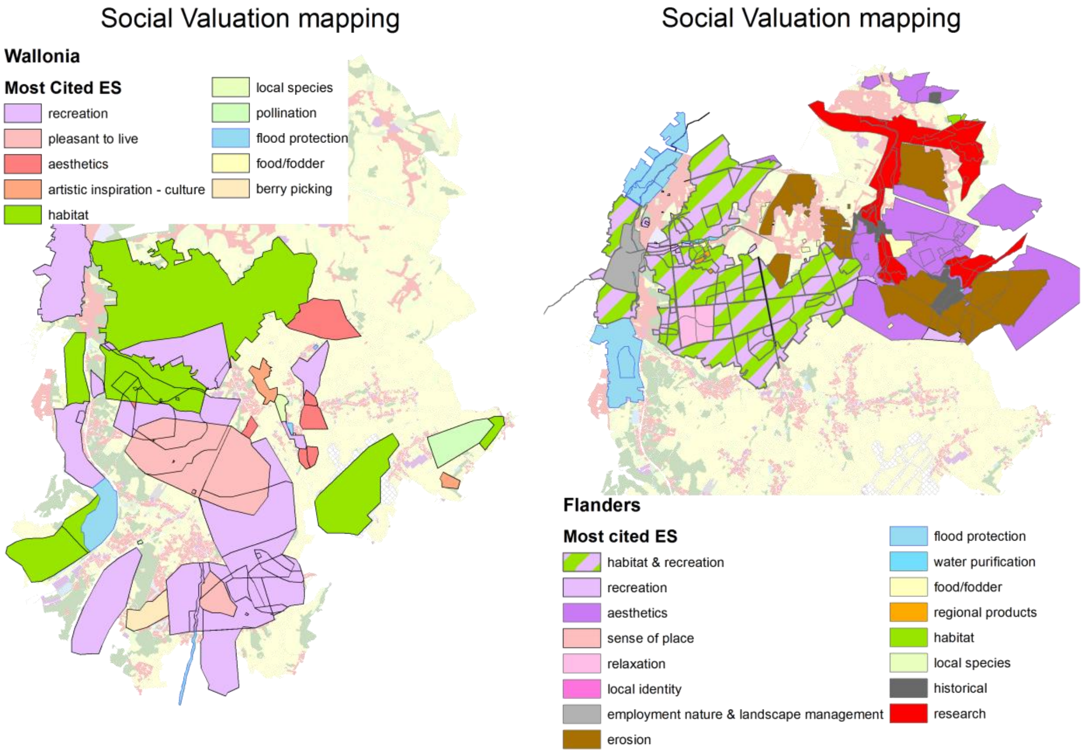
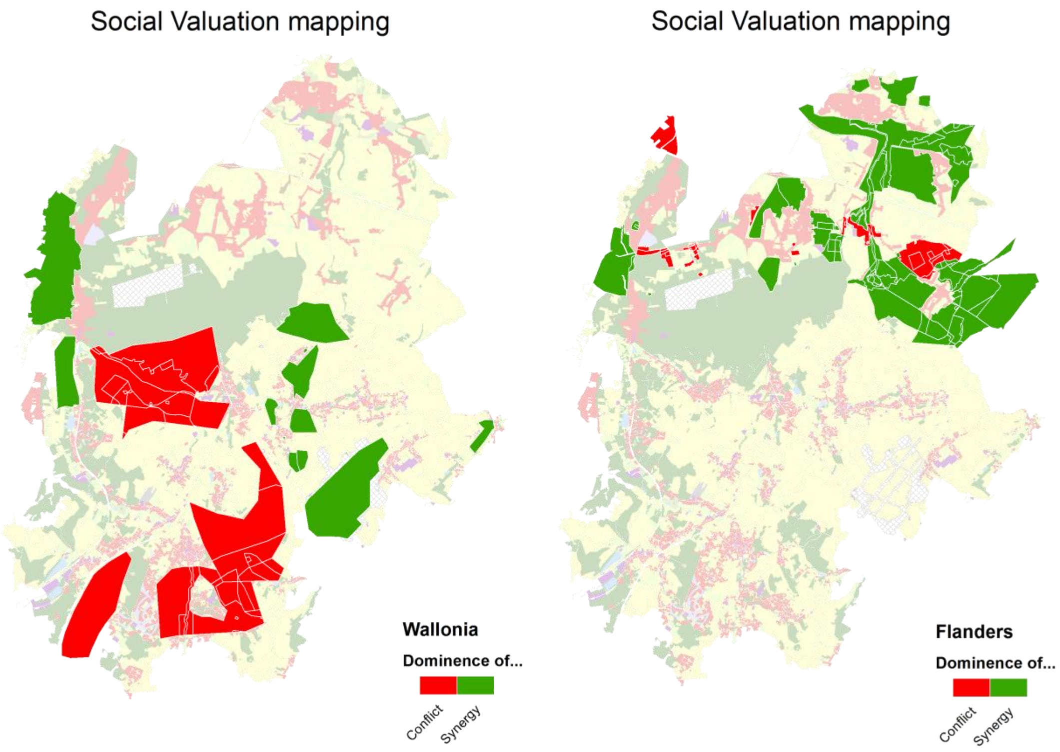


Figure 16: zones where conflicts and synergies have been identified.



c. Temporal dimension of ecosystems services

In order to measure future states of the landscape, i.e. changes in ES provision resulting from potential land use changes, we need a dynamic model. This is an important component of the VOTES framework as it is the spatially explicit depiction of alternative land use features (Cowling *et al.* 2008). Dynamic models have the advantage of not only providing a description of key ecosystem units and functions, but also of depicting their interactions in space and time. These models describe the interactions between land use, climate and environmental changes to project their combined impacts on ecosystems structure and functions under given scenarios for the future.

Ecological value of ES is closely linked to sustainability. The use of these services should indeed be limited to sustainable use levels to guarantee their continued availability (de Groot *et al.* 2002). These sustainable use levels should be evaluated within a complex system framework (Limburg *et al.* 2002), i.e. by taking into account the interactions between ecosystem functions, which requires a dynamical representation of the ecosystems and the social systems (Boumans *et al.* 2002).

In that context, 'land use' refers to both the vegetation cover and the techniques managing that cover. Therefore, the modelling exercise does not only imply the identification of the biophysical processes driving the cover dynamics but it also requires information about the socio-economic context in which land management decisions are made, especially regarding farming activities.

Methods

In order to do so, we combine the CARAIB DVM (used for the biophysical valuation), accounting for the evolution of the natural environment, with a spatial Agent-Based Model

(ABM), representing the societal and spatial components of the complex system under study (after Murray-Rust *et al.* 2011). This emerging technique in geocomputation allows capturing systems dynamics, complexity and properties that can lead to multiple, interacting and conflicting processes, self-organisation and emergence (amongst many others: Bousquet and Le Page 2004, Gilbert and Bankes 2002, Parker *et al.* 2003, Phan and Amblard 2007).

Running the couple DVM-ABM simulator for a recent period of the past allowed for its calibration and to produce maps of the current situation in terms of land use, land cover and ES locations and values (see subsection 2.1b, Biophysical valuation, page 28). Likewise, simulations under different scenarios, which depict distinct policy contexts and broader-scale socio-economic implications, will provide information on potentially new spatial distributions of ES. These changes over time allow updating the set of indicators for defined time steps (e.g. every 10 years) and for each scenario. Moreover, vectors of change (of indicator values) can be drawn when for instance an agricultural parcel is converted into a residential area, or when a farmer decides to convert practice from 'intensive' to 'organic farming' with more AEM.

i. Scenarios

Socio-economic storylines

The three storylines depict different pictures of possible future developments. Nevertheless, we assume for all three of them that Belgium and thus the case study will develop along a line that approaches European standards (after EU-funded ECOCHANGE project, adapted from the classical SRES storylines [Nakicenovic *et al.* 2000]).

❖ **BAMBU (business as usual)**

Brabant-Wallon seeks to realize the potential synergies between economic development and protection of the environment through organic and less intensive agriculture, the protection of nature and through supporting clean businesses and service sectors in the region. Although concentrating on less intensive agriculture in general, there are still big farms with intensive agriculture exporting to national and international markets. In general the region developed well. Welfare remains on a high level. People are well educated, the unemployment rate is low. The people mostly work in the Brussels area and accept the daily commuting (mainly by public transport), as this allows them to live in peri-urban area close to nature for recreation. Such areas have been further elaborated. People are aware of on-going global changes, are willing to contribute to their solution, mainly through economic instruments and technological progress.

❖ **GRAS (market oriented)**

As the general developments in the EU in 2050 are oriented towards more liberalisation and loss of power of the influential institutions, the development of Brabant-Wallon in the last decades was accordingly shaped by the diminishing importance of the big institutions of Brussels. Despite this loss, the region managed to continue playing an important role on the international market, as many headquarters of big corporations remained located in Brussels. Thus, Brussels and its adjacent regions profited from growing economic liberalism and deregulation and remained wealthy.

❖ **SEDG (sustainable development)**

Brabant-Wallon 2050 is shaped by a general belief in sustainable development and a change towards the latter. People are convinced that their way of life matters for people around the world and that they carry a part of the responsibility to improve people's quality of life. The area remains wealthy and well-educated but is not driven by economic growth and income increase. People enjoy the opportunities they have, starting from recreation over supplies of organic and fair trade products to an enhanced citizen integration and empowerment.

Climate scenarios

The climate projections used when running the CARAIB DVM come from the ARPEGE-Climat model (Gibelin and Déqué 2003; Salas y Mélia et al. 2005). Simulations were built for the period 1950-2050, under the A2, A1B and B1 SRES scenarios of the IPCC (Nakicenovic *et al.* 2000), respectively matching the GRASS, BAMBU and SEDG socio-economic storylines described above.

For all the meteorological variables (minimum and maximum air temperature, precipitation, percentage of sunshine hours, air relative humidity and wind speed), we calculated the anomalies in the ARPEGE-Climat simulations between any given month (past or future) and the average monthly values for the reference period 1985-2008. These anomalies were then interpolated over the study area and combined with the monthly averages of the Beauvechain meteorological data to provide monthly time series for 1950-2050 for all SRES scenarios simulated by ARPEGE-Climat. The DVM was run over the years 1985 to 2050 in transient mode using these climatic scenarios as inputs.

ii. Land use dynamics

The societal and spatial components of the complex system under study are modelled with an Agent-Based Model. In a nutshell, the simulator considers all farmers independently. Every time a rotation ends on one of his/her parcel, s/he takes a decision on the next crop rotation to apply, considering his/her economic situation, his/her sensitivity to environmental and social impacts of the available crops and expected returns from growing the crop rotation. His/her actual returns are a modulation of price evolution (essentially scenario based) and effective vegetation growth (as simulated with CARAIB). More details can be found in Murray-Rust *et al.* (2011). In addition, a certain amount of agricultural surface is claimed by urbanisation every year and removed from farmer access.

A number of quantitative variables and thresholds are derived from the qualitative information contained in the scenario storylines (e.g. farmers are more willing to adopt organic production, because of a positive societal feedback, besides crop prices, in the SEDG scerario). These include: [1] farmer typologies (i.e. the behavioural responses of farmers based on interviews in the case study area), [2] economic trends (i.e. crop prices evolution) and [3] societal changes (i.e. keeping/removing subsidies, technologies influence, farming management strategies, people concern for landscape conservation …).

Baseline data are derived from existing land use maps, crop rotation databases, global market prices (including FAO figures), farmers' interviews and scientific literature (e.g. Abiltrup *et al.* 2006). A specific attention has also been put on urban sprawl data because of the specific situation of the case study area.

iii. Dynamic Vegetation Modelling

Therefore, the range of the DVM primary inputs is extended for including socio-economic and environmental changes described in the explored scenarios (e.g. new agricultural practices and milder climatic conditions). Then, the ABM simulates spatially and dynamically land use change resulting from agents' behaviours and land management choices as a response to these socio-economic and environmental changes. Finally, the biophysical indicators are re-evaluated per scenario in light of these dynamic changes.

Results

The projection of vegetation growth is made for a time horizon of 2050, with intermediate results for every decade between 2000 and 2050. Valuation of ES is achieved through the use of indicators, which can be evaluated from the outputs of joint simulations of the DVM and ABM under the selected climate change and storyline scenarios. The biophysical valuation focuses on the same subset of ES used for assessing the current values, i.e. protection against flood (rank 1 in social survey), food/fodder (rank 8), protection against erosion (rank 10), natural water purification (rank 16), carbon storage (rank 25), wood production (rank 26), and biofuels (rank 32).

Two different set of maps of the biophysical indicators evolution are analysed: [1] under climate change only (off-line DVM simulations) and [2] under combined climate and land use change (DVM-ABM integrated results).

i. Future evolution of ES under climate change

Under prescribed environmental changes corresponding to the climatic scenario A2 and associated increase of the atmospheric CO_2 concentration, we can already observe a strong response of the various ES indicators between 1991-2000 and 2041-2050 (Figure 17).

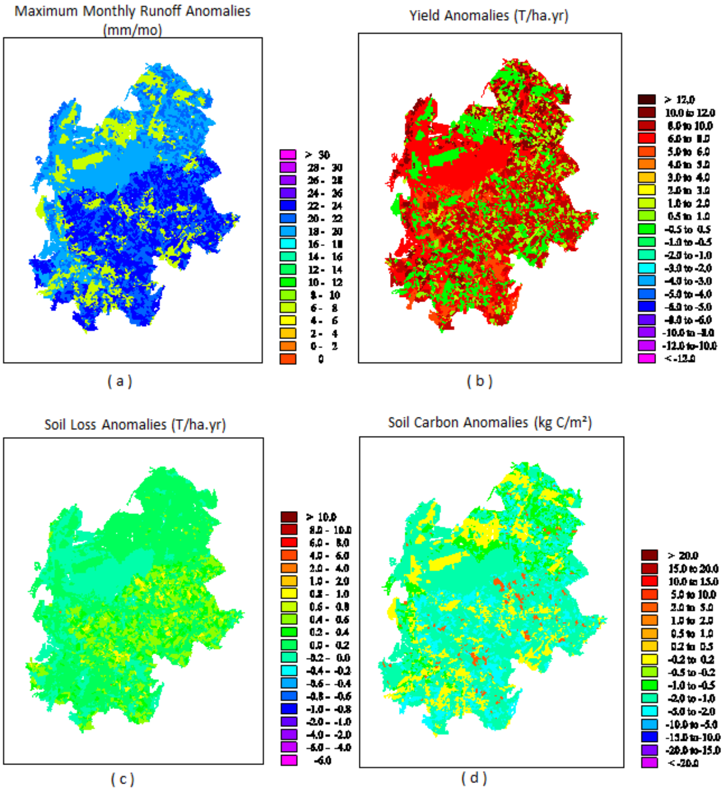
Maximum monthly run-off increases evenly over the study area, with typical increase of 10 to 20 mm. Its cumulated value over the study area can thus be expected to increase significantly from the present to the future in response to climate change.

This implies a significant impact over water quality and a higher risk of floods in the area. In terms of land use, we can easily understand the role of the forest, which exhibits a lower run-off increase compared to the agricultural part of our case study. The same trend can be observed on the map of soil loss anomalies (Figure 17b), where the forest, natural and pasture areas lead to smaller soil loss anomalies compared to croplands. The difference due to land use and land cover is less marked for soil carbon (Figure 17d) than for other ES indicators, even if, once again, natural areas can be identified. An overall trend to soil carbon reduction is indeed observed in response to climate warming which favours CO_2 release from soil heterotrophic respiration.

Regarding absolute yield and wood production anomalies in $T.ha.yr^{-1}$ (Figure 8b), crops seem to be less influenced by the environmental changes than forest areas. However, relative increases are similar: for wood production, the area shows a gain of approximately 11% compared to the present, while crop yields increase on average by only 10% (both values being for the 2041-2050 period, relative to 1991-2000). This increase is presumably the result of the CO2 fertilization effect. This increase in productivity is not large enough to compensate for the increase in soil heterotrophic respiration, so that there is a net reduction of carbon sequestration over the whole area.

In conclusion of this preliminary step, we can identify a non-negligible impact of climate change on the ES provision in the study area.

Figure 17: Maps of the anomalies (2041-2050, compared to 1991-2000) of each ES indicators under climate scenario A2 (IPCC). Land use and land cover are assumed constant with respect to the current situation.



ii. Future evolution of ES under combined climate and land use change

The final aim of the project is to obtain integrated results, where the impacts of climate and land use changes are combined under a given socio-economic storyline. The methodology developed for this last step is made of a joint application of the DVM and the ABM. First, the expected changes in ES indicators in response to environmental changes, which are direct/indirect outputs of the CARAIB DVM, are introduced as inputs into the ABM. The agents defined in the ABM react to these environmental changes as well as to pressures exerted by changes in the socio-economic context defined by the storyline. The result of these agent reactions is a change in land use and/or land cover. This allows a mapping of the changes in ES indicators, which takes both environmental (climate, CO_2) and land use/cover changes into account.

Land use change: Urban sprawl & future farming practices

The surfaces available for building further residential and other dwellings are identical for all three scenarios. They correspond to the areas indicated as such in official zoning maps (see Figure 18). However, the yearly rate of urbanization has been adapted according to the scenario storylines so current trends of urban growth apply to BAMBU, with a higher and lower shift for GRAS and SEDG respectively.

Through simulations, the remaining agricultural land is managed according to the scenario storylines with quite distinct variations of the rotation applied observed. For example, monocropping was allowed under BAMBU scenario but banned under SEDG (see Figure 19). As a result, the diversity of the landscape, i.e. the number of different crop types observed at one moment in time, is much higher under SEDG (see Figure 20). This is a partial consequence of more farmers enrolling for organic production (see Figure 21).

Figure 18: Current state of urban areas in the four municipalities, by age of building and remaining areas available for further building expansion

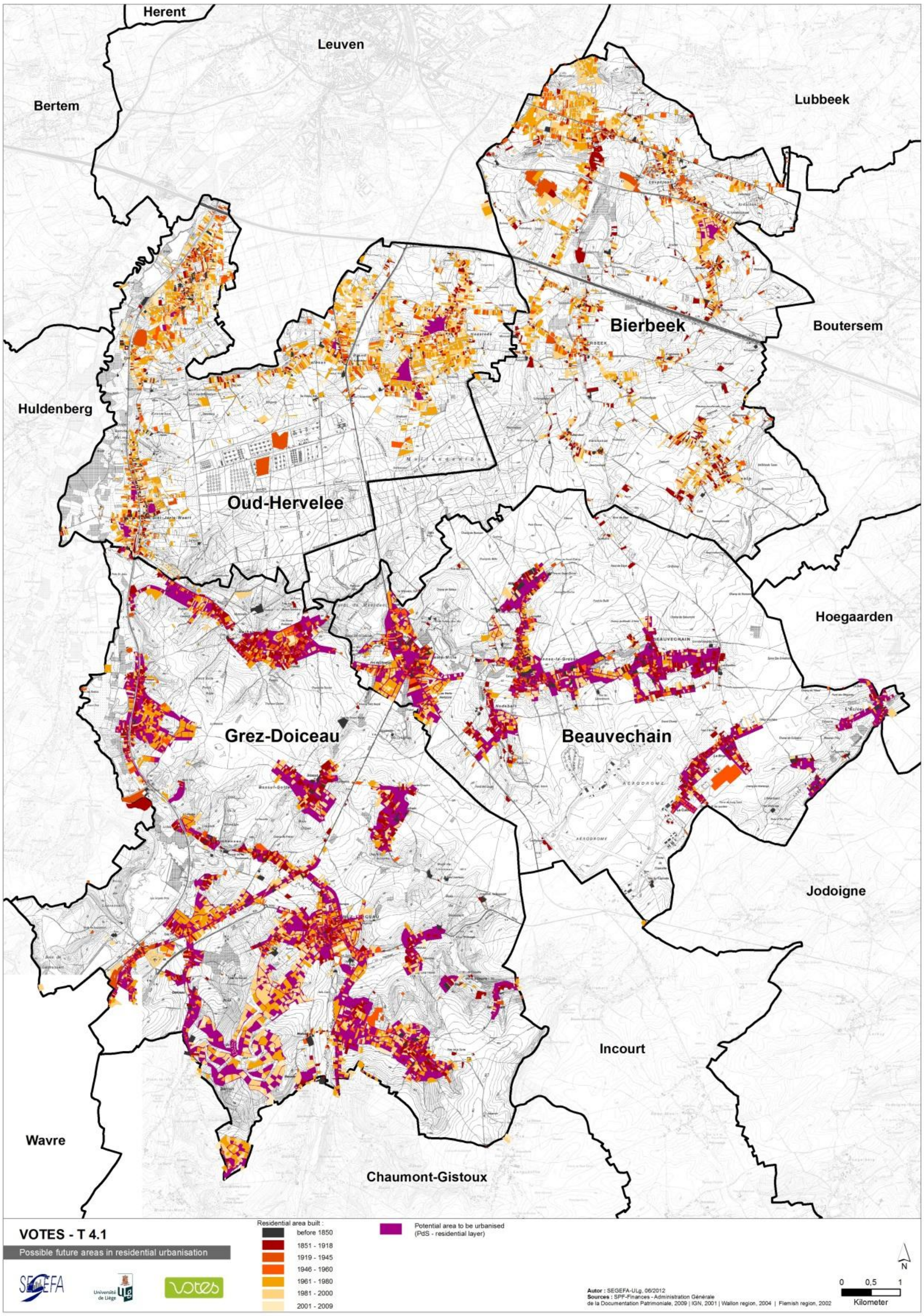


Figure 19: Landscape change between todays' distribution and simulated management practices in 2050, under two scenarios: business as usual (BAMBU) and sustainable development (SEDG)

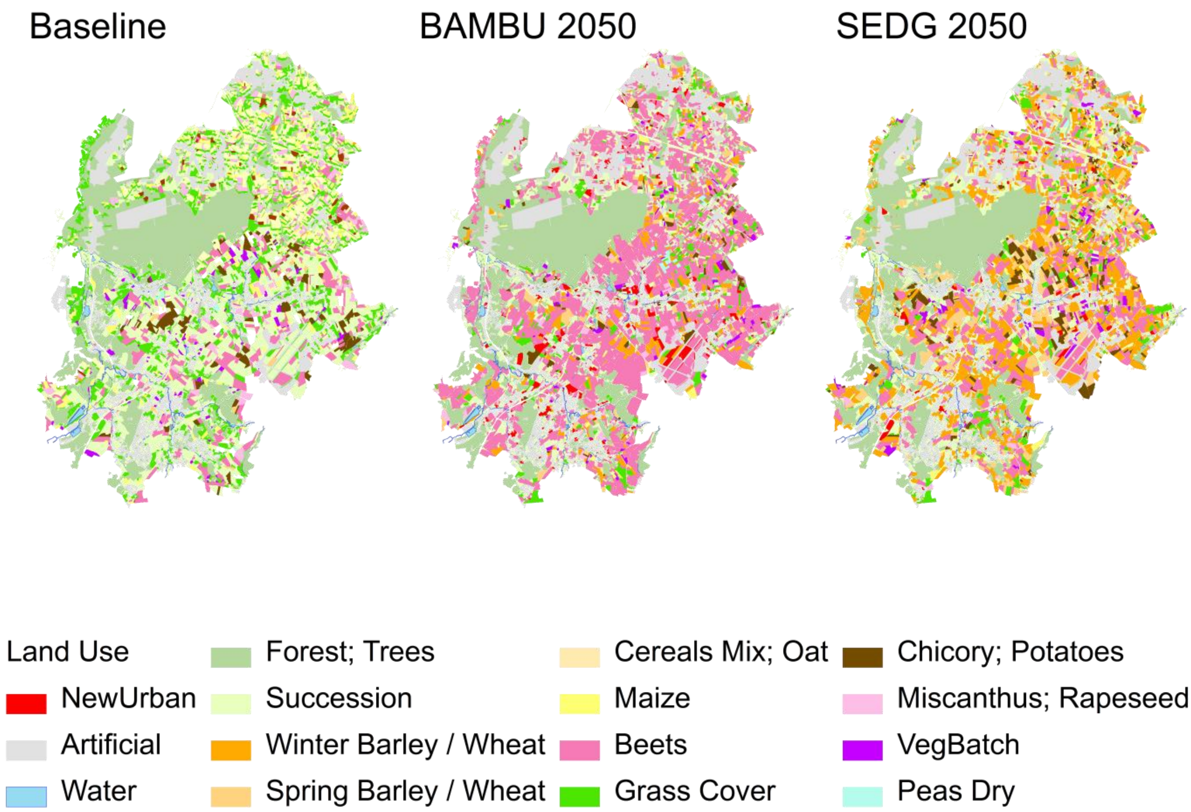


Figure 20: the "diversity" indicator at baseline and under two scenarios: business as usual (BAMBU) and sustainable development (SEDG)

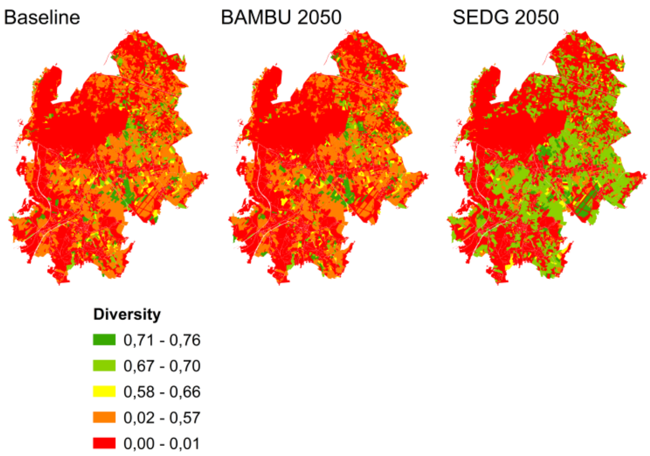
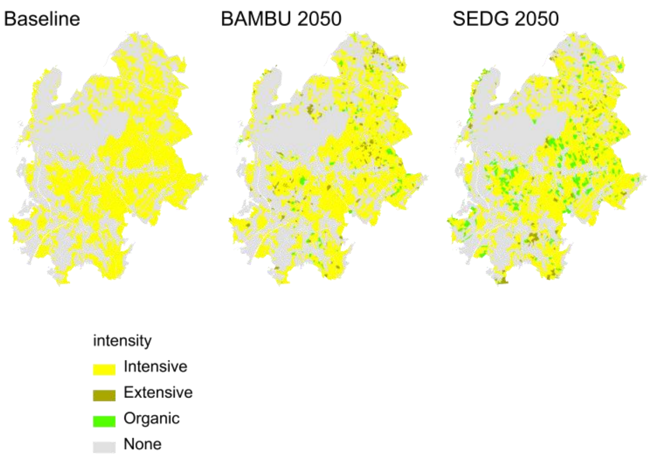


Figure 21: The management orientation at baseline and under two scenarios: business as usual (BAMBU) and sustainable development (SEDG)



Evolution of ES

The three scenarios suggest different response of land use in the study area. On the whole, they show different responses in term of urbanized and forest areas. According to the SEDG scenario, urbanized area experiences a smaller increase (in comparison with the current land use) than the one experienced under the GRAS scenario (but not in terms of number of plot of land). On the other hand, areas dedicated to forests or trees increase slightly under the land use change calculated for the SEDG scenario, but they also increase in the results for the GRAS scenario and the increase is even larger than for SEDG. So, land use changes with respect to current land use map are more important under the GRAS scenario.

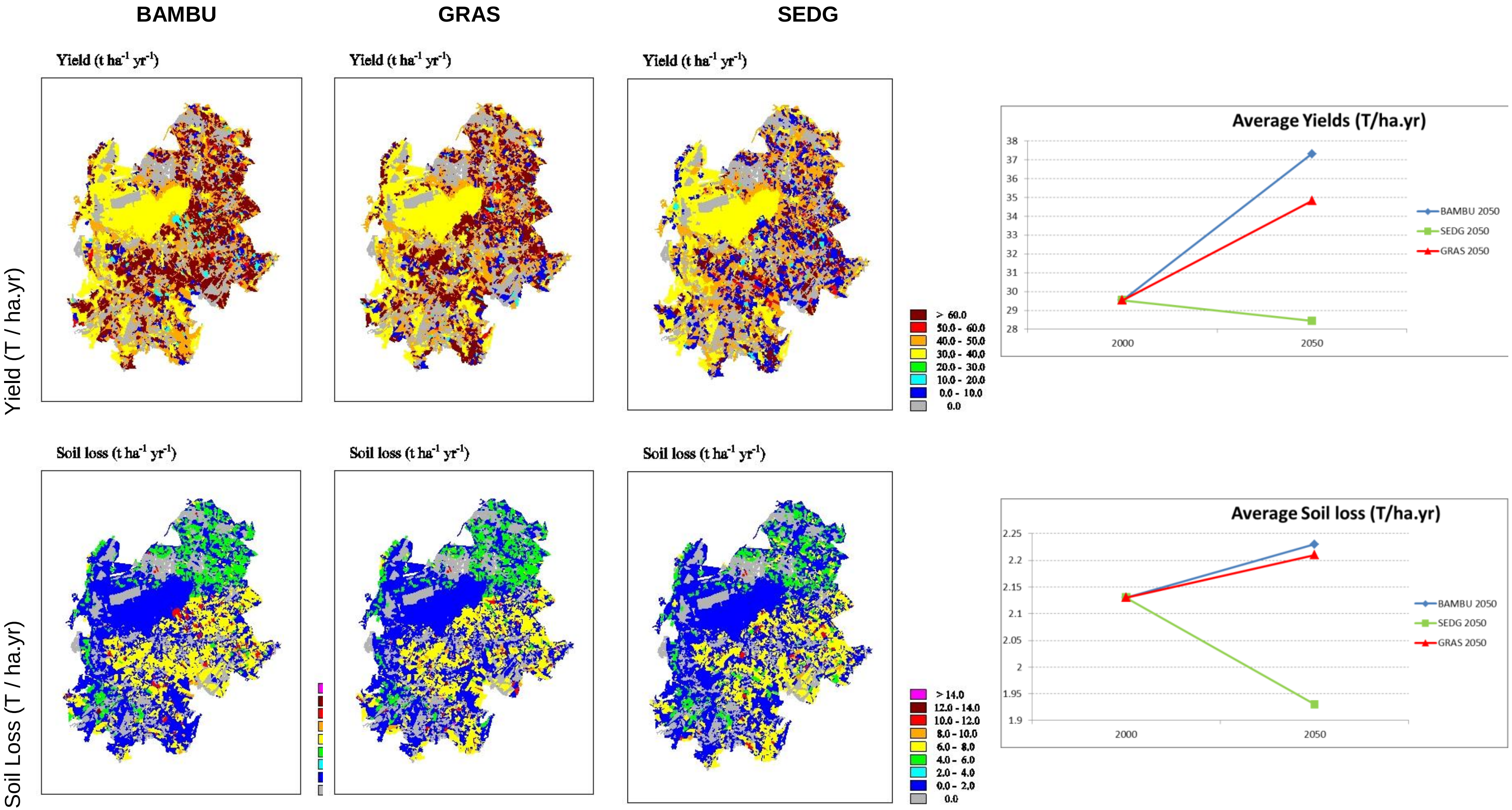
These changes will have an impact on the provision of different ecosystem services. Directly affected by land use changes, the crops and forests productivity show some important variations (Figure 22a-b-c). At the end of the period, a well-marked increasing trend can be observed for the cropping of sugar beets (and grass cover) under BAMBU and GRAS scenarios while the third scenario favoured a mix between cereals, sugar beets and grass cover. This last choice explains the important decrease observed under SEDG scenario for the cumulated crop yield over the entire area (Figure 23a) and, probably, the larger variability of the results. Changes in the land cover type has well-marked effects on the cumulative yield of forests and trees over the area, due to the combination of an increased yield under environmental changes (CO_2 fertilisation combined with lengthening of growing season) and an increasing trend of forest/tree areas under socio-economic changes (Figure 10b).

Regarding biofuel production (evaluated through the yield of rapeseed crops), no long-term trend is observed for all scenarios, but strong (almost) cyclic variations are present between 2010 and 2050 (Figure 23c), due to the varying number of rapeseed plots associated with crop rotation.

Another important ES estimated here is carbon storage into the soil. Like for other ES, we can highlight a strong impact of the land cover type on the distribution of its indicator values (Figure 22g-h-i). During the concerned period, cumulative soil carbon stock decreases, indicative of a more important release of CO_2 into the atmosphere, with worse results for SEDG scenario (Figure 10d). According to BAMBU scenario, decrease is less marked than for the other two scenarios, probably as a response to the expansion of forests and trees areas, which allows a larger storage of carbon into the soil and partially compensates for the overall decrease due to enhanced soil heterotrophic respiration.

As a result of the changes in run-off (Figure 22j-k-l & 10f) and land cover, soil loss exhibits globally a small decrease (Figure 22d-e-f & 10e), with a positive impact of the land cover changes under the SEDG scenario.

Figure 22: Maps of the absolute values (2050) for some selected ES indicators and their average change.



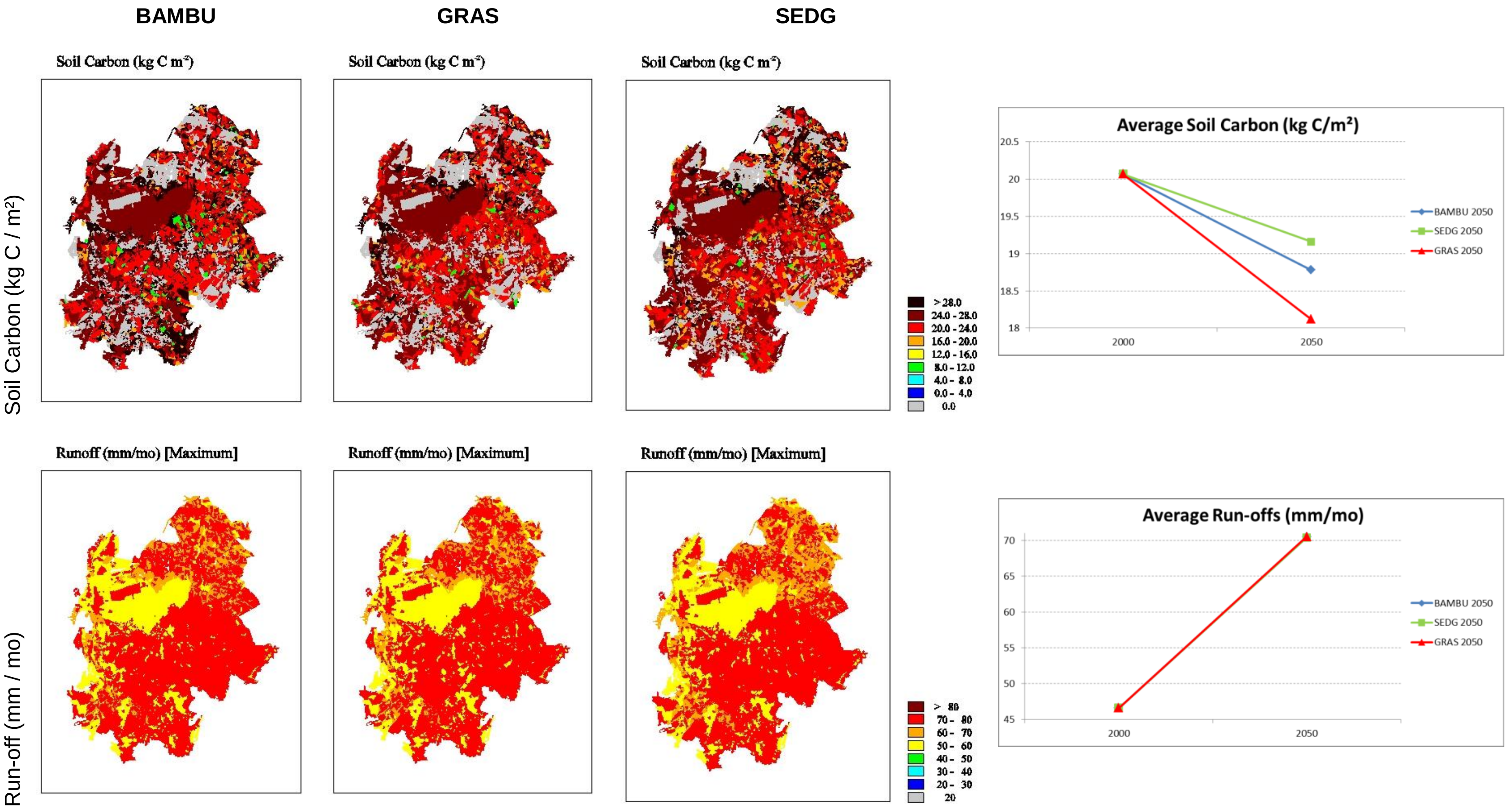
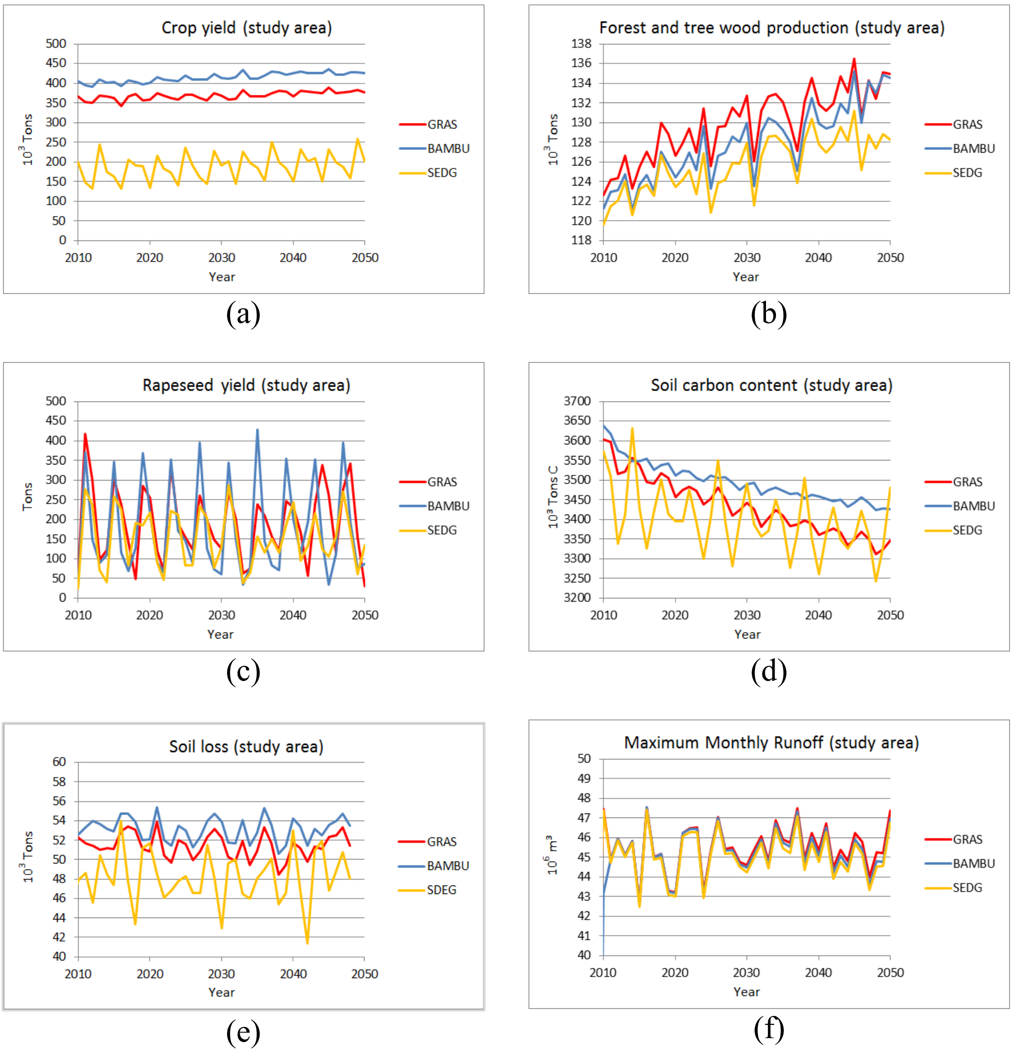
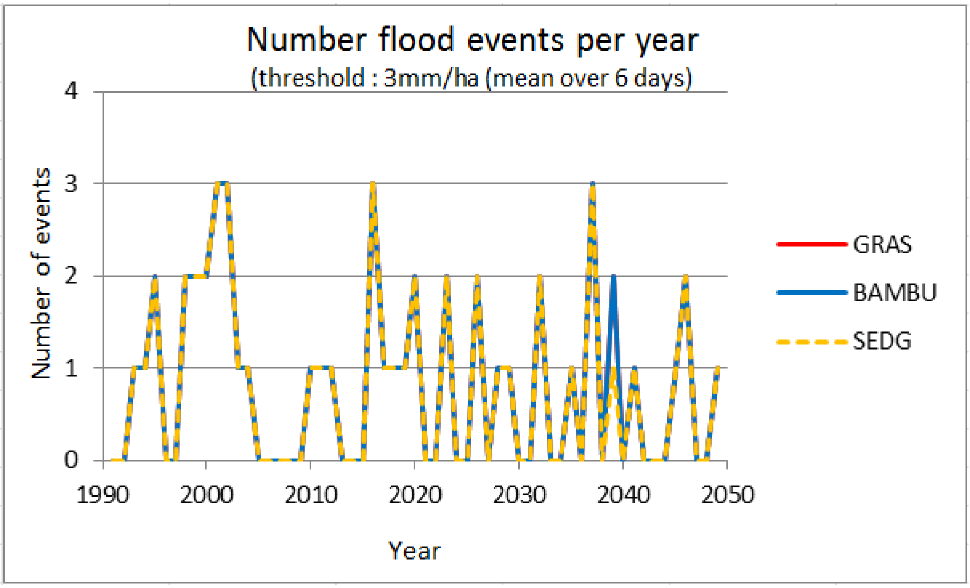

BAMBU
GRAS
SEDG
Soil Carbon (kg C / m²)
Soil Carbon (kg C m⁻²)
Soil Carbon (kg C m⁻²)
Soil Carbon (kg C m⁻²)
> 28.0
24.0 - 28.0
20.0 - 24.0
16.0 - 20.0
12.0 - 16.0
8.0 - 12.0
4.0 - 8.0
0.0 - 4.0
0.0
Average Soil Carbon (kg C/m²)
20.5
20
19.5
19
18.5
18
2000
2050
BAMBU 2050
SEDG 2050
GRAS 2050
Run-off (mm / mo)
Runoff (mm/mo) [Maximum]
Runoff (mm/mo) [Maximum]
Runoff (mm/mo) [Maximum]
> 80
70 - 80
60 - 70
50 - 60
40 - 50
30 - 40
20 - 30
20
Average Run-offs (mm/mo)
70
65
60
55
50
45
2000
2050
BAMBU 2050
SEDG 2050
GRAS 2050

Figure 23: Graphs of indicator evolution for some ecosystem services (cumulative values for the study area): crop yield (a), forest and tree wood production (b), rapeseed yield (c), soil carbon content (d), soil loss (e), number of high run-off events (f).



To answer the question of the protection against flood, we associated floods observed in the four municipalities and the nearby areas with the run-off (Figure 22j-k-l) of the area calculated by the model for the same period. This procedure allowed to fix a threshold on daily run-off (or more precisely a 6-day running mean of daily run-off) above which a flood is obtained (Figure 24). Using this threshold on daily run-off in the model allows the calculation of the average number of floods per year and its evolution into the future for the three scenarios. The results show no significant increase of the average number of flood events over time, although floods seem to be more recurrent near the end of the simulated period. As previously mentioned, the land use change is critical through increasing urbanized and forested areas which may result in a balance between the well-marked run-off peaks of the constructed areas and the low run-off of the forests. However, there is no major difference between the three scenarios in terms of projected number of flood events, probably because of a compensation of the increase of urbanized areas by an increase of the forest areas in the studied scenarios (see above).

Figure 24: Graphs of the number of flood events



2.3 PARTICIPATORY LAND USE MANAGEMENT FOR SUSTAINABLE ECOSYSTEM SERVICES

The valuation results, set of indicators, graphs and maps of LUC (i.e. communication tools) were presented to stakeholders during the course of a workshop, organised for gathering every person interviewed plus any other local people interested by the subject.

Results were presented for the state of existing ES in the case study area and their current estimated values. The aim of this plenary was to confront, at the scale of the area, the "scientific picture" of current ES to the "societal picture" held by the participants. Subsequently, a group discussion amongst stakeholders was set up in order to debate upon potential conflict zones such as AEM requests, afforestation/deforestation schemes, river corridor plans and residential development projects. The discussion focused on evaluating the results relating to the SEDG scenario, in comparison to the BAMBU's. Possibly, other appropriate visualization techniques, such as cards synthesizing the main outcomes, could have been used.

The final aim was to discuss potential win-win-win situations (i.e. in economic, environmental and social terms) which will recognize both short and long term needs, balance a full portfolio of ES, and increase the resilience of managed landscapes (Foley *et al.* 2006) in order to better picture a sustainable and acceptable scenario for the future of the local community.

Only half of the stakeholders invited were present during the workshops (with more people for the French-speaking one). First, reactions were enthusiastic and well-focused on environmental state and its potential evolution. However, no discussion challenged the way landscape is managed at the moment (i.e. mainly intensive farming of one crop at a time on large parcels). Second, the social valuation mapping was one of the most discussed because the respondents' view of urbanisation being a threat to the conservation of the Meerdaal wood was disconnected to the protected status of the area. Finally, It was suggested that the simulator could better use the legislative prescriptions applying to areas dedicated to future urbanisation.

2.4 POLICY VALUATION: SYNERGIES BETWEEN ECO-SYSTEM SERVICES CONCEPT AND STRATEGIC ENVIRONMENTAL ASSESSMENT

In spite of the growing attention towards ES, mainstreaming in decision-making frameworks regarding land use and land management is still lacking. Indeed, ES valuation remains an elusive concept to non-scientists and to a majority of policy-makers, making any integration of ES valuation tools difficult at this stage. Hence the challenge consists in converting this concept to meaningful measures, which can easily be integrated to current decision-making frameworks.

Thus the need arises to:

- develop a set of practical tools and guidance for the integration of ES valuation into existing (or new) tools for decision making;
- go beyond developing more accurate methodologies to value ecosystems, and also adapt to the needs, demands and constraints decision makers have to deal with in their daily reality.

The range of policy instruments potentially available to mainstream ES is extensive and involves a wide array of stakeholders (e.g. private sector, NGOs, public sector). Some of these instruments already include a number of ES although they are not identified as such (Maes *et al.* 2011). There is no single instrument more appropriate for the integration of ES. Rather, a choice must be made depending on the decision making context, scale of impact, time frame for planning and available resources (e.g. financial capital, human capital).

Several options to mainstream ES have been mentioned in the literature so far:

- New EU directive (RUBICODE);
- Water Framework Directive, Common Agriculture Policy, Natura 2000, Birds Directive;
- REDD+ (World Land Trust, IIED[4], …);
- Impact Assessments, Strategic Environmental Assessments (OECD[5], WRI[6], SENSU[7], MERITE[8]);
- Private standards (FSC[9]);
- Portfolio Screening (RIVM[10]);
- …

a. Ecosystem Services and Strategic Environmental Assessments

Mainstreaming ES into existing policies appears as a cost effective solution (TEEB 2011). Therefore, and for a number of other reasons listed hereafter, our objective for this

[4] International Institute for Environment and Development

[5] Organization for Economic Co-operation and Development

[6] World Resource Institute

[7] Research Group on Strategic Approaches to Environment and Sustainability

[8] MERITE project, Netherlands

[9] Forest Stewardship Council

[10] National Institute for Public Health and the Environment Netherlands

study is to identify potential synergies between ES valuation and Strategic Environmental Assessments (SEA).

SEA is a « *systematic process for evaluating the environmental consequences of proposed policy, plan or programme initiatives in order to ensure they are fully included and appropriately addressed at the earliest appropriate stage of decision making on par with economic and social considerations* » (Sadler and Verheem 1996). It is intended to promote sustainable development by integrating environmental considerations into strategic decision-making for a wide range of actions and development sectors (Lawrence 1997; Treweek *et al.* 2005).

SEA is currently the main tool in Belgium for policy makers to assess environmental impacts of proposed plans and programmes during the decision-making process.

The choice of SEA over SA, or other policy tools mentioned before, was based on previous work and suggestions from the OECD (2008), from Slootweg *et al.* (2010) and TEEB (2011). Cases studied by Slootweg and van Beukering (2008) provide evidence that valuation tools of ES can be easily integrated in the SEA process, providing information much wanted by decision-makers. Moreover, in all cases studied on an international level, valuation of ES resulted in major policy changes or decision-making on strategic plans (Slootweg and van Beukering 2008) illustrating the added value of ES valuation in SEA processes.

Additionally, concentrating the debate on a known instrument would improve the amount and quality of expert input and feedback, which, given the restricted time and resources to carry out this section of the study, was an important aspect as well.

Finally, SEA has several advantages which can greatly enhance ES integration and impact:

- it is already implemented in Flanders and the Wallonia and therefore comes with valuable institutional capacity;
- it covers a wide range of issues (agriculture, forestry, energy, industry, transport, waste & water management …), thus improves potency for impact;
- it (is intended to) relies on the 3 pillars of sustainability which are used throughout the VOTES approach as well;
- it aims at transparency and efficiency in decision making;
- some ES are already routinely used in SEA (Slootweg *et al.* 2010)

About SEA

SEA (EU directive 2001/42/EC) is in force since 2001 and had to be implemented by each member state in 2004. Article 1 of the SEA Directive (2001/42/EC) states that SEA is intended "*to provide for a high level of protection of the environment and to contribute to the integration of environmental considerations into the preparation and adoption of plans and programmes (PP) with a view to promoting sustainable development*". More specifically, its main purpose is to anticipate and mitigate environmentally related impacts of significant spatial developments and of multiple individual projects at an early stage of the (public) decision making process. The latter often entails additional EIA to be carried out in line with SEA.

By elaborating a series of alternative scenarios, the SEA procedure allows to make transparent and best possible trade-offs in particularly complex decision making environments and under high uncertainty. In short, SEA is a set of procedures relating to the provision of information, consultation and preparation of an environmental report and taking findings into account in planning.

According to the directive, SEA requires to go through four key stages: [1] screening, [2] scoping and preparing an environmental report, [3] consultations and [4] information as to adoption. Even so, there is no single formal procedure for SEA since it will need to be adapted to the high diversity of plans and programmes. Nonetheless, an important amount of international good practice guidance exists to assist decision makers and consultants on how to carry out SEA. Table VI gives a more detailed overview of the important stages of an SEA process.

Table VI: Key Stages for the SEA process (adapted from DAC SEA guidelines)

SEA STAGE	ACTION POINTS
Establishing the context of the SEA	Screening
	Setting the objectives
	Identify stakeholders
SEA Implementation	Scoping
	Collecting baseline data
	Identifying alternatives
	Identifying how to enhance opportunities and mitigate impacts
	Quality Insurance
	Reporting
Informing and influencing decision making	Making recommendations (in dialogue with stakeholders)
Monitoring and evaluating	Monitoring decisions taken on PP
	Monitoring implementation of PP
	Evaluation of both SEA and PP

b. Methodology

The integration of ES to SEA can be addressed at several levels: the conceptual level (general frameworks), the regulatory level (purpose and scope of SEA requirements) and the applied level (integrating ES at every step of the SEA process). Due to restrictions in time and human resources we opted to start with conceptual integration. The next step would be to work at the regulatory and applied levels as well in order to achieve effective integration. This however requires a conceptual framework which is clear to all the stakeholders involved in the integration process.

To insure data validity, a triangulation of methodologies was used: literature review, expert interviews and focus group discussions.

Literature review

During the months of June, July and August 2012 an intensive review was done about SEA implementation in Belgium. Important law and policy documents were screened in

Flanders and Wallonia to determine to what extent SEA has been implemented effectively in formal procedures. Additionally informal contacts were made with government officials to assess results and gather extra information.

Another review was carried later on, and until March 2012, about ES integration experiences into policy instruments and specifically into environmental assessments.

Expert interviews

From August 2011 until January 2012, 8 Belgian key academic experts on SEA and ES were interviewed to determine the current state of knowledge on these issues. These interviews were conducted at an early stage of the work package (August until November 2011) of the project. These interviews consisted of open-ended questions and were informal. Written notes were kept about each interview.

Additionally numerous (about 40) other informal interviews with national and international governmental officials, academics and consultants were conducted during conferences[11] and workshops[12] or simply by means of phone calls. Attention was paid to build up a network to allow feedback from various stakeholders.

A number of SEA and ES experts were selected and then interviewed based first on recommendations from academic experts, and using a snow ball sampling method afterwards. In total, 10 formal interviews were conducted with decision makers involved in SEA and experts from consultancy bureaus[13] carrying out SEA. Respondents were specifically selected based on their knowledge about SEA and ES (with a strong preference for respondents aware of both topics). Interviews were done between October and April, using semi-structured questions and until data saturation, although the number of interviews was limited by the number of available experts on the issue of ES as well. Interviews were also recorded. Questions were based on the following topics:

- Background, SEA and ES experience, and role of the interviewee;
- Status Quo of SEA: Positive and negative aspects and suggestions for improvement of current practices. Knowledge about SEA procedures;
- Effectiveness of current environmental policies;
- General expectations for decision making concerning ecosystems in the future;
- Networks of SEA in Belgium.

Data from interviews were analysed in the light of the Belgian environmental policy context and synthesized into key points of attention. These were then discussed informally with respondents during focus groups discussion.

Focus group discussions

One focus group discussion was held at the SEA body ("*MER dienst*") in Brussels for respondents from Flanders. The aim of this focus group was to present some preliminary findings and recommendations for the integration of ES valuation to SEA in Flanders and to discuss the potential of such integration.

[11] ESP conference Wageningen 2011, "eVALUEate NATURE" Brussels 2011, Leipzig TEEB conference 2012.

[12] Belgian BEES workshops.

[13] Arcadis, Ecores, Mieco Effect in Belgium.

A representative of the SEA body, of a major consultancy bureau and of the ministry of Nature and Energy were present, as well as two members of the VOTES project.

First a PowerPoint presentation about ES valuation and the VOTES project was given to refresh participants' memory about the issues. Afterwards, a 2h debate followed. A list of important recommendations identified by the VOTES project was presented afterwards for further discussion.

c. Results

Status-quo of SEA in Belgium

The legal framework for SEA in Belgium is determined by Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment (Schurmans *et al.* 2008). This directive has currently been transposed both into federal and regional legislation. Whether the former or the latter is applicable, depends on the government who is issuing the plan or programme in particular – and thus on the policy area the plan or programme relates to.[14] In this section, we will investigate the current legal situation on the federal, Flemish and Walloon level.

i. Federal level

Environmental protection in Belgium is for a very large part a matter for the Regions. However, because certain plans or programmes in policy domains for which the federal government holds competence, can have considerate effects on the environment as well, it was necessary to transpose Directive 2001/42 on the federal level. Eventually, this was done though the "*Plan-MER Law"* of 13 February 2006[15] (Schurmans *et al.* 2008).

The law lists a number of plans and programmes which by right require an SEA. These are situated in the field of energy policy (e.g. plans and programmes with regard to the means of production of electricity, development of the electricity transmission grid, the supply of natural gas …), the long-term treatment of radioactive waste and the exploration and exploitation of non-living resources in the territorial sea and the continental shelf. Furthermore, plans or programmes that can have significant effects on (marine) areas that are protected by Directive 92/43/EC, are also by right obliged to undergo an SEA. [16]

Any other federal plan that constitutes the framework for carrying out projects and that can have significant effects on the environment are subjected to a screening procedure, which is guided by an advisory committee.[17] Some plans, however, are explicitly exempted from the duty to undergo an SEA.[18]

[14] *Ibid.*, 28.

[15] *BOJ* 10 March 2006.

[16] Art. 6 Plan-Mer Law.

[17] Art. 5 Plan-Mer Law.

[18] Plans and programmes which only serve national defense or civil emergency; financial or budget plans and programmes (Art. 8 Plan-Mer Law) and plans and programmes which determine the use of small areas at local level and minor modifications to plans and programmes, provided they cannot have significant environmental effects (Art. 6, § 2 Plan-Mer Law).

ii. Regional level

Flanders

In the Flemish Region, Directive 2001/42/EC has been transposed into a new Chapter II of Title IV of the Decree of 5 April 1995 containing General Provisions related to Environmental policy (*Decreet houdende Algemene Bepalingen Milieubeleid*, hereafter: DABM). This chapter was inserted into the DABM by the Decree of 27 April 2007[19] and replaced the old Chapter II, after the European Court of Justice ruled against the Flemish government in 2006 for failure to adopt the provisions necessary to comply with Directive 2001/42/EC.[20]

The rules of Chapter II are applicable to any plan or programme that (a) constitutes the framework for granting a licence for a project or (b) for which, given the possible impact on areas, an appropriate assessment is required according to article 36 ter, § 3, par. 1 of the Decree of 21 October 1997 on the conservation of nature and the natural environment[21] (*Decreet betreffende het natuurbehoud en het natuurlijk milieu*, hereafter: Nature conservation decree).[22] Some plans or programmes are explicitly excluded from the scope of application of the DABM.[23]

However, only in certain cases an SEA needs to be drawn up. The general rule is that a plan or programme that falls within the scope of application of chapter II and that neither determines the use of a small area at a local level nor includes any small changes[24], is subjected to an SEA: (1) if the plan or programme relates to *agriculture, forestry, fishery, energy, industry, transport, waste management, water management, telecommunication, tourism, town and country planning or land use*, and forms the framework for the granting of a licence for a project listed in Annexes I and II of the Order of the Flemish Government of 10 December 2004 containing the establishment of categories of projects subjected to EIA.[25] These plans or programmes are *by right* obliged to undergo an SEA; (2) if, for a plan or programme *other than those mentioned under* (1), the initiator of the plan or programme does not prove, based on the criteria specified in Annex I of the DABM, that this plan or programme cannot have considerable environmental effects.[26] In a number of cases, the plan or programme can still be exempted from the obligation to undergo and SEA, on request of the initiator of the plan.[27]

---

[19] *OJ* 20 June 2007.

[20] ECJ 7 December 2006, C-54/06. Available at http://curia.europa.eu

[21] *OJ* 10 January 1998, as modified.

[22] Art. 4.2.1. DABM

[23] Plans or programmes which only serve national defense; financial or budget plans and programmes; plans or programmes co-financed under programming period 2000-2006 concerning EC Council Regulation no. 1260/1999 of 21 June 1999 laying down general provisions on the Structural Funds and under programming period 2000-2006 and 2000-2007 of EC Council Regulation no. 1257/1999 of 17 May 1999 on support for rural development from the European Agricultural Guidance and Guarantee Fund (EAGGF) (Art. 4.2.2. DABM).

[24] For plans or programmes that do determine the use of a small area at a local level or include a small change, an SEA does not need to be drawn up, provided the initiator proves, based on the criteria specified in Annex I that the plan or programme cannot have considerable environmental effects (Art. 4.2.3., § 3 DABM).

[25] *OJ* 17 February 2005, as modified.

[26] Art. 4.2.3., § 2 DABM.

[27] Art. 4.2.3., § 3bis-quater DABM.

Wallonia

❖ Spatial plans

In the Walloon Region, Directive 2001/42/EC has not been transposed into a single harmonised legal text, but rather into several pieces of legislation (Neuray 2005; Haumont 2007; Schurmans *et al.* 2008; Gonthier 2009; Leprince *et al.* 2010).

First of all, the Walloon Land use planning, Town planning, Heritage and Energy Code (*Code wallon de l'Aménagement du Territoire, de l'Urbanisme, du Patrimoine et de l'Energie*, hereafter: CWATUPE[28]) contains the SEA-legislation for *spatial plans*. The CWATUPE constitutes the framework for two categories of spatial plans on different administrative levels: (1) plans which contain general spatial policy choices, on the regional level (*Schéma de développement de l'espace regional*, hereafter: SDER) and on the local level (*Schéma de structure communal*, hereafter: SSC); and (2) actual land use plans, on the regional level (*Plan de secteur*, hereafter: PDS) and on the local level (*plan communal d'aménagement*, hereafter: PCA).

The SDER is drawn up by the Walloon government, while the SSC is drawn up by the local council. Both documents need to contain an analysis and an evaluation of the potential significant effects they can have on the environment.[29] According to the Walloon government, a "limited" SEA by the same authorities who draw up the SDER and SSC is sufficient given the "indicative nature" of these plans(Schurmans *et al.* 2008). However, some authors question if this is in full compliance with the obligations of Directive 2001/42/EC.[30] The procedures to draw up the SDER and SSC, including the evaluation of their environmental effects, are fairly similar.[31] First, a preliminary plan is being made, which is subjected to a public inquiry and submitted for advice to a number of advisory bodies, a.o. the Walloon Environmental Council for Sustainable Development (*Conseil Wallon de l'Environnement pour le Développement Durable*, hereafter: CWEDD). Together with the final adoption of the plan, an environmental declaration (*déclaration environnementale*) is prepared that summarizes in what way environmental considerations that were raised during the procedure are being dealt with in the final plan. With regard to the SSC, the college of Mayor and Aldermen is required to periodically submit a monitoring report to the local council on the significant environmental effects of the implementation of the plan and the possible corrective measures to be taken.[32]

The PDS are by right obliged to undergo an SEA (*étude d'incidence environnementale strategique*). First, the Walloon government draws up a preliminary PDS, and orders a licensed and independent EIA-expert to carry out an SEA of the plan.[33] With regard to the minimum content of this SEA, the CWATUPE reiterates all elements of Annex II of Directive

[28] Since 1 May 2010 the former 'CWATUP' has been renamed to 'CWATUPE' (Art. 2 and art. 17, par. 1, Framework-Decree of 19 April 2007, *BOJ* 29 May 2007 and art. 5, par. 1, Order of the Walloon Government of 17 April 2008, *BOJ* 30 July 2008, as modified).

[29] Art. 13, § 2, 7° CWATUPE and art. 16, 8° CWATUPE for SDER and SSC respectively.

[30] GONTHIER E., 'L'évaluation des incidences sur l'environnement des projets et des plans et programmes' in M. DELNOY, *Actualités du droit de l'aménagement du territoire en de l'environnement*, Limal, Anthemis, 2009, 211.

[31] Art. 14 CWATUPE and art. 17 CWATUPE for SDER and SSC respectively.

[32] Art. 18bis CWATUPE.

[33] Art. 42, par. 6 CWATUPE.

2001/42/EC, except for a statement summarizing the reasons why certain other alternatives have been selected (Gonthier 2009). The specific content of the SEA, however, is determined by the government on a case-by-case basis.[34] In carrying out the SEA, useful information obtained during other environmental assessments can be taken into account. Once the preliminary plan and SEA are ready, a public enquiry is organised, which lasts 45 days.[35] Subsequently, after a large number of advisory bodies (including the CWEDD and the Walloon DG Natural Resources and Environment – DGARNE) were able to produce their advice, the PDS is approved by the Walloon government. Together with this final adoption, and similar to the procedure for the establishment of the SDER and SSC, an environmental declaration is issued that summarizes in what way environmental considerations that were raised during the procedure are being dealt with in the final plan.

Finally, the PCA are also, in principle, obliged to undergo an SEA. The procedure is relatively similar to the one for the adoption of the PDS, but there are some notable differences. For example, the SEA can be drawn up by the local council – an independent EIA-expert is not required.[36] Furthermore, the council can decide that an SEA is not required when the PCA is not likely to have significant environmental effects – even when this concerns a new PCA.[37]

- **List I and EIA related plans**

Secondly, Book I (*Livre 1^er^*) of the Walloon Environment Code (*Code de l'environnement,* hereafter: the Code[38]) lists two categories of plans which are subjected to an SEA:

(1) plans and programmes, including their reviews, that are included on a list I that is drawn up by the Walloon government.[39] On this list are plans and programmes that are believed to (potentially) have significant environmental effects.[40] This list has been drawn up in Annex V of Book I of the Code and includes land consolidation plans, waste management plans, water management plans, the air quality action programme, the soil quality action programme… In a number of cases, however, plans and programmes on this list can still be exempted from the SEA-procedure.[41]

---

[34] Art. 42, par. 2 CWATUPE. Before the SEA is actually being drafted, its proposed content and the preliminary PDS are submitted to a number of advisory bodies, a.o. the CWEDD.

[35] Art. 43 CWATUPE.

[36] Art. 50, § 2, par. 1 CWATUPE.

[37] Art. 50, § 2, par. 3. CWATUPE. For the PDS, this was only possible when an existing plan was being revised. Some authors question the conformity of this legislation with Directive 2001/ 42/EC: GONTHIER E., 'L'évaluation des incidences sur l'environnement des projets et des plans et programmes' in M. DELNOY, *Actualités du droit de l'aménagement du territoire en de l'environnement*, Limal, Anthemis, 2009, 213.

[38] This is the codification of Walloon Environmental Law; Decree of 27 May 2004, *BOJ* 27 May 2004, and Order of the Walloon Government 17 March 2005, *BOJ* 4 May 2005.

[39] Art. D. 53, § 1, par. 1, Book I of the Code.

[40] E.g. plans and programs elaborated for the sectors of agriculture, forestry, waste management, industry etc. or plans and programs that need an appropriate assessment, according to the Nature Conservation Law of 12 July 1973.

[41] Provided they cannot have significant environmental effects: (a) plans and programmes which determine the use of small areas at local level, (b) minor modifications to plans and programmes, or (c) plans or programmes that do not constitute the framework for future projects that will require an E.I.A. (Art. D. 53, § 1, par. 2, Book I of the Code). The exemption needs to be granted by the Walloon government.

(2) plans or programmes that do not feature on the abovementioned list I, but which constitute the framework for future projects that will require an EIA. and which can have significant environmental effects.[42] Again, there is a possibility to be exempted from the SEA-procedure.[43]

❖ **Other plans**

Plans and programmes that do not fall within the two previous categories, but which can have significant environmental effects, and which are not provided for by legislative, regulatory or administrative provisions, can still be obliged by the Walloon government to undergo an SEA. This is decided on a case-by-case basis.[44]

Finally, certain types of plans are, by right, exempted from the duty to undergo an SEA.[45]

SEA practice and ES potential: feedback from experts interviews

Current SEA practices were discussed during interviews with experts from the MER body (Flanders), the CWEDD[46] (Wallonia) and 4 Belgian consultancy bureaus. Feedback from these experts is presented hereafter in two sections: 1) general feedback applicable in both Flanders and Wallonia and 2) some specific feedback about the Flemish and Walloon regions.

i. General feedback

Lack of clear guidance for SEA

Although the initial goal of SEA was to achieve sustainability, its daily use focuses on the biophysical aspects. This is for example illustrated by the structure of SEA reports, which is often based on the guidance for EIA (Table VII). Moreover there is a lack of clear, contextually adapted SEA guidance, making SEA exercises a challenge and severely limiting the number of institutions able to perform them adequately.

Table VII: Structure of the Project – MER

deel 1	*procedurele aspecten*
deel 2	*Algemene methodologische aspecten*
deel 3	*Methodologie per discipline : mens : gezondheid*

[42] Art. D. 53, § 2, par. 1, Book I of the Code. These plans and programmes will eventually be included on a List II, based on the criteria of art. D. 54 Book I of the Code, which has not yet been drawn up by the Walloon government.

[43] Art. D. 53, § 2, par. 2, Book I of the Code.

[44] Art. D. 53, § 3, Book I of the Code.

[45] Plans and programmes which only serve national defense or civil emergency; financial or budget plans and programmes; plans and programmes co-financed by the EU under the current programming periods concerning Council Regulations no. 1260/1999 and no. 1257/1999; the plan for sanitary landfills referred to in art. 24, § 2 of the Waste Decree of 27 June 1996 (art. D. 53, § 4); plans regulated by the CWATUPE (art. D. 53 § 5);

[46] Conseil wallon de l'environnement pour le développement durable

deel 4	*Methodologie per discipline : mens : ruimtelijke aspecten*
deel 5	*Methodologie per discipline : fauna en flora*
deel 6	*Methodologie per discipline : bodem*
deel 7	*Methodologie per discipline : water*
deel 8	*Methodologie per discipline : lucht*
deel 9	*Methodologie per discipline : licht, warmte en stralingen*
deel 10	*Methodologie per discipline : geluid en trillingen*
deel 11	*Methodologie per discipline : monumenten, landschappen en materiële goederen in het algemeen*

SEA and socio-economical assessments

Socio-economic issues are tackled by a range of parallel, non-integrated, instruments. As a result SEA tends to concentrate on a conservation paradigm leaving out broader sustainability issues. Whereas some areas have such high levels of biodiversity that they require strict conservation, it is equally important to realize that the provision of goods and services from ecosystems cannot depend solely on strict conservation measures and requires trade-offs to be made with economic and social issues (Slootweg *et al.* 2010). Alas, at this stage, SEA results often end up conflicting with socio-economic assessments leaving decision makers with a challenging task to achieve best possible trade-offs with little comparable data and at a relatively late stage of the PPP progress. As a result there is a high demand amongst experts to see an integration of SEA and socio-economical assessments. The ES concept is therefore appealing to them, yet unclear.

Time and financial constrains

There is a general consensus amongst a large number of officials that SEA is often perceived as a costly and time consuming reporting exercise mainly aiming at identifying environmental constraints to economic development whilst lacking essential content quality control. Time and financial resources are important constraints for SEA. As Slootweg *et al.* (2010) put it: "(…) *environmental assessment, by definition, has to deal with incomplete information that must be collected in a limited amount of time, within the limits of a budget more or less defined by the magnitude of the project under study*". In Flanders, the MER body is giving increased attention to the development of an integrated track to speed up the SEA process. Hence, while the potential of ES to highlight ecosystem benefits to society is welcomed by many officials, they are concerned however about ES slowing down a process which is already time consuming as it is. The main value of the ES valuation approach here is to have a means to show the added value of a SEA in terms of avoided costs and current and potential economic benefits. A much desired aspect by officials involved in environmental management, but also by consultancies.

Quality of current SEA reports

There are many complaints about the low quality content from a large number of SEA reports. The low quality of SEA reporting and processes is often due to the inadequate tenders from SEA contractors leaving too much room to consultancy bureaus working at minimal prices and providing poor quality assessments. In a sector where competition is high, it is not surprising that consultancy bureaus generate low quality reports at low prices to ensure market shares. This phenomenon was confirmed by experts working for consultancies.

A few officials argued that better quality control of consultancy bureaus could be a solution (e.g. quality control audits) to avoid low quality reports from consultancy bureaus while others seemed content about the current quality control measures. The necessity of quality control for SEA was already identified early on by Devuyst *et al.* (1999) in Flanders.

Need for operational criteria, indicators and user-friendly tools

The idea to go about SEA processes with clear criteria and indicator (check-) lists to evaluate both environmental impacts and decision making was mentioned several times as a viable and much desired instrument to improve SEA quality. It mainly illustrates the demand for practical and user-friendly tools to carry out SEA on the one hand, but also highlights that indicator based tools are highly valuated by policy makers.

Relating to ES assessments, a list of criteria could for example be established for each ES with corresponding indicators on how to measure their present state and their evolution over time; as attempted in the VOTES project and explained above.

SEA should be a planning process

Another recurrent problem stated by officials and consultants alike is that SEA is all too often carried out as a reporting exercise[47] instead of being a planning process. They hope that integrating the ES approach in SEA can bring about the necessary momentum for change. By adapting the key stages of SEA to include ES, attention could be paid to ensure a greater focus on processes rather than outputs.

Also, because ES requires including time scale issues (e.g. due to time lag effect of long term biophysical processes), they see an opportunity to implement better monitoring tools to assess environmental impacts after plan and programme implementation. Monitoring is virtually non-existent at this stage. A consultant pointed out at the cost of monitoring as a major barrier to implementation.

ii. Wallonia feedback

SEA is not well implemented yet in Wallonia. Currently there is a lack of clear guidance on how to carry out an SEA. As a result, public institutions recurrently formulate unclear tenders to consultancy bureaus, which then generate low quality assessments based on limited and often inaccurate data. Some officials ask for new guidance for SEA and better quality control for consultancy bureaus. Only few (2) consultancy bureaus actually stated that they knew how to carry out an SEA, illustrating a lack of institutional capacity for SEA as well.

Nonetheless this is seen as an opportunity to some experts. As guidance has to be developed yet, they expect a window of opportunity to directly include some ES in SEA guidelines. However, officials unanimously mention the need for political will to do so. As a

[47] Thus following an EIA-like approach rather than following the key stages of an SEA.

matter of fact several experts believe that a lack of political support is at the basis of a poor implementation of SEA.

Also, report screening by the CWEDD is now mainly aimed at report structure control rather than content control. Their role will need to be expanded to include process control and content quality control as well.

iii. Flanders feedback

SEA appears to be well implemented in Flanders but there is still a lack of practical SEA process guidance as well. The main issues concerning SEA processes are incomplete tenders and poor quality assessments as a result (as mentioned before), a lack of post planning monitoring and SEA focused on biophysical aspects only.

Because SEA is already well institutionalized in Flanders, there will be a need for a large stakeholder participation in designing ES inclusive SEA procedures. An important barrier identified by interviewed academics and acknowledged by a number of officials is the fragmentation of environmental institutions in Flanders. ES valuation is a data hungry tool that will require important inter-sectorial cooperation whilst opening up the decision making process. While this seems an appealing aspect of the ES valuation tool, it is questionable if such a process could proceed easily with the current level of institutional competition.

Hence, similarly to Wallonia, but for a different reason, political support is expected to be an important requirement for successful ES mainstreaming to SEA. Indeed it is necessary to achieve institutional cooperation and avoid pervasive effects of inter-sectorial competition.

d. Recommendations

Developing time efficient and cost efficient methods

There is a demand from decision makers and consultants alike, to develop time efficient and low cost procedures to carry out SEA processes (including monitoring). It requires that scientific methods for ES valuation[48], or for SEA practices in general, need to be adapted based on practical time and cost limitations. Where the time issue is already partly addressed by the SEA body in Flanders, which is developing an integrated SEA track rather than a parallel SEA track, it should still receive increased attention in future scientific research about ES valuation methods and tools.

Including practical policy requirements (such as time and costs) in scientific research is however a sensitive topic in the scientific community and will require a robust science-policy interface to improve communication and cooperation. Failure to do so will result in a situation where decision makers have to develop their own adapted methods based on extensive scientific material, while they often do not dispose of sufficient knowledge capacity in their midst or simply do not have sufficient time and resources for it. Scientists on the other hand, are concerned by an excess of research directives from policy institutions, jeopardizing scientific independence and objectivity.

All things considered, the level of complexity and uncertainty typically involved in SEA requires a focus on robust processes and transparent decision making, rather than reaching for all-explanatory methods and models. A balance between decision maker needs

[48] Both economic and non-economic.

and scientific integrity concerns is key to achieve this, albeit not enough as we will discuss in the next point.

Opening up the decision making process and develop a legal framework for ES

As stated above, SEA are typically carried out in a context where uncertainty and complexity is ubiquitous. To compensate for a recurrent lack of scientific data, SEA procedures require public consultation and participation. The aim is to gather as much knowledge as possible from stakeholders while building up a transparent and engaged decision making process. A problem arises in Belgium, where internal, inter-sectorial competition between governmental institutions to secure projects, subsidies and responsibilities is high.

In addition, there is an apparent lack of communication between the Flemish and Walloon region about SEA (sparse and irregular communication). SEA, and especially ES based SEA, requires opening up decision making processes to be effective. To address this competition issue, it is a necessity to engage politicians and acquire political support, not only on EU level (as is the case with the 2020 targets on biodiversity) but also on the federal and especially regional levels. Strong argumentation about the added value of SEA and ES is called for. This was acknowledged by the EU as well, as they are starting the BESAFE project [49] in 2012, focusing on the effectiveness argumentation strategies by policy makers. Develop and adapt existing legal frameworks as to formally include ES would help to clarify sectorial responsibilities as well.

Improve quality control for SEA processes

The need to organize an effective quality assurance system of both SEA information and processes was already acknowledged at the Convention on Biological Diversity (CBD 2006). The desire for increased quality control of SEA processes and reports has also been mentioned by several officials and members of consultancy bureaus in Flanders and Wallonia, and in several other EU member states as well. Attention must be given to identify or create appropriate institutions to carry out quality control.

Suggestions were made by a few policy makers to follow a certification-like approach (e.g. Forest Stewardship Council, ISO norms, etc.) with an accreditation body supervising SEA practitioners (e.g. consultancies) about SEA processes and procedures; and consequently issuing accreditations granting the right to perform SEA. Such an accreditor role would befit regional SEA bodies[50] as they already possess much of the required knowledge about procedures. Little additional institutional capacity is therefore required. In the event that an SEA is then carried out by another public body, an internal audit procedure seems straightforward but will require an objective approach to avoid a conflict of interests and ensure legitimacy. Whichever case will imply the need to formulate a comprehensive list of SEA process-based quality criteria. It should be clear that this approach goes beyond any existing control procedures for report content, or individual skill level requirements for SEA practitioners, and seeks to achieve a process based control[51] system.

---

[49] http://cordis.europa.eu/search/index.cfm?fuseaction=proj.document&PJ_RCN=12228591

[50] MER-dienst in Flanders, CWEDD in Wallonia

[51] As opposed to performance based.

Tune EIA and SEA with one another

The dynamics of ecological systems take place on many different scales simultaneously. The challenge is to understand how processes on one scale relate to processes on other scales (Hlodan 2005) and which scale is appropriate for a given SEA. There is currently a mismatch between the scale of the system and the scale at which policy makers typically operate (Rounsevell *et al.* 2010).

Likewise, ES valuation research is roughly split between studies focusing on small spatial extents or global scales. Although often quite accurate, small spatial extent studies lack both an appropriate scope (number of ES studied) and scale (spatial and temporal) to be relevant for decision makers (Nelson *et al.* 2009; de Groot *et al.* 2010). The VOTES project was designed in order to initiate a response to those caveats.

Ecosystem management that focuses on delivering a single ES will almost certainly reduce its ability to provide others (Fitter *et al.* 2010), but the extent of that limitation remains unknown if a holistic approach is not considered. Assessments conducted over large spatial extent lack the necessary precision to predict impacts of land-use management practices on ES production. Therefore, there is a necessity for an approach combining rigorous small scale assessments with large and broad scale assessments (Nelson *et al.* 2009).

One way to tackle this problem within environmental assessments is to combine both EIA (local, project level) and SEA (strategic level, large spatial extent). For this option to be effective, SEA of plans and programmes, and EIA of projects, should be adjusted to each other and complement each other (as suggested by Devuyst *et al.* 1999 for similar reasons). At this stage there are only few EIAs directly relating to previous SEA undertaken at for higher spatial level.

Developing new and improving low-cost monitoring systems for SEA

Temporal dynamics are important in an ES approach as a substantial number of ES rely on biophysical processes, which operate on far longer time scales than the usual planning horizon steering SEA (Dawson *et al.* 2010). Translating biophysical time lags into short term planning horizons remains therefore a prerequisite to achieve sustainability. Additionally, the lack of current monitoring in SEA needs to be addressed. ES indicators can help to evaluate the state of ES over time.

Simulators, such as the CARAIB DVM adapted for the VOTES project and combined with an ABM, can meet this requirement, at a medium-term lower cost, if political decisions are opting for continuity. Indeed, the start-up cost for developing a spatio-dynamic simulator is quite heavy but, if designed correctly at the beginning, maintenance and further development are much more cost effective. Such development would benefit from the inclusion of experts in engineering requirement.

In addition, a couple ABM-DVM allows for scenario testing and the exploration of potential consequences of a specific local project over a larger landscape. Of course, the current state of these simulators does not comply with a user-friendly requirement, but attractive front-end could easily be developed in order to satisfy such a demand.

Adapt list of mandatory plans and programmes subjected to SEA

An important step to include ES into formal SEA procedures is to adapt the list of plans and programmes that require mandatory impact assessments and, more importantly, to modify the list of screening criteria in Annex II of the SEA directive in such way that it include ES. Suggestions for new criteria can be extracted from the screening criteria of the Convention on Biological Diversity (CBD 2006) for instance, or from the recently published impact and dependence scoping tool from the World Resource Institute[52].

Develop guidance on how to identify relevant stakeholders during SEA screening

In any ES analysis, it is capital to identify stakeholders that [1] will likely be affected by changes in ES, [2] manage and provide ES and [3] have interests related to ES. Guidance needs to be developed on how to identify these stakeholders and ensure meaningful participation procedures. . Although there are already procedures to involve stakeholders in SEA, these are not aimed at the inclusion of stakeholders affected by (possible) changes in ES provision.

The approach taken within the VOTES framework seems a good start since it paid off. Other means for increasing participation would be to rely on a larger number of local NGOs and community groups through federative bodies such as local commissions for nature conservation, for rural development …

Redefine the scope of SEA

Currently, SEA cannot contain any economic analysis although SEA was designed to achieve sustainability, which should have called for fully accounting for the three pillars. Whereas the inclusion of ES valuation in SEA does not call for complete economic impact analysis, the economic aspect has nonetheless an important role in landscape and planning decisions. Therefore we argue that economic aspects can and should be allowed in SEA, **at the same levels** of social and environmental valuations.

e. Main benefits of ES integration to SEA

Summarizing the main benefits of ES valuation and its inclusion in SEA from the literature, from expert interviews and from the VOTES framework presented above, we identified the following aspects:

- ES valuation had proved to be an effective tool to engage and include stakeholders and therefore can improve transparency and participation into SEA processes;
- ES valuation highlights social equity issues by mapping the distribution of ES benefits and losses for end users;
- The potential of ES valuation to identify environmental benefits in monetary terms is of high value to influence decision making, but respondents (social valuation, economic valuation) clearly demonstrated that other means of valuing ES, the environment and nature;
- ES valuation provides a mean to gain insights in short and long term trade-offs of plans and programmes.
- Provide a strong means to advocate the benefits of SEA in terms of avoided costs and economic benefits, while also providing comparable arguments towards higher levels of decision making when economic studies and SEA are taken into account simultaneously.

[52] http://www.wri.org/publication/ecosystem-services-review-for-impact-assessment

f. Moving forward

The potential of SEA to improve decision making is not directly questioned at this stage by its proponents, but they acknowledge that its efficiency is still very much fluctuating. Hence they believe there is a window of opportunity to improve SEA practices by including an ES valuation approach. However there is a lack of practical examples (concrete case study based) to support this potential. We hope the work undertook during the VOTES project and reported here demonstrates that potential.

Also, there is a level of distrust towards ES valuation by officials from the SEA body in Flanders. Much too often, "ES valuation" is seen as a synonym of "monetary valuation", a type of valuation many considers too risky. The underlying reasons for this distrust need to be understood and addressed. Also, more attention needs to be directed towards a deep policy-science debate about ES valuation tool.

It is urgent that we move forward and try out ES valuation tools in SEA in real cases. This might prove to be challenging and will require adequate follow-up by a group of experts in both SEA and ES valuation (e.g. MERITE project in the Netherlands).

To achieve real life testing, we need involving more stakeholders and develop a practical tool for analysing and valuating ES in the context of SEA. The VOTES methodology presented in this report should be a good basis for developing such a tool. In addition, a desk study using past SEA cases might also be informative to assess potential changes in decision making processes and determined if an ES analysis had been applied.

At the same time, it should be clear that an integration of ES valuation framework to SEA is not the only way forward to improve the state of our ecosystems. Although useful and promising, other tools should not be left out as they are often adapted to particular sectors. For example, labelling (Ghazoul *et al.* 2009) and portfolio screening are valuable options in the private sector, although the focus here was on decision making in the public sector.

3. POLICY SUPPORT

The VOTES framework we developed during this project highlights a number of elements that should help a better understanding of the challenges relating to ecosystem services valuations in decision making aiming sustainable development.

Before discussing the added-value of these elements, in the light of their usefulness for policy makers, we must clarify that ecosystem services valuation in the VOTES project is not all about estimating their monetary value. "Valuation" must be understood as estimating the position of a service on a scale, regardless of its units (€; CO^2/m^2; Tons/ha …) or its levels (good/neutral/bad; important/neutral/not important …). The core principle is that people benefit from ecosystem services in all aspects of their life, and not only in their wallets (e.g. food access, water quality access, sense of place, good health …). Therefore, when prices are estimated, it is only because the valuation refers to a well-known scale. It does not imply that the service can be considered all of sudden as a commodity. In that line, note there is an EU project (EC 7th Framework Programme) enforcing research on how to move forward from "just" economic value (http://www.besafe-project.net/).

The framework has to be understood as a process of knowledge building, not as a definite measuring tool, of these challenges. With the VOTES project, we identified a lack of understanding of the ecosystem services concept amongst most stakeholders, although the majority was aware of the importance of nature for human well-being. We believe we have made a case for using ecosystem services concept as a mean to achieve sustainable landscape management. The method allows for building better understanding of the (land use/environment) dynamics amongst the stakeholders, considering the complexity of the system, and allowing for taking best-informed decisions considering the specific society context.

The ecosystem services approach relates to the importance of nature to human well-being. The concept revolves around the idea of a maximum carrying capacity of the landscape. In other words, space is a limited resource that cannot offer an infinite number of land uses, hence potentially restricting the quantity and the quality of ecosystem services. Therefore, for a sustainable landscape management and planning, one must evaluate socially, environmentally and economically, the current state of ecosystem services. Furthermore, one must also define adequate indicators for monitoring their evolution with respect to [1] the intrinsic spatial dynamics of land use and [2] the changes implied by new projects, regardless of their spatial extent. In that sense, we must emphasize again that ecosystem services valuation must be seen as a mean, not as an end.

The construct of indicators provides arguments for better communicating, either to local people or to higher decisional levels, about new plans affecting the landscape in a local community. Several of the local representatives we met stressed the importance of providing such measurements and communication tools to them so they could adequately answer requests from regional and European levels about the local state of the environment. When the VOTES results were presented, they expressed a quite positive response to the idea of pursuing the development of such a method, that they could use eventually directly.

At the moment, Strategic Environmental Assessment (SEA) reports are limited to estimating the consequences on nature (the biophysical aspects) and not well implemented, partly due to a lack of political support. Likewise, Cost-Benefit Analyses (CBA) are purely evaluating the economic consequences of a project. While these tools reduce the complexity of the system to be evaluated, they might neglect the interactions between both aspects. Therefore and even though the importance of monetary valuation for policy makers is acknowledged, we pledge for a better integration of ecosystem services valuation in both tools in order to more clearly identify trade-off and synergies amongst the different ecosystems services affected by a new project. This is the only way to acknowledge the holistic nature of the landscape and to anticipate potential future issues in other sectors than the one of the new project. We believe the framework we developed is a good start for elaborating a cost-effective approach since it is rather a matter of reorganizing the links between SEA, CBA and ES valuations. In the latter, the social valuation can involve a limited number of respondents, especially where local community groups exist and have already identified key ecosystem services seen as important to local people, even though not using the same terminology.

An operational procedure for this better integration is still to be developed, though. The task is tremendous and will be achieved only when sufficient scientific work gathering enough interdisciplinary teams will be completed. Nonetheless, we believe such integration will considerably strengthen Strategic Environmental Assessment by helping identify the location for a new project where the money invested will be minimal, but the gains will be maximal for the local community and the environment. Moreover, identifying benefits along the three pillars of sustainable development will give more objective arguments for supporting "environmental" project.

Note we are at a momentum for developing such tool. There is great expectation in business consultancy for evaluating ecosystem services in audit assessments because they receive questions from private companies on how to carry on an Ecosystem Assessment. Therefore, there is a private demand for an evaluation framework. But, if the State is formalising a methodology, the consultant bureau will follow that one rather than developing their own.

Because SEA is already well institutionalized in Flanders, there will be a need for a large stakeholder participation in designing ES inclusive SEA procedures. Hence, similarly to Wallonia, but for a different reason, political support is expected to be an important requirement for successful ES mainstreaming to SEA. Indeed it is necessary to achieve institutional cooperation and avoid pervasive effects of inter-sectorial competition.

In order to progress towards a successful integration of ES into SEA a series of aspects need to be addressed first to improve current SEA procedures. Based on the literature and on interviews conducted during the VOTES project, we presented a set of general recommendations for SEA procedures in order to facilitate integration of ES to SEA in Belgium. These recommendations are not aimed to provide input to the applied level of ES integration. Previous research from the OECD already provided a first set of general recommendations and considerations for each step of the SEA process and can be found in the OECD guidance on SEA and ES (OECD 2008 and 2010).

During the VOTES project, we interacted with local stakeholders and regional planners for rooting the research in the real civil society context. With this experience, we confirm the importance of including the stakeholders in order to create a process of understanding on both sides. We recommend increasing the participatory aspect in future ecosystem services valuation, for an even better transition of landscape management and planning.

4. DISSEMINATION AND VALORISATION

4.1 ORAL SCIENTIFIC COMMUNICATION

1. Dendoncker *et al.* (2010) *Valuing ecosystem services: the VOTES framework*, PLUREL Conference (EC-funded) « Managing the Urban Rural Interface » (Parallel session S15: quality of life and ecosystem services in urban-rural region), 19-22 Oct 2010, Copenhagen (Denmark)
2. Marek *et al.* (2010) "Theoretical Discussion on Economic Valuation of Greenness: From Ecosystem Services to Green Infrastructures", ENTI 2010, "9th International Conference of Territorial Intelligence – Ecological and Social Innovation ", Nov 2010, Strasbourg (France)
3. Francois *et al.* (2011) "VOTING for the right scale in biophysical valuation of ecosystem services." Biodiversity and ecosystem services, BEES Workshop, 23rd of March 2011, Leuven
4. Francois *et al.* (2011) "Participatory valuation and modelling of ecosystem services under land use change", EGU General Assembly, March 2011, Vienna (Austria)
5. Fontaine *et al.* (2011), "The VOTES project", 4th ESP Conference, Workshop 2: Valuation of ecosystem services and use in trade-off analysis and other decision support systems (2c : Tools and integrative valuation frameworks), Oct 2011, Wageningen (The Netherlands)
6. De Vreese, R. (2010). Social Assessment of terrestrial ecosystem services in a multifunctional peri-urban space. Poster presented at the 5th ALTER-Net Summer School. September, 5th – 15th, 2010, Peyresq (France)
7. De Vreese R. (2011). Scale issues in Social Assessment of Ecosystem Services – who VOTES Presentation at the 7th BEES Workshop – Ecosystem Services and their (e)valuation: linking concepts, principles and values to policies. Brussels, March 23, 2011.
8. De Vreese R. (2011). A forest isn't a forest. Towards an explanatory framework on views on nature, ecosystem services assessment and use of the urban forest. Presentation at the European Forum on Urban Forestry, June 2, 2011, Glasgow (UK).
9. De Vreese R. (2011). A forest isn't a forest. Towards an explanatory framework on views on nature, ecosystem services assessment and use of the urban forest. Presentation at the Ecosystem Services Partnership 2011 Conference, October 5, 2011, Wageningen (The Netherlands).
10. Marek *et al.* (2011) "Economic Valuation of Ecosystem services – moving from the literature to the implementation of techniques within the VOTES project", 4th ESP Conference, Workshop 2: valuation of ES and use in trade-offs analysis and other decision support systems, Oct 2011, Wageningen (The Netherlands)
11. Jacquemin *et al.* (2011) "Biophysical valuation of ecosystem services in the VOTES project: use of a dynamic vegetation model". Session 1, 4th ESP Conference, Oct 2011, Wageningen (The Netherlands)
12. Fontaine *et al.* (2012), "Is your landscape endangered? Presenting some methods and technical elements when modeling farming activities within a Spatial Multi-Agents System", *naXys Seminars*, Feb 2012, Namur

13. Fontaine *et al.* (2012), "The VOTES framework", TEEB Conference, Special Session: Participatory Valuation of Ecosystem Services, March 2012, Leipzig (Germany)
14. Mortelmans D. *et al.* (2012), "Mainstreaming Ecosystem Services into Strategic Environmental Assessments: the Belgian case", TEEB Conference Abstract, March 2012, Leipzig (Germany)
15. Dendoncker *et al.* (2012), "The VOTES framework", BEES final workshop, March 2012, Brussels

4.2 POSTERS IN SCIENTIFIC CONFERENCE

1. Fontaine *et al.* (2010), "Changements d'occupation du sol: qui VOTE?", "Journée d'étude sur l'occupation du sol en Wallonie", Gembloux, Oct 2010
2. Marek *et al.* (2010) "Theoretical Discussion on Economic Valuation of Greenness: From Ecosystem Services to Green Infrastructures", ENTI 2010, "9th International Conference of Territorial Intelligence – Ecological and Social Innovation ", Nov 2010, Strasbourg
3. Fontaine *et al.* (2011), "The VOTES project", Higher Education & Research Awards for future generations (HERA) Poster Session: Quelles approches transversales pour intégrer le développement durable dans la recherche? Exemples en Fédération Wallonie-Bruxelles, Bruxelles, Dec 2011
4. Jacquemin *et al.* (2012) "Dynamic modeling of future land use change under urbanization and climate change pressures : application to a case study in central Belgium", EGU General Assembly, April2012, Vienna

4.3 LAYMAN PRESS ARTICLE

1. "Ruralités Magazine" (n°9), *Quantifier et évaluer les services écosystémiques*, Réseau Wallon de Développement Rural, Eds: Daniel Burnotte, 1er Semestre 2011

5. PUBLICATIONS

1. Fontaine CM, Dendoncker N, De Vreese R, Jacquemin I, Marek A, Van Herzele A, Devillet G, Mortelmans D, François L (*in review*), Participatory Valuation and Modelling of Ecosystem Services under Land Use Change
2. Marek *et al.* (*in prep.*) "Economic Valuation of Ecosystem Services – using techniques of valuation : travel cost method and group deliberation within the VOTES project"
3. Mortelmans *et al.* (*in prep.*) "Policy valuation: synergies between Ecosystem Services concept and Strategic Environmental Assessment"
4. Dendoncker *et al.* (*in prep*) "Integrated Valuation of Ecosystem Services in a Peri-urban Landscape: Results and Lessons Learned from a Case-Study in Belgium."
5. De Vreese *et al.* (*in prep.*) "Mapping social valuation of ES for conflicts local management"
6. Jacquemin *et al.* (*in prep.*) "Land use change, dynamic vegetation modelling and socio-economic scenarios for ES valuation and monitoring"

6. ACKNOWLEDGMENTS

The partners of the VOTES projects want to acknowledge the close collaboration with some of the partners of the ECOCHANGE project (http://www.ecochange-project.eu/, EC 6th Framework Programme), in particular at The Sustainable Europe Research Institute (SERI, Austria) and at the University of Edinburgh (UK). **Special thanks to Dr. Dave Murray-Rust** (University of Edinburgh) for the software development of the ABM framework.

7. REFERENCES

Abildtrup, J., Audsley, E., Fekete-Farkas, M., Giupponi, C., Gylling, M., Rosato, P. & Rounsevell, M. (2006), Socio-economic scenario development for the assessment of climate change impacts on agricultural land use: a pairwise comparison approach Environmental Science & Policy, 9 (2): 101-115

Allin S., Henneberry J., Keskin B. (2010) VALUE- WP4 Action 4.1.: Handbook on running focus group interviews, University of Sheffield, unpublished.

Barbour, R.S. (2001), Checklists for improving rigour in qualitative research: a case of the tail wagging the dog? *British Medical Journal* 322, 1115 – 1117.

Barnaud, C, Antona, M., and Marzin, J. (2011), Vers une mise en débat des incertitudes associées à la notion de service écosystémique, *VertigO*, Vol. 11 (1), 24p.

Blamey, R.K., and James, R.F., (1999), Citizens' juries—An alternative or an input to environmental cost-benefit analysis, Conference of the Australian and New Zealand Society for Ecological Economics (Brisbane, Australia), Griffith University.

Boogaard, H.L., van Diepen, C.A., Roetter, R.P., Cabrera, J.M.C.A. and Laar, H.H.v., 1998. WOFOST 7.1 : user's guide for the WOFOST 7.1 crop growth simulation model and WOFOST Control Center 1.5. Technical document / DLO Winand Staring Centre;52. DLO Winand Staring Centre, Wageningen.

Boumans, R., Costanza, R., Farley, J., Villa, F. and Wilson, M. (2002), Modeling the dynamics of the integrated earth system and the value of global ecosystem services using the GUMBO model. *Ecological Economics* 41, 529-560.

Bousquet, F., Barreteau, O., Le Page, C., Mullon, C., and Weber, J. (1999), An environmental modelling approach: the use of multi-agent simulations, in Advances in environmental and ecological modelling, ed. Blasco F., Elsevier, Paris, pp 113- 122.

Bousquet, F., and Le Page, C. (2004), Multi-agent simulations and ecosystem management : a review. *Ecological modelling*, 176, 313-332.

Bryan, B.A., Raymond, C.M., Crossman, N.D., and Macdonald, D.H., (2010), Targeting the management of ecosystem services based on social values: Where, what, and how? *Landscape and Urban Planning* 97, 111-122.

Buijs, A. E., B. Pedroli, and Y. Lu¨ ginbu¨ hl. 2006. From hiking through farmland to farming in a leisure landscape: Changing social perceptions of the European landscape. Landscape Ecol. 21(3):375–389.

Buijs, A., 2009. Lay People's Images of Nature: Comprehensive Frameworks of Values, Beliefs, and Value Orientations. Soc. & Natural Resources 22, 417–432.

Cast, A., MacDonald, D.H., Grandgirard, A., Kalivas, T., Strathearn S., Sanderson M., Bryan, B., and Frahm, D. (2008), South Australian Murray-Darling basin environmental values report. Water for a Healthy Country Flagship Report series. CSIRO Sustainable Ecosystems, Australia.

Castoldi, N. and Bechini, L. (2010), Integrated sustainability assessment of cropping systems with agro-ecological and economic indicators in northern Italy. *European Journal of Agronomy* 32(1), 59-72.

CBD (2006). "BIODIVERSITY IN IMPACT ASSESSMENT Background Document to Decision VIII/28 of the Convention on Biological Diversity: Voluntary Guidelines on Biodiversity-Inclusive Impact Assessment." CBD Technical Series(26).

Chambers, R. (1994), The origins and practice of Participatory Rural Appraisal. *World Development* 22, 953-956.

Colson V. (2009) La fonction récréative des massifs forestiers wallons: analyse et évaluation dans le cadre d'une politique forestière intégrée. Faculté Universitaire des Sciences Agronomiques de Gembloux – inédit.

Coote, A. and Lenaghan, J. (1997), *Citizen's juries: Theory into practice.* London: Institute for Public Policy Research.

Costanza, R. (2000), Social goals and the valuation of ecosystem services. *Ecosystems* 3, 4-10.

Cowling, R.M. and Wilhelm-Rechman, A. (2007). Social Assessment as a key to conservation success. Oryx 41, 135–136.

Cowling, R., Egoh, B., Knight, A.T., O'Farrell, P.J., Reyers, B., Rouget, M., Roux, D.J., Welz, A., and Wilhelm-Rechman, A. (2008), An operational model for mainstreaming ecosystem services for implementation. *PNAS* 105(28), 9483-9488.

Daily G.C., Söderqvist T., Aniyar S., Arrow K. , Dasgupta P., Ehrlich P.R., Folke C.,Jansson A., Jansson B., Kautsky, Levin, Lubchenco, Mäler, David Simpson, Starrett, Tilman, Walker (2003) The Value of Nature and the Nature of Value. Science 289 (5478) 395

Daugstad, K., H. Svarstad, and O. I. Vistad. 2006. A case of conflicts in conservation: Two trenches or a three-dimensional complexity? Landscape Res. 31(1):1–19.

Dawson, T. P., M. D. A. Rounsevell, et al. (2010). "Dynamic properties of complex adaptive ecosystems: implications for the sustainability of service provision." Biodiversity and Conservation **19**(10): 2843-2853.

De Groot, W.T., van den Born, R.J.G., 2003. Visions of nature and landscape type preferences: an exploration in The Netherlands. Landscape and Urban Planning 63, 127–138.

De groot (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 (2006), 175-186.

de Groot, R.S., Wilson, M.A., and 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., R. Alkemade, et al. (2010). "Challenges in Integrating the Concept of Ecosystem Services and Values in Landscape Planning, Management and Decision Making." Ecological Complexity **7**(3): 260-272.

Devuyst, D., T. Van Wijngaarden, et al. (1999). "Implementation of SEA in Flanders: Attitudes of key stakeholders and a user-friendly methodology." Environmental Impact Assessment Review **20**: 65-83.

Dury M., A. Hambuckers, P. Warnant, A. Henrot, E. Favre, M. Ouberdous, L. François (2011)

En Chee Y. (2004) An ecological perspective on the valuation of ecosystem services. Biological Conservation 120 (2004) 549-565

Responses of European forest ecosystems to 21st century climate: assessing changes in interannual variability and fire intensity. iForest - Biogeosciences and Forestry 4, 82-89.

Fisher, B., Turner, R., and Morling, P. (2009), Defining and classifying ecosystem services for decision-making. *Ecological Economics* 68(3), 643-653.

Fitter, A., T. Elmqvist, et al. (2010). "An Assessment of Ecosystem Services and Biodiversity in Europe." Nature **30**: 1-28.

Foley, J.A, DeFries, R., Asner, G., Barford, C., Bonan, G., Carpenter, S., Chapin, S., Coe, S.T., Daily, G.C., Gibbs, H.K., Helkowski. J., Holloway, T., Howard, E.A., Kucharik, C.J., Monfreda, C., Patz, J.A., Prentice, C., Ramankutty, N. and Snyder, P.K. (2005), Global consequences of land use. *Science* 309, 570-574.

Folke, C., 2006. Social–ecological systems and adaptive governance of the commons. Ecol Res 22, 14–15.

François, L., Delire, C., Warnant, P. and Munhoven, G., (1998), Modelling the glacial-interglacial changes in the continental biosphere. Global Planetary Change, 16, 37-52.

François, L., Goddéris, Y., Warnant, P., Ramstein, G., de Noblet, N., Lorenz, S. (1999), Carbon stocks and isotopic budgets of the terrestrial biosphere at mid-Holocene and last glacial maximum times, Chemical Geology, 159, 163-189.

Funtowicz, S. O., and Ravetz, J. R. (1994), The worth of a songbird: ecological economics as a postnormal science. *Ecological economics*, 10(3), 197-207.

Gagnon Thompson, S.C., Barton, M.A., 1994. Ecocentric and anthropocentric attitudes toward the environment. Journal of Environmental Psychology 14, 149–157.

Gérard, J.-C., Nemry, B., François, L., Warnant, P., (1999), The interannual change of atmospheric CO_2: contribution of subtropical ecosystems? *Geophysical Research Letters*, 26, 243-246.

Ghazoul, J., C. Garcia, et al. (2009). "Landscape labelling: A concept for next-generation payment for ecosystem service schemes." Forest Ecology and Management **258**(9): 1889-1895.

Gibelin AL, Déqué M (2003). Anthropogenic climate change over the Mediterranean region simulated by a global variable resolution model. Climate Dynamics 20: 327-339.

Gilbert, N. and Bankes, S. Platforms and Methods for Agent-Based Modeling. (2002), Proceedings of the National Academy of Sciences of the United States of America, 99 (10), pp. 7197-8.

Glaser, B.G., Strauss, A.L., 1967. The discovery of grounded theory: Strategies for qualitative research. Aldine de Gruyter.

Gonthier, E. (2009). "L'évaluation des incidences sur l'environnement des projets et des plans et programmes." Limal, Anthemis: 181-221.

Haines Young, R., and Potschin, M. (2010), The links between biodiversity, ecosystem services and human well-being, in Ecosystem Ecology: a new synthesis, BES Ecological Reviews Series, eds. Raffaelli, D., and Frid, C., Cambridge: Cambridge University Press.

Hanley, N. (2010), Why is it so difficult to measure the economic value of changes in "biodiversity"?, Conference "Biodiversity: Basic Commodity or Luxury Item?, Leuven, Belgium.

Haumont, F. (2007). "Urbanisme et environnement." 1317-1326.

Hawkins K. (2003) Economic valuation of ecosystem services. University of Minnesota, unpublished

Heal, G. (2000) Valuing Ecosystem Services. Ecosystem (2000) 3, 24-30.

Heal, G. (2000a), Nature and the Marketplace. Washington, D.C, Island Press.

Hein. L, van Koppen. K, de Groot, R.S, and van Ierland, E.C., (2006) Spatial scales, stakeholders and the valuation of ecosystem services. *Ecological Economics* 57:209-228.

Hlodan, O. (2005). "Simon A. Levin's Passion for Ecology." BioScience **55**(10): 828-831.

Holcombe, R. (1983) Applied Fairness theory: comment. *American Economic Revue* 73(5), 1153-1156.

Jacobs, M. (1997), Environmental valuation, deliberative democracy and public decision-making, in *Valuing Nature: Economics, Ethics and Environment*, ed. Foster, J. London: Routlegde, p211-231.

Kaplowitz, M.D., and Hoehn, J. (2001), Do Focus Groups and Personal Interviews Reveal the Same Information for Natural Resource Valuation?, *Ecological Economics,* 36, 237-247.

Kuzel, A.J. (1999), Sampling in Qualitative Inquiry. In: *Doing Qualitative Research (2nd Edition)*. Eds. Crabtree, M., and Miller, W., London: Sage.

Lambin, E.F., Turner, B.L.I., Geist, H.J., Agbola, S., Angelsen, A., Bruce, J.W., Coome, O., Dirzo, R., Fischer, G., Folke, C., George, P.S., Homewood, K., Imbernon, J., Leemans, R., Li. X, Moran, E.F., Mortimore, M., Ramakrishnan, P.S., Richards, J.F., Skanes, H., Steffen, W., Stone, G.D., Svedin, U., Veldkamp, T.A., Vogel, C. and Xu, J. (2001) The causes of land use and land-cover change: moving beyond the myths. *Global environmental change* 11, 261-269.

Laurent, J-M., Bar-Hen, A., François, L., Ghislain, M., and Cheddadi, R. (2004), Refining vegetation simulation models: From plant functional types to bioclimatic affinity groups of plants. *Journal of Vegetation Science*, 15, 739-746.

Laurent, J-M., François, L., Bar-Hen, A. Bel, R. Cheddadi, R. European Bioclimatic Affinity Groups: data-model comparisons. *Global Planetary Change*, 61, 28-40, 2008.

Lawrence, D. P. (1997). "Integrating Sustainability and Environmental Impact Assessment." Environmental Management **21**(1): 23-42.

Leeuwis, C. (2004), *Communication for rural innovation – Rethinking agricultural extension*. Blackwell Science

Leprince, S., P. Moërynck, et al. (2010). "Droit de l'environnement: les codes, la charte." La charte, Bruxelles **XXXV**: 1014.

Loomis J., Kent P., Strange L., Fausch K., Covich A. (2000) Measuring the Total economic value of restoring Ecosystem services in an impaired River basin : results from a contingent valuation survey. Ecological Economics 33(2000) 103-117.

Maes, J., L. Braat, et al. (2011). PEER: A spatial assessment of ecosystem services in Europe: Methods, case studies and policy analysis - phase 1, PEER.

Martin-Lopez B. et al. (2007) Influence of user characteristics on Valuation of Ecosystem services in Donana Natural Protected Area (south-west Spain). Environmental Conservation 3'(3), 215-224.

MEA (2005), *Millennium Ecosystem Assessment: Ecosystems and Human Well-being: Synthesis.* Washington, DC: Island Press.

Metzger, M.J, Rounsevell, M., Acosta-Michlik, L., Leemans, R., and Schroter, D. (2006), The vulnerability of ecosystem services to land use change, *Agriculture, Ecosystems and Environment* 114(1), 69-85.

Moons, E., Eggermont, K., Hermy, M., Proost, S., Nunes, P., Loomis, J., and Van Ierland, E. (2000), Economische waardering van bossen: Een case-study van Heverleebos-Meerdaalwoud. Garant.

Mortelmans, D., 2009. Handboek kwalitatieve onderzoeksmethoden. Acco, Leuven ;;Voorburg.

Murray-Rust, D., Dendoncker, N., Dawson, T., Acosta-Michlik, L., Karali, E., Guillem, E., and Rounsevell, M. 2011. Conceptualising the analysis of socio-ecological systems through ecosystem services and agent based modelling, *Journal of Land Use Science* 6:2. 83-99.

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. *Frontiers in Ecology and the Environment* 7(1) 4-11.

Nakicenovic, N. & Swart, R. IPCC (Ed.) (2000), Special Report on Emissions Scenarios (IPCC) Cambridge University Press, UK

Neuray, J.-F. (2005). "Leçons de ddroit de l'environnement." Kluwer: 80-103.

OECD (2008). "Strategic Enviromental Assessment and Ecosystem Services."

Otto, D., Rasse, D., Kaplan, J., Warnant P., and François L. (2002), Biospheric carbon stocks reconstructed at the Last Glacial Maximum: comparison between general circulation models using prescribed and computed sea surface temperatures. *Global Planetary Change*, 33, 117-138.

Parker, D.C., Manson, S.M., Janssen, M.A., Hoffmann, M.J., and Deadman, P. (2003), Multi- agent systems for the simulation of land-use and land-cover change: a review. *Annals of the Association of American Geographers* 93 (2), 314-337.

Pearce D., Atkinson G., Mourato S. (2006) Cost-benefit Analysis and the Environment – Recent Developments. OECD Publishing.

Phan, D., and Amblard, F. Eds. (2007), *Agent-based Modelling and Simulation in the Social and Human Sciences*, Oxford, The Bardwell Press.

Pope, J. (2003) *Sustainability Assessment: What is it and How Do We Do It*., Murdoch University, Australia: Institute for Sustainability and Technology Policy.

Quetier, F., Lavorel, S., Thuiller, W., and Davies, I. (2007), Plant-trait-based modeling assessment of ecosystem-service sensitivity to land use change, *Ecological Applications,* 17(8), 2377-2386.

Raymond, C.M., Bryan, B.A., MacDonald, D.H., Cast, A., Strathearn, S., Grandgirard, A., and Kalivas T. (2009) Mapping community values for natural capital and ecosystem services. *Ecological Economics* 68:1301-1315

Reginster, I., and Rounsevell, M. (2006), Scenarios of future urban land use in Europe *Environment And Planning B-Planning & Design*, 33 (4) : 619-636

Richards, L., 2005. Handling qualitative data : a practical guide. SAGE Publications, London;Thousand Oaks CA.

Rounsevell, MDA, et al. (2010). "A conceptual framework to assess the effects of environmental change on ecosystem services." Biodiversity and Conservation **19**(10): 2823-2842.

Rounsevell, M.D.A., and Metzger, M.J., (2010a), Developing qualitative scenario storylines for environmental change assessment. *WIREs Climate Change,* 1, 606-619.

Sadler, B. and R. Verheem (1996). "Strategic Environmental Assessment Status, Challenges and Future Directions." Ministry of Housing, Spatial Planning and the Environment, Netherlands **54**.

Salas y Mélia D, Chauvin F, Déqué M, Douville H, Guérémy JF, Marquet P, Planton S, Royer JF, Tyteca S (2005). Description and validation of CNRM-CM3 global coupled climate model. Note de centre GMGEC, CNRM, 103.

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

Schröter, D., Cramer, W., Leemans, R., Prentice, C., Arnell, A.W., Araujo, M.B., Bondeau, A., Bugmann, H., Carter, T.R., de la Vega-Leinert, A.C., Erhard, M., Ewert, F., Fritsch, P., Friedlingstein, P., Glendining, M., Gracia, C.A., Hickler, T., House, J.I., Hulme, M., Kankaanpää, S., Klein, R.J.T., Lavorel, S., Lindner, M., Liski, J., Metzger M., Meyer, J., Mitchell, T., Morales, P., Reidsma, P., Pla, E., Pluimers, J., Pussinen, A., Reginster, I., Rounsevell, M., Sanchez, A., Sabaté, S., Sitch, S., Smith, B., Smith, J., Smith, P., Stykes, M.T., Thonicke, K., Thuiller, W., Tuck, G., van der Werf, G., Vayreda, J., Wattenbach, M., Wilson, D.W., Woodward, F.I., Zaehle, S., Zierl, B., Zudin, S., Acosta-Michlik, L., Moreno, R., Espinera, G.Z., Mohren, F., Bakker, M., and Badeck, F. (2005) Ecosystem service supply and vulnerability to global change in Europe. *Science,* 310(5752), 1333-1337.

Scherrer S. (2003) Evaluation economique des aménités récréatives d'une zone humide intérieure : le cas du lac du der. Série Etudes 03-E05, 1-75

Schurmans, M., M. Boodts, et al. (2008). "Een globaal overzicht van de plan-mer-regelgeving: van europees, federaal, tot regionaal." MER: 3-90.

Slootweg, R., A. Rajvanshi, et al. (2010). Biodiversity in environmental assessment : enhancing ecosystem services for human well-being. Cambridge, UK ; New York, Cambridge University Press.

Starks, H., Brown Trinidad, S., 2007. Choose Your Method: A Comparison of Phenomenology, Discourse Analysis, and Grounded Theory. Qualitative Health Research 17, 1372 –1380.

Strauss, A.C., Corbin, J., 1998. Basics of Qualitative Research: Second Edition: Techniques and Procedures for Developing Grounded Theory. Sage Publications.

Stern, P.C., Dietz, T., 1994. The Value Basis of Environmental Concern. Journal of Social Issues 50, 65–84.

Slootweg, R. and van Beukering, P. (2008), *Valuation of ecosystem services and strategic environmental assessment*. Utrecht, The Netherlands: Netherlands Commission for Environmental Assessment.

Spash C.L. (2007) Deliberative monetary valuation (DMV): Issues in combining economic and political processes to value environmental change. Ecological Economics 63 (2007), 690-699.

Steffen, W. (2009), Interdisciplinary research for managing ecosystem services. *PNAS* 106, 1301-1302.

Supit, I., Hooijer, A.A. and Diepen van, C.A., 1994. System Description of the WOFOST 6.0 Crop Simulation Model Implemented in CGMS, Volume 1: Theory and Algorithms. EUR 15956 EN, Joint Research Center, Commission of the European Communities, Luxembourg

Tashakkori A, and Teddlie, C. (2003), *Handbook of mixed methods sampling in social and behavioural research.* London: Sage.

TEEB (2010), *The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature*: *A synthesis of the approach, conclusions and recommendations of TEEB*. Nagoya: UN.

TEEB (2011). The Economics of Ecosystems and Biodiversity in National and International Policy Making. London and Washington, Earthscan.

Terra S. (2007) Guide de bonnes pratiques pour la mise en œuvre de la méthode des coûts de transport. Direction des études économiques et de l'évaluation environnementale, Série Méthode 05-M05, 1-39

Treweek, J, Therivel, R., Thompson, S., and Slater, M. (2005), Strategic Environmental Assessment as a tool for Promoting the Conservation and Sustainable Use of Biodiversity. *Journal of Environmental Assessment Policy and Management,* 7(2), 173–199.

Turner II, B.L., Skole, D.L., Sanderson, S., Fischer, G., Fresco, L.O., and Leemans, R. (1997) Land Use and Land Cover Change. *Earth Science Frontiers* 4, 26-33.

Turner R.K. and Daily G.C. (2008) The Ecosystem Services Framework and Natural Capital Conservation. Environ Resource Econ (2008)39, 25-35.

Van Herzele, A., Collins, K., and Tyrväinen L. (2005). Involving people in urban forestry: A discussion of participatory practices throughout Europe. In *Urban forests and trees in Europe*. Eds. Konijnendijk, C.C., Nilsson, K., Randrup, T.B., Schipperijn, J. Springer Academic Publishers

Van Herzele, A., van Woerkum, C.M.J. (2008), Local knowledge in visually mediated practice. *Journal of Planning Education and Research* 27, 444-455.

Van Herzele A., van Woerkum, C. (2011), On the argumentative work of map-based visualisation. *Landscape and Urban Planning 100*: 396-399.

Verheem, R. (2002), Recommendations for Sustainability Assessment in the Netherlands. In. *Environmental Impact Assessment in the Netherlands. Views from the Commission for EIA in 2002*. The Netherlands : Commission for EIA.

Verstraeten, G., J. Poesen, G. Demarée, and C. Salles (2006), Long-term (105 years) variability in rain erosivity as derived from 10-min rainfall depth data for Ukkel (Brussels, Belgium) : Implications for assessing soil erosion rates, J. Geophys. Res., 111, D22109, doi:1.1029/2006JD007169

Ward F. and Beal D. (2000) Valuing Nature with Travel Cost models. A Manual. Edward Elgar, Cheltenham, UK, 255p.

Warnant, P., François, L., Strivay, D., Gérard, J.-C., (1994), CARAIB: a global model of terrestrial biological productivity. *Global Biogeochemical Cycles*, 8, 255-270.

Wilson, M.A., and Howarth, R.B., (2002), Distributional fairness and ecosystem service valuation. *Ecological Economics* 41, 431-443.

ANNEXE

ANNEX 1: COPY OF THE PUBLICATIONS

Are available on our website

http://www.belspo.be/belspo/ssd/science/pr_terrestrial_en.stm