Final report

Estimate of the benefits delivered by the Flemish Natura 2000 network

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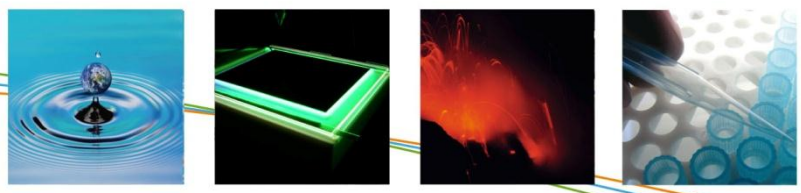

ABSTRACT

→ Objective

This study gives an estimate of the **benefits delivered by the Flemish Natura 2000 network as a whole and at site level**. With this study the Agency for Nature and Forests wants to gain insight into the societal benefits delivered by Special Areas of Conservation (SAC) and Special Protection Areas (SPA): which are these benefits, how large are they and where are they delivered. In addition, it is examined how these benefits change following the realisation of the nature conservation objectives (NCOs) within these areas. This is used, among other things, as a step towards the development of alternative funding techniques which can make the value (or part of that value) of ecosystem services flow back to the network.

In this study we consider benefits from a societal and not a private point of view. A positive contribution is made to the level of prosperity if the project results in an increase in overall prosperity, which means irrespective of the distribution over people or areas. Therefore, this report does not look into the question of who carries the burdens and who reaps the benefits of a policy decision. The social dimension behind the benefits is not discussed.

→ Method

To value the benefits, the framework of the ecosystem services is applied. Ecosystem services (ESS) are those services which ecosystems provide to society. Ecosystem services support human well-being in different ways. Basic services, such as food and wood production, are necessary to provide for one's livelihood. An impact on air quality, noise and recreation leads to an improved health condition. Opportunities for recreation increase the physical and psychological well-being and strengthen social relationships. In order to record the benefits of the realisation of Natura 2000 in Flanders, we will quantify and value the impact of this ecological network on ecosystem services and the ensuing benefits as much as possible.

The information required to that end is not available for all the ecosystem services. That is why we use a pyramid approach. We value the services for which this is possible and do thus not consider the whole range of ecosystem services that are supported through biodiversity. In the first instance, we give a qualitative indication, for as many services as possible, of whether and how they change. Secondly, for a selection of ecosystem services we quantify the biophysical impact of the realisation of the COs. This selection is made in function of the availability of data, the scientific credibility and the level of acceptance of quantification functions. Finally, we determine the monetary value of the change in these ecosystem services for a number of these quantified services. This report discusses a total of 17 different ecosystem services. We thus neither consider all the ecosystem services defined at the European level (CICES, 2012), nor all the potential benefits.

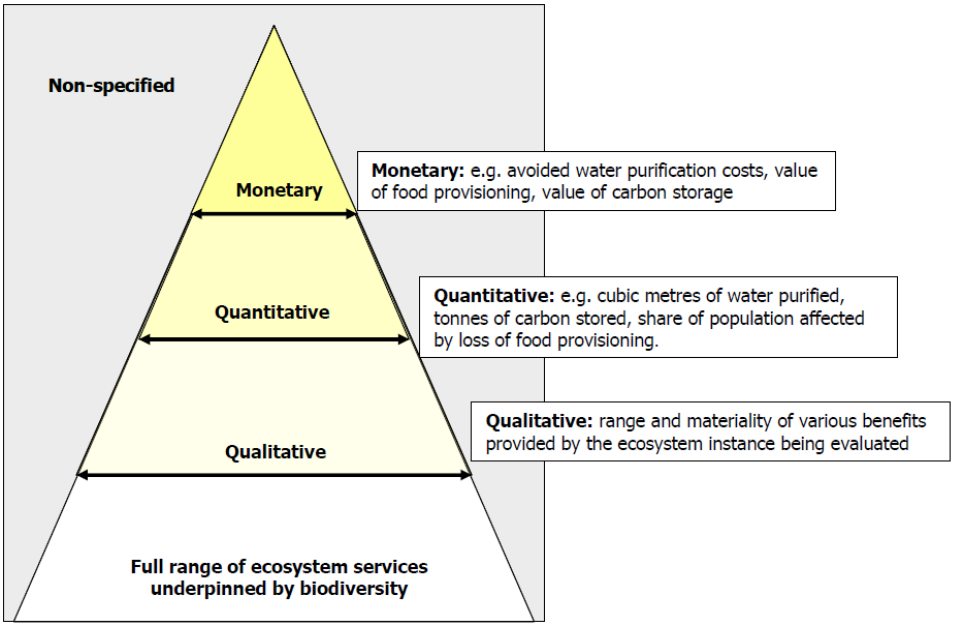

Figure: Pyramid-approach in ecosystem services assessment (Gantioler et al., 2010)

We do not claim having recorded all the benefits in this study. It is an estimate of what can be calculated on the basis of the knowledge that is currently available in Flanders. Since a number of important benefits, such as coastal protection and flood prevention, could not be valued on the scale of 'Flanders', the calculated benefits may be an underestimation of the real benefits.

For the cultural services we focus on the detailed valuation of recreation and experience by tourists and recreational users, the experience by people living in the neighbourhood and the health benefits. For other cultural services, such as education, research and non-use value, insufficient data and functions are available to apply them to this scale and within this context. Cultural services can also be valued as a whole (on the basis of stated preferences), whereby no further distinction can be made for recreation and non-use value, for instance (see also Nature Value Explorer, Liekens et al., 2013). Because the valuation functions that are available for Flanders are difficult to apply to this scale and within this context, and because the results partially overlap with the valuation of individual cultural services, they are not taken into further consideration in this study.

The different services are valued using the most suitable and available methods and data for that specific service. The valuation is partially based on market prices (agriculture and wood production, replacement costs, avoided sickness costs), revealed preference methods (travel cost method for experience by recreational users, hedonic method for experience by people living in the neighbourhood) and, to a lesser extent, on stated preferences (valuation of health effects). For several services the valuation is based on a combination of various methods and studies in Flanders and abroad.

Table: Overview of ecosystem services and the extent to which their valuation has been discussed in this study

Section	Group	Ecosystem service	Qualitative	Quantitative	Monetary
Provisioning services	Nutrition	Agricultural production: crops, cattle and derived products (such as meat, milk,...)	X	X	X
		Wild animals from terrestrial ecosystems			
		Wild plants from terrestrial ecosystems			
		Freshwater animals (such as fish) and plants			
		Marine animals (such as fish, shellfish) and plants, algae			
		Plants, algae and animals from in-situ aquaculture			
	Water	Supply of surface and ground water	X	X	X
	Materials	Wood production	X	X	X
		Other plant materials			
		Animal materials (such as fur)			
		Genetic, medicinal and cosmetic resources			
	Energy	Biomass			
Regulating services	Reduction of waste, toxics and other substances	Bioremediation			
		Dilution, filtration and storage of pollutants: air quality through capture of fine dust	X	X	X
		Dilution, filtration and storage of pollutants			
		Reduction of odour/noise/visual impact (limited to noise)	X	X	X
	Regulation of water and land flows	Stabilisation of water levels (water retention and infiltration)	X		
		Protection against river flooding	X	C	C
		Protection against coastal flooding (coastal protection)		C	C
		Erosion prevention	X	C	C
	Regulation of the physical, chemical and biological environment	Global climate regulation (carbon sequestration in soils)	X	X	X
		Global climate regulation (carbon sequestration in biomass)	X	X	X
		Regional and local climate regulation			
		Water quality (denitrification)	X	X	X
		Water quality (N, P storage)	X	X	
		Pollination and seed dispersal	X	X	
		Nurseries			
		Natural pest and disease control (including invasive species)			
Cultural services	Total cultural services valued as a whole with stated preferences				
	Recreation and experience	Experience by recreational users and tourists	X	X	X
		Experience by people living in the neighbourhood	X	X	X
		Health effects of contact with nature	X	X	X
	Information and knowledge	Education			
		Research			
	Cultural, spiritual and symbolic value				
	Non-use value				

X: developed for scale 'Flanders' + case studies; **C:** only developed for case studies

Furthermore, we want to stress that the figures give a valuation from an anthropocentric point of view, on the basis of the current preferences for the Flemish population in its entirety. They are also limited to the services which we can value. Other aspects are not considered at all in this study or only to a limited extent. This is the case for instance for the biological/ecological importance of certain ecosystems for plant and animal species or for the rarity of certain ecosystems in our country. The figures offer policy makers information about the loss of prosperity that would occur, if certain ecosystem services were to disappear or be damaged. They help to decide whether or not to make certain choices/investments for nature conservation and nature management and to choose between alternative locations, planning and/or management methods for the (re)construction of nature.

Apart from that, specific attention is also devoted to additional economic effects. These effects cannot be added to the benefits of ecosystem services, but give an indication of the potential economic impact on a number of sub-aspects. In this context we focus on the indirect economic impact of recreation and tourism on the added value and employment. This is limited for purposes of illustration. For instance, we will not discuss any potential indirect economic effects on the agricultural sector and wood-processing industry.

Natura 2000 areas do not just include nature areas. Apart from nature, SACs and SPAs also encompass agricultural land and more urbanised areas. In this study we consider the Natura 2000 areas as a whole. The benefits delivered by these other land uses are included as well. We thus do not only focus on nature within Natura 2000 areas. Agricultural production is an obvious example. The positive contribution of these agricultural areas to infiltration, C sequestration in soils, recreation, etc. is taken into consideration too.

For this study we build on a number of existing instruments, such as Natuurwaardeverkenner (Nature Value Explorer) and RuimteModel Vlaanderen (Spatial Model for Flanders), to value the ecosystem services generated by the Flemish Natura 2000 network in a spatially explicit manner. The methods in the Natuurwaardeverkenner have been used to value the majority of ecosystem services (see www.natuurwaardeverkenner.be). RuimteModel Vlaanderen is a spatially dynamic land use model built to explore any developments in spatial use in Flanders throughout time (http://rma.vgt.vito.be/verkenner). It was also used in the calibration exercise to record the spatial allocation of target distances between the current environmental quality and the environmental quality that is required for a favourable conservation status, per habitat type and per special area of conservation (SAC). To this end, the total required area per habitat type, as specified in the regional nature conservation objectives, was divided over the different sub-areas of SACs in Flanders. The results of this calibration exercise were also calculated in this valuation study and constitute the basis of what can be expected after the realisation of the NCOs. This also implies that we work spatially in an explicit manner. The value of ecosystem services is calculated on a hectare scale.

→ Land use before and after the realisation of the NCOs within SACs and SPAs

Today, SACs and SPAs already mainly consist of nature areas. About one third of the surface area is still agricultural land. Only 7.6% consists of land used for urban and military purposes. Following the realisation of the NCOs, an increase is recorded, especially in heathland and land dunes, forests and shrubs and estuarine nature, within all SACs and SPAs. This is above all at the expense of fields or pastures and to a limited extent of other land use (unclassified), flower- and species-rich grasslands, and military land use. The reduction in flower- and species-rich grasslands seems

surprising, but is caused by the conversion of grasslands with nature management to nature types other than grasslands.

The area of habitat types grows by approximately 50%. This is a much stronger growth than the increase in natural land use in general. This means that the objectives are largely realised through the conversion of existing nature and not through the creation of additional nature. Of the approximately 24,000 ha, the largest part by far is realised through forest conversion. Although the amount of flower- and species-rich grasslands and brushwoods decreases in the overall land use, it strongly increases when only considering Natura 2000 habitat types.

Table: Total land use in all SACs and SPAs before and after the realisation of the NCOs

Land use category *	**Current situation**		**After realisation of the NCOs**		**Difference**	
	Ha	**%**	**Ha**	**%**	**Ha**	**% increase**
Urban and military land use	12,525	7.6%	12,372	7.5%	-153	-1.2%
Fields or pastures	55,306	33.4%	50,044	30.2%	-5,262	-9.5%
Heathland and land dunes	9,464	5.7%	12,494	7.5%	3,030	32.0%
Forests and shrubs	54,356	32.8%	56,984	34.4%	2,628	4.8%
Flower- and species-rich grasslands and brushwood	14,589	8.8%	14,300	8.6%	-289	-2.0%
Rivers and stagnant waters	5,327	3.2%	5,388	3.3%	61	1.1%
Marshes	2,448	1.5%	2,298	1.4%	-150	-6.1%
Sea coast and estuaries	7,916	4.8%	9,044	5.5%	1,128	14.2%
Other	3,640	2.2%	2,648	1.6%	-992	-27.3%
Total	165,571	100.0%	165,572	100.0%		

** Table for the translation of land use into land use category in Annex 1*

Table: Area of habitat types and regionally important biotopes in all SACs and SPAs before and after the realisation of the NCOs

Land use category *	**Current situation**		**After realisation of the NCOs**		**Difference**	
	Ha	**%**	**Ha**	**%**	**Ha**	**% increase**
Heathland and land dunes	8,930	19.0%	12,236	17.3%	3,306	37.0%
Forests and shrubs	23,588	50.3%	40,245	56.8%	16,657	70.6%
Flower- and species-rich grasslands and brushwood	4,564	9.7%	6,541	9.2%	1,977	43.3%
Rivers and stagnant waters	1,003	2.1%	1,409	2.0%	406	40.5%
Marshes	1,347	2.9%	1,666	2.3%	319	23.7%
Sea coast and estuaries	7,485	16.0%	8,806	12.4%	1,321	17.6%
Total	46,917	100.0%	70,903	100.0%	23,986	51.1%

** Table for the translation of land use into land use category in Annex 1*

Due to the rasterisation of SACs and SPAs, the exact areas may deviate from the areas included in other reports. The total area of all SACs, for instance, is 78 ha or 0.1% less than the areas considered with the calibration model. However, this hardly affects the results.

Additional forest goals in the context of Natura 2000 that are realised outside SACs and SPAs are not included in these areas and their benefits are therefore not calculated either. As a result, part of the impact of this forest expansion on a number of ecosystem services, such as the decreasing agricultural production and the increasing wood production, air quality, C sequestration in biomass and recreation, is not considered.

→ Qualitative description of the different ecosystem services and the impact of the realisation of the NCOs

Ecosystem service	Description	Impact of realisation of NCOs	
Agricultural production	Agricultural production largely goes hand in hand with the amount of agricultural land that is available in SACs and SPAs. Depending on the crop type (grassland-field) and the soil suitability, the benefits may vary.	- -	The change in land use from agriculture to nature will reduce this service. About 10% of the agricultural land disappears after realisation of the NCOs. Therefore, the production will fall by about 10% as well. At the level 'Flanders', there is thus an important loss of the service 'agricultural production' within SACs and SPAs. This ecosystem service is deteriorating in almost each of the SACs and SPAs. In terms of economic benefits, the scale of this loss almost never outweighs the benefits resulting from the increase in other ecosystem services.
Wood production	Wood production depends on the tree species (in accordance with the forest mapping), the suitability of the soil for this tree species and the harvesting regime (distinction between publicly and privately managed forests). Forest expansion has a positive effect on this service. The impact of forest conversion depends on the tree species.	+-	At the level 'Flanders', the service 'wood production' slightly increases within SACs and SPAs following the realisation of the COs. There is an important growth in a number of woody SACs and SPAs which compensates for the loss of forest in other areas. This increase is mainly owing to forest expansion. The losses usually result from a conversion of forest to a heathland habitat. The impact of forest conversion (coniferous to deciduous) differs from case to case. It depends on the specific tree species and the suitability of the soil for these tree species. We assume that there is no difference in harvesting regime before and after the realisation of the NCOs.
Air quality - capture of fine dust	The air quality depends on the type of vegetation. A larger canopy leads to a greater capture of fine dust. In this context the impact of deciduous forests is lower than that of coniferous forests, especially during winter. Therefore, the conversion of coniferous forests may have a negative impact on this service. The planting of additional forest will make this service increase.	- -	Within SACs and SPAs the realisation of the NCOs has a negative impact on the service 'air quality'. This is due to a transition to lower types of vegetation, such as heathland, grassland, marsh and estuarine habitat. The conversion of coniferous forests to deciduous forests also has a negative impact. The creation of additional forest mainly takes place outside SACs and SPAs and is therefore not included here.
Reduction of noise nuisance	The reduction of noise nuisance is considered within the noise contours along busy roads. An impact can be recorded when forests are located between dwellings that experience noise nuisance and the road.	+-	This service is relatively unimportant compared to other services and there is assumed to be no difference before and after the realisation of the NCOs.
Carbon sequestration in biomass	This service varies approximately to the same extent as wood production. The carbon sequestration will also vary as a result of forest conversion. Harvesting regimes do not	+-	The realisation of the NCOs has a mainly positive impact on this service. This is realised through forest expansion. The additional C sequestration in biomass resulting from an increased area of forest

	have any bearing on this service because it depends on the annual increment and not on the amount that is harvested.		compensates for the declining biomass following the conversion of forest to heathland, grassland and estuarine habitat on the scale 'Flanders'. The impact may be negative for specific areas where forest disappears or only forest is converted.
Carbon sequestration in soils	In function of the changing land use (nature type) and changing water management, the amount of carbon sequestration will be affected. In particular, the restoration of the natural hydrology (rewetting) in valleys and depressions and the expansion of the nature types 'wet forests' and 'bogs' substantially increase the potential of this service.	++	Soil carbon sequestration increases considerably under the Natura 2000 scenario. This is, on the one hand, the result of an expansion of wet grassland, swamp wood, forest and estuarine habitat compared to more managed land use forms, and, on the other hand, of a rewetting of these areas that goes hand in hand with the type of management. The increase in this service in valleys, forested areas and flood plains compensates for the decrease in the conversion to heathland. Depending on the soil type, water management and land use, the results for this service can vary strongly by area.
Prevention of coastal and river flooding	The importance for flooding depends on the water buffering capacity and the vulnerability of the land use to flooding. Benefits are realised through the conversion of a flood-prone land use type to a type of low flood risk. Additional water buffering capacity can be created in areas of low flood risk.	+	The transition from flood-prone land use (usually agriculture) to a land use of low flood risk (nature) through the realisation of Natura 2000 has a positive impact on this service. The benefits are realised in two different ways. On the one hand, the damage costs are lower when a nature area is flooded than when an agricultural area is flooded. On the other hand, a nature area can be used as a buffer area, which avoids flooding elsewhere. The qualitative assessment only takes account of the first factor. The real importance of this service in Flanders is underestimated.
Water retention	Water retention in shallow groundwater implies the (temporary) retention of water. This has positive effects in case of peak discharge (increased storage) and of drought (retention of water, sponge effect). Water retention as a support function plays a very decisive role for ecosystem services, such as denitrification, soil carbon sequestration and the associated nutrient retention. Water retention is influenced by soil characteristics, drainage and land use (desired drainage).	+	The conversion of agricultural land in artificially drained areas to wet habitat types, and the associated restoration of the natural hydrology, is the main reason why this service gains importance after the realisation of the NCOs. This service is not declining in any of the SACs and SPAs.
Water infiltration	Infiltration or ingress of rainwater into the soil is an important ecosystem function. Infiltration increases both the available amount and quality of groundwater and surface water. Infiltration depends on the soil and the land use. Changes in land use may lead to increased or decreased water infiltration, depending on the type of vegetation.	+	This service becomes more important after the realisation of the NCOs. The additional benefits are mainly realised through an increase in the heathland area. Especially coniferous forests have a relatively high interception and are often converted to dry forests or heathland. This service is not declining in any of the SACs and SPAs.
Water supply	This study mainly approaches water supply from the angle of increasing the aquifer recharge in areas with a high groundwater abstraction pressure. The importance depends on infiltration, the abstraction pressure in the area and the quality of the infiltrated water (fertilised or non-fertilised area).	+	This service increases considerably following the realisation of the NCOs. First of all, the amount of infiltration increases due to the conversion of coniferous forests to heathland or dry forests. These habitat types are very common in sandy regions which are also characterised by a high groundwater abstraction pressure. There is also an important shift from infiltration without nature management to nature management.

Nutrient removal (denitrification)	Under certain favourable conditions of water management, ecosystems can filter nutrients (nitrogen, phosphorus) from ground and surface water through bacterial denitrification. The soil humidity level is an important variable for determining the potential denitrification. Rewetting increases the potential denitrification. The actual denitrification will be higher in areas with a high nitrate concentration in the groundwater, which is caused by (supra)local nitrate leaching. In the conversion of agriculture to nature this has a positive effect. The avoided nitrate leaching is quantified as well.	++	In particular the formation of large nature units allows for large-scale rewetting. The conversion of forest or agriculture to rather wet nature types, such as marsh, swamp forest and humid grassland makes it possible to restore the natural soil hydrology. The conversion of agriculture to nature leads to a reduction in local nitrate leaching. The actual denitrification will often be reduced as well. The leaching which is avoided as a result of such a conversion is a benefit in itself. However, even if the total denitrification hardly increases as a result of reduced pressure, the denitrification rate will increase in most cases and the water quality will improve.
Nutrient removal (N/P storage in soils)	In function of the changing land use (nature type) and changing water management, the amount of carbon sequestration and, by consequence, also of the nitrogen and phosphorus storage in soils will be influenced. In case of rewetting, the potential to store nitrogen and phosphorus in soils increases due to the lower mineralisation rate.	+	This service depends on the water management and on the amount of soil carbon sequestration: the higher the amount of organic carbon that is sequestered in the soil, the higher the nutrient supply. An enhanced carbon sequestration following a conversion to very wet habitat types (marshes, bogs and estuarine environments) increases this service. The restoration of the natural hydrology also causes this service to become more important. Both factors strongly enhance the importance of this service. This service declines in some of the heather-dominated SACs and SPAs. This is due to a lower soil carbon sequestration under heathland compared to forest.
Erosion prevention	Erosion prevention depends on the vulnerability of plots to erosion and on the land use. The conversion of field to nature has a large impact on erosion prevention. This service is very important, especially for forests. However, erosion is also substantially reduced by heathland and grassland.	+	The largest benefits of this service are realised through a conversion of field to forest, heathland or grassland. The conversion of intensive (such as cultivated grassland) to extensive land use (fallow grassland) also increases the benefits of this service. This service is especially important in very rugged SACs and SPAs. When forest is converted to heathland or grassland, this service may slightly decrease, although at the level 'Flanders' this is limited, since it usually takes place in less hilly areas.
Pollination	Pollination depends on the absent vegetation within SACs and SPAs which would be suitable for pollinating insects and the available agricultural crops in an area around SACs and SPAs that require pollination. A growth in habitat types that are suitable for pollinating insects, ecosystems that are rich in nutrients and small-scale landscape elements increase the importance of this service.	+-	At the level 'Flanders', this service hardly undergoes any changes. At the level of SACs and SPAs there is generally a slight increase in the importance for pollination of these areas, except in those SACs and SPAs where pollination-dependent agriculture is converted to habitat types that provide little pollination, such as beech forest and barren grassland.
Experience by recreational users and tourists	The experience by recreational users and tourists depends on the land use and, more specifically, on the available green space (nature and agriculture) within SACs and SPAs, the population density (local municipality, supra-local and regional) and the amount of green space available in the surroundings of SACs and SPAs. This is also dependent on the extent to which	++	The importance of this service grows substantially. Following the realisation of the COs the estimated number of visits to nature and forest rises because more accessible nature becomes available and the size of the areas increases. In this context we assume that areas where habitat types are created become more accessible to recreation. On the other hand, the recreation in agricultural areas decreases as a result of the declining amount of agricultural area in

	green space is actually accessible and organised for recreation. These aspects are only roughly valued. For the quantification we distinguish between nature and forest and agricultural area, but not between different types of nature (forest, heathland,…). For the valuation we do not make any distinction between types of green space (nature and agriculture).		SACs and SPAs. In net terms, the number of visits rises. The impact of additional organisation and branding of areas can signify a further increase in visitor numbers and related benefits. This was not explicitly considered. Due to the growing population and urbanisation outside Natura 2000 areas, the demand for recreation in these areas will increase in the long term.
Quality of living environment (prices of housing)	Houses which look out onto or are situated near green and open spaces (nature and agriculture) offer a higher quality of living, which leads to higher property values. The added value for the outlook on green space depends on the number of houses within a 100-metre distance to SACs and SPAs. The added value is also generated at a greater distance (up to 1km). However, this overlaps with recreation.	+-	Because no distinction is made between types of green space for the quantification, we cannot calculate any effects for conversion within the green space. We therefore assume that this benefit does not change after realisation of the NCOs.
Health	Green space in the direct living environment has a positive effect on the mental and physical health. The effects of this service are directly related to the number of people living within a distance of 1km to SACs and SPAs. The functions for quantifying this do not make any distinction between types of green space (agriculture, forest, nature types).	+-	Because no distinction is made between types of green space for the quantification, we cannot calculate any effects for conversion within the green space. We therefore assume that this benefit does not change after realisation of the NCOs.

→ **Quantitative and monetary valuation of services**

When looking at the monetary value of the 11 valued ecosystem services of the existing Natura 2000 network, it strikes that especially the services related to health (air quality, recreation, health effects of contact with nature) constitute a large part of the total benefits. In addition, soil carbon sequestration and, to a lesser extent, agricultural production and nutrient removal also have important value. Wood production, carbon sequestration in biomass, noise nuisance reduction and water supply are less important in the overall benefits. A total value of about 800 million to 1.4 billion euros per year corresponds to about 124 to 222 euros per Flemish person per year. Expressed per hectare, this is a value of about 4,700 to 8,500 euros per year.

Table: Quantitative and monetary valuation of 11 considered ecosystem services in all SACs and SPAs in the current situation (2010)

	Quantification per year			Valuation (k€/year)	
Ecosystem services	**Low**	**High**	**Unit per year**	**Low**	**High**
Agricultural production		89,087	k€ added value of production		89,087
Wood production		161,722	m^3 harvested wood		5,422
Air quality: capture by plants	3,981	7,975	Ton captured fine dust	214,953	430,658

Carbon sequestration in biomass	154,349		Ton C sequestration in biomass	33,957	
Carbon sequestration in soils	28,474,560		Ton C stock in soils	156,610	
Noise nuisance reduction	321		Houses with impact buffer	7	51
Flood prevention	Only qualitative				
Water infiltration	302,745		1,000 m^3 infiltration capacity	Supporting	
Water retention	227,468		1,000 m^3 water retention capacity	Supporting	
Water supply	15,869		1,000 m^3 water abstraction in nature	1,190	3,174
Nutrient removal	1,094,088		kg N removal	5,470	80,963
Nitrogen storage in soils	1,735,758		Ton N stock in soils	Supporting	
Phosphorus storage in soils	115,717		Ton P stock in soils	Supporting	
Erosion prevention	Only qualitative				
Pollination	216		Ha of agricultural area within 1km around SACs and SPAs depending on pollination	Not valued	
Experience by recreational users and tourists	25,757	42,928	1,000 visits per year	77,270	386,350
Quality of living environment	81.37		1,000 houses within 100m	14,849	29,922
Health effects of contact with nature	1,801		1,000 people living within 1km	183,479	
Total				***782,296***	***1,399,673***
Total in € per ha				***4,725***	***5,454***

When comparing the monetary value of 11 ecosystem services after the realisation of the COs with the current situation, other services become important. We record a clearly negative impact on agricultural production as a result of the disappearance of agricultural land. This is only for a small part compensated for by additional wood production. Forest conversion which involves replacing coniferous forest with deciduous forest, which, relatively speaking, captures less fine dust, results in lower benefits for an improvement of the air quality. An important qualification in this respect is that forest expansion, which has a positive impact on air quality, mainly takes place outside SACs and SPAs and is not considered in this estimation of benefits. Carbon sequestration in soils and biomass, on the other hand, does improve. The removal of nutrients strongly increases. Recreation also increases because more accessible nature becomes available and the areas grow in size. More and better opportunities for recreation also lead to benefits for the living environment and for public health. However, due to the risk of double counting these are not considered separately. In net terms, we estimate the additional benefits for the 11 valued services at 15 to 94 million euros per year.

Table: Additional quantitative and monetary value of 11 ecosystem services after realisation of the COs in all SACs and SPAs

	Quantification per year			**Valuation (k€/year)**	
Ecosystem services	**Low**	**High**	**Unit per year**	**Low**	**High**
Agricultural production	-7,238		k€ added value of production	-7,238	
Wood production	167		m^3 harvested wood	213	
Air quality: capture by plants	-77.88	-149.93	Ton captured fine dust	-4,205	-8,096
Carbon sequestration in biomass	5,024		Ton C sequestration in biomass	1,105	
Carbon sequestration in soils	1,758,763		Ton C stock in soils	9,673	

Noise nuisance reduction	0		Houses with impact buffer	0	0
Flood prevention	Only qualitative				
Water infiltration	4,692		1,000 m^3 infiltration capacity	Supporting	
Water retention	9,240		1,000 m^3 water retention capacity	Supporting	
Water supply	2,163		1,000 m^3 water abstraction in nature	162	433
Nutrient removal	420,915		kg N removal	2,105	31,148
Nitrogen storage in soils	101.830		Ton N stock in soils	Supporting	
Phosphorus storage in soils	6,789		Ton P stock in soils	Supporting	
Erosion prevention	Only qualitative				
Pollination	-4		Ha of agricultural area within 1km around SACs and SPAs depending on pollination	Not valued	
Experience by recreational users and tourists	4490.98	7484.97	1,000 visits per year	13,473	67,365
Quality of living environment	0.00	0.00	1,000 houses within 100m	0	0
Health effects of contact with nature	0		1,000 people living within 1km		0
Total				***13,341***	***83,807***

→ **Additional effects**

Additional effects include the effects of the ecosystem services on (local) economy and employment. This is relevant for several services (such as agricultural and wood production), but we limit the analysis to the effects of recreation and tourism.

We estimate that, following the realisation of the NCOs, the annual spending by recreational users increases by 30 to 67 million euros. This is an increase in the added value from 13 to 28 million euros or an additional employment of 471 to 1,062 full-time equivalents.

Table: Additional effects following realisation of the NCOs in all SACs and SPAs

Additional effects (difference current situation – situation after realisation of NCOs)	**Quantification per year**		
	Low	**High**	**Unit**
Spending by recreational users	29,928	67,485	k€ spent per year
Added value by recreation (direct and indirect)	12,573	28,351	k€ added value
Employment through recreation	471	1,062	Full-time equivalents