

Final report

Evaluation of the socio economic impact of the FLANDRE project on the local economy, population and restoration of ecosystem services

De Nocker Leo, Broekx Steven, Demeyer Rolinde, Simoens Ilse, Turkelboom Francis, Provoost Sam,
Van der Biest Katrien

Study performed for the “Vlaamse Overheid, Agentschap voor Natuur en Bos West-Vlaanderen” and the “Conservatoire de l’Espace Littoral et des Rivages Lacustres”, for the LIFE+ Nature Restoration Project FLANDRE (Flemish And North French Dunes Restoration)(LIFE12/NAT/BE/000631), cofinanced by the European Union (Life)

2020/RMAt/R/

February 2020



Vlaanderen

AGENTSCHAP
NATUUR & BOS



Conservatoire
du littoral



VITO NV

Boeretang 200 - 2400 MOL - BELGIE
Tel. + 32 14 33 55 11 - Fax + 32 14 33 55 99
vito@vito.be - www.vito.be

BTW BE-0244.195.916 RPR (Turnhout)
Bank 375-1117354-90 ING
BE34 3751 1173 5490 - BBRUBEBB

[Document Number]

SUMMARY

1. Goal of the project

The LIFE+ NATURE project 'FLANDRE' (Flemish And North French Dunes Restoration) is a collaborative project of the Agentschap voor Natuur en Bos, the Conservatoire du Littoral et des Rivages lacustres and the Département du Nord, co-financed by the European Union, to restore nature in the coastal dunes between Dunkerque (France) and Westende (Belgium).

The goal of the project is to consolidate the Natura 2000 network in both countries by restoring the characteristic habitat types and increasing the public support. The project aims to take a first step towards the creation of a transnational 'European' nature park.

2. Goal and approach of this study

The aim of this study is to estimate the impact on economy and employment, on ecosystem services and on biodiversity (for the nature restoration measures in the Oostvoorduin). The **direct effects** of the project are rather limited, because the project provides for limited acquisition of land and limited interventions in the landscape or facilities for recreation. The focus of the study is on **the indirect effects**. To this end, the study gives indicators that illustrate the importance of the dunes to society and economic sectors, and identifies the factors that determine that importance. We discuss how the FLANDRE project can influence those factors and how it can contribute to a better anchoring of the protection of this coastal nature. For this purpose, different methods are combined.

3. The consultation of the different stakeholders and visitors in 2014 and 2019

Firstly, the consultation in 2014 of the different stakeholders (tourism, coastal protection, water supply, real estate) in both countries shows that they support this project and that it is consistent with their own vision. All respondents mentioned the local administration as the main bottleneck of the project, because they do not see nature conservation as a priority. On the other hand, for the realization of the cross-border nature park it is necessary that local authorities support this project. It is therefore recommended to further analyze this problem and to find ways of cooperation with the local authorities and establish common goals.

Secondly, in 2014, 392 visitors of the domains managed by the Département du Nord and the Agentschap voor Natuur en Bos were surveyed and information about their profile, knowledge and experience and perception of the coastal landscape was reported. The survey shows that the dunes are visited by a large public of all ages. Both people in the area and tourists strongly appreciate the dunes. They visit the dunes mainly to experience nature and to walk. Biodiversity is not a dominant reason. For visitors, visiting the dunes is an addition to their visit to the beach. The silence, the shelter from the wind it provides, the relief and the panoramic views are features for which the dunes are greatly appreciated and that are found less on the beach.

The 2019 stakeholder survey

The results of the 2019 survey show that the stakeholders surveyed are very positive about the LIFE+ project FLANDRE as it has strongly inspired them to a joint vision for the future towards one large, cross-border nature reserve. They therefore want a similar follow-up project and the idea to work with a common management plan for both countries in which an integrated coastal policy is achieved and a balance is found between people and nature. The interviews with stakeholders revealed a number of interesting themes and perspectives that were found to be important in relation to FLANDRE.

The most valuable and positive impact of Flandre is the facilitation of the cooperation between France and Belgium. Both Flemish and French stakeholders wish to continue this improved cooperation in the long term in next European cross-border nature conservation project. It is not unimportant to mention that cooperation between the stakeholders and the coastal municipalities in FLANDRE was almost absent.

With regard to sustainable management, the stakeholders surveyed mainly refer to manual beach cleaning, natural coastal protection and sustainable hunting as critical points that are not yet implemented everywhere. According to them, there is a need for a project focussing on beach cleaning and consultation with every coastal municipality. In addition, the accessibility of the dune areas is also mentioned as an important theme. Stakeholders consider it necessary that the dune areas are made accessible to the public as much as possible with the protection of sensitive areas where necessary. According to them, this could also contribute to the social support: another necessity that was mentioned, and that can be realized through the awareness, information and education of visitors to the dune areas via the municipal canals.

We conclude that the greatest impact of FLANDRE relates to a stronger cooperation between the French and Flemish stakeholders during this project, a greater awareness of the sustainable management of the dune areas, and a common vision towards one large, cross-border nature reserve with a common management plan for an integrated, sustainable coastal policy that strikes the right balance between people and nature protection.

4. Socio-economic impact and effect on employment

Based on a combination of different data, we estimate that 1,5 to 4 million people per year visit the project area, that they together spend 25 to 130 million euros and thus create employment for 2250 people (FTE) per year, of which 1600 local FTE.

This impact is particularly strong in the Flemish part, because it is larger and is also estimated to have more visits per hectare. These figures provide a rough but clear indication that the socio-economic impact of the project area for tourism and recreation is very high, and that an adequate protection of the dunes is important for the sustainable development of coastal tourism.

The Life + Flandre project contributes to the sustainable anchoring and development of the recreational functions of the area, both through specific measures in the short term (restoration of landscape quality, layout) and in the long term (management plans, awareness, etc.).

5. Impact on the ecosystem services

Ecosystem services refer to the goods and services that nature provides to people, society and economy. This study builds on the methods used to estimate ecosystem services for Natura2000 areas in Flanders (www.natuurwaardeverkenner.be), supplemented with specific data about the Flemish and the French part of the project area. Table S1 summarizes the results. The area has little provisioning services, but it does have some important regulating services and cultural services.

The services that are important for this area at the same time often lead to pressure on the area and risks of overexploitation (water collection, tourism and recreation). Certain features such as fragmentation and interwovenness with residential areas lead to high values of cultural services for environment or health, but are also referred to as problematic (eg. for landscape quality).

Table S1: Value of ecosystem services for the area and impact of Flandre project

Ecosystem service	Unit	Value of the ESD		Impact of Flandre project	
		K €/y	%	Short term	Long term
Provisioning services		-	-	-	-
Regulating services					
Soil carbon storage	K €/y	1.104	3%	=	=
Water quality	K €/y	4	0,0%	=	=
Water supply	K €/y	402	1,0%	+	+
Coastal safety	K €/y	1.981	6%	=	++
Pollination		na	na		
Air quality	K €/y	4.740	13%	--	-
Cultural services					
Recreation / tourism	K €/y	21.650	43%	+	++
Amenity	K €/y	1.483	4%	=	+/=
Health	K €/y	8.839	30%	=	+/=
TOTAL	K €/y	40.203	100%	=	+
Value/ha	€/ha	12.238		=	+

- (1) Based on the average of the low and high estimate for the service for the total project area
 - = not important for the studied area
 na = not available, not quantifiable or impossible to express in monetary value

The effects of the life + Flandre project

Due to the nature and size of the project, the analysis indicates that the direct and immediate socio-economic effects of the projects will be small compared to the situation in 2014. On the other hand, we expect the project to have positive long-term effects in order to anchoring the sustainability of the area and the delivery of the related services.

The analysis shows that the Flandre life + has contributed to better protection of the area and its services. This concerns the acquisition of sites, the preparation of management plans, the restoration of habitats that are important for both nature and tourism, the improvement of cross-border understanding and cooperation, the increased awareness of the importance of the area and its potential.

The analysis in 2019 shows the positive long-term effects. Firstly, the survey of the various stakeholders shows that there is increasing support for lasting, cross-border protection and development of the area. Secondly, the analysis shows that the most important ecosystem services (coastal safety, recreation and tourism) will increase due to the measures, either already implemented or part of the management plans. Coastal safety and recreation benefit from more dynamic dunes, and the habitat types that increase (white dunes, wet dune pans) increase the landscape quality for visitors and tourists. On the other hand, deforestation and removal of shrubs leads to less capture of particulate matter and lower public health benefits.

6. Evaluation of the nature restoration in the Oostvoorduinen in Oostduinkerke

This report describes the situation at the start of the project in order to measure the effects on the restoration of biodiversity. It concerns the recovery of the target habitat types ("2130 Fixed dunes with herbaceous vegetation or Gray dunes" and "2190 Humid dune slacks") and target species ("1614 *Apium repens*", "1202 *Bufo calamita*" and "1166 *Triturus cristatus*"). This evaluation uses methods from the project "Permanent Inventory of Nature Reserves at the Coast" (PINK).

To this end, four distinct parcels were distinguished, for which we described the current situation and made recommendations for remedial action.

Assessment of impact at the end of project in 2019

The excavations in the Oostvoorduinen within the framework of action C.1 of the LIFE Flandre project resulted in a substantial increase of nature conservation values compared to the initial situation in 2015. Many interesting plant species characteristic for dune slacks (habitat type 2190) as well as dune grassland (habitat type 2130) were able to establish. Considering the pioneer character and the small population sizes of the target species, the site does not yet meet the criteria for a good conservation status of these habitat types. We expect this will be the case for dune slacks within a number of years. For dune grassland, potentials are limited and a much slower evolution is expected.

The project was less successful in respect to EU-Habitat Directive's Annex species 1614 *Apium repens*, 1202 *Epidalea calamita* en 1166 *Triturus cristatus*. In the ponds none of these amphibians were found. *Apium repens* did appear, most probably from the soil seed bank, but could not establish so far. Probably the pioneer environment is not beneficial for the species. On the long term, when soil development has taken place and vegetation is somewhat ore closed, permanent establishment is more likely, at least if the site will be grazed. On short term however, a mowing regime is recommended until a more stable vegetation has established.

CONTENTS

Summary	I
Contents	V
List of tables	VIII
List of figures	IX
CHAPTER 1 Introduction	1
1.1. <i>Background</i>	1
1.2. <i>Aims of the study</i>	1
CHAPTER 2 Methodology	3
2.1. <i>Exploratory research and scope</i>	3
2.1.1. In the short run, direct impacts are likely to be limited	4
2.1.2. In the longer run, potentially important indirect impacts	5
2.2. <i>Socio-economic impact assessment</i>	7
2.2.1. Exploratory analysis in 2014: identification of potential impacts	7
2.2.2. Analysis in 2019: Assessment of the impact of the project	8
2.3. <i>Impact on ecosystem services</i>	8
2.4. <i>Impact on biodiversity</i>	10
CHAPTER 3 Socio economic impact	11
3.1. <i>Introduction</i>	11
3.2. <i>Interviews with actors from different stakeholders in 2014</i>	11
3.2.1. Method	11
3.2.2. Current situation	12
3.2.3. Expectations	15
3.2.4. Shortcomings of the project	17
3.2.5. External bottlenecks for the realisation of the project	18
3.2.6. Conclusion	19
3.3. <i>Survey visitors in 2014</i>	20
3.3.1. Method	20
3.3.2. Results	20
3.3.3. Conclusion	28
3.4. <i>Quantitative estimate of socio economic indicators</i>	28
3.4.1. Introduction	28
3.4.2. Method and data	29
3.4.3. Update for new data in 2019	29
3.4.4. Results socio economic impact in 2019	30
3.4.5. Conclusion	33
CHAPTER 4 Impact on ecosystem services	34

4.1.	<i>Introduction</i>	34
4.2.	<i>Methodology</i>	34
4.2.1.	Quantification of regulating services _____	34
4.2.2.	Monetary valuation _____	36
4.3.	<i>Soil organic carbon storage</i>	36
4.3.1.	Description _____	36
4.3.2.	Quantification _____	36
4.3.3.	Monetary valuation _____	37
4.3.4.	Results _____	37
4.4.	<i>Water quality regulation</i>	39
4.4.1.	Description _____	39
4.4.2.	Quantification _____	40
4.4.3.	Monetary valuation _____	41
4.4.4.	Results _____	41
4.5.	<i>Stabilisation water levels/Infiltration</i>	41
4.5.1.	Description _____	41
4.5.2.	Methodology _____	42
4.5.3.	Results _____	42
4.6.	<i>Water provisioning from ground water</i>	43
4.6.1.	Description _____	43
4.6.2.	Methodology and monetary valuation _____	43
4.6.3.	Results _____	43
4.7.	<i>Protection against floods</i>	45
4.7.1.	Description _____	45
4.7.2.	Methodology and interpretation for the study area _____	45
4.7.3.	Quantification and monetary valuation for a part of the project area (case study)	48
4.7.4.	Extrapolation of the estimates to the project area _____	49
4.8.	<i>Air quality</i>	49
4.8.1.	Description _____	49
4.8.2.	Quantification _____	50
4.8.3.	Monetary valuation _____	50
4.8.4.	Results _____	50
4.9.	<i>Pollination</i>	51
4.10.	<i>Recreation and tourism</i>	51
4.10.1.	Method _____	51
4.10.2.	Results _____	51
4.11.	<i>Amenity</i>	51
4.11.1.	Method _____	51
4.11.2.	Results _____	52
4.12.	<i>Health</i>	52
4.12.1.	Method _____	52
4.12.2.	Results _____	53
4.13.	<i>Overview ecosystem services</i>	53
CHAPTER 5	Nature restoration, Assessment 2014 _____	55

5.1. <i>Introduction</i>	55
5.2. <i>Methods</i>	55
5.3. <i>Results</i>	56
5.4. <i>Current and potential values</i>	59
CHAPTER 6 Nature restoration, Assessment 2019	60
6.1. <i>Methods</i>	60
6.2. <i>Results</i>	62
6.2.1. Tansley-survey and conservation status	62
6.2.2. Target species	65
6.2.3. Amphibians	65
6.3. <i>Conclusions</i>	67
CHAPTER 7 socio economic impact of the project	69
7.1. <i>Indicators for the assessment of the project</i>	69
7.2. <i>Interviews with actors from different stakeholders in 2019</i>	71
7.2.1. Introduction	71
7.2.2. Methodology	71
7.2.3. Results per theme	72
7.2.4. Issues, recommendations and visions for the future	79
7.2.5. Conclusions of the survey in 2019	82
7.3. <i>Impact on ecosystem services</i>	83
7.3.1. Introduction	83
7.3.2. Assessment of the impact of the project on ecosystem services	83
7.4. <i>Conclusions related to the socio economic impacts</i>	86
7.4.1. The socio economic benefits of the natural area	86
7.4.2. The impacts of the life + Flandre project	86
Literature	88

LIST OF TABLES

Table 1: Summary of scope in different chapters	4
Table 2: Most important measures foreseen in the project	5
Table 3: Indicators identified in 2014 to monitor the impact of the project in 2019	6
Table 4: List of available methodologies to value ecosystem services and focus of this study	9
Table 5: Number of questionnaires and number of visitors	21
Table 6: Answer to the question "what attracts you to come here?" expressed in percentages	23
Table 7: Answers to the question "What is for you the difference between a walk in this area and a stroll on the beach?" expressed in percentages	24
Table 8: Preferred areas compared to the location of the survey	25
Table 9: Dune landscape photos series 1 – Average scores of the visitors and positive or negative perceptions	26
Table 10: Dune landscape photos series 2 – Average scores of the visitors and positive or negative perceptions	27
Table 11: Indicators for the socio economic importance of the project area, Flemish part	31
Table 12: Indicators for the socio economic importance of the project area, French part (2019)	32
Table 13: Indicators for the socio economic importance of the total project area (2019)	33
Table 14: Overview of selected ecosystem services.	34
Table 15: Overview of maps used in thee cosystem service models	35
Table 16: Results for the ecosystem service carbon sequestration	38
Table 17: Results for the service of water quality regulation (update 2019)	41
Table 18: Results for the ecosystem service water provisioning	44
Table 19: Results for the service of coastal flood protecton (update 2019)	49
Table 20: Results for the ecosystem service air quality	50
Table 21: Benefits for recreation and tourism for the Belgian and French part	51
Table 22: Benefits for amenity value for the Belgian and French part of the study area	52
Table 23: Benefits health for the Belgian and French part	53
Table 24: Summary overview of ecosystem services	54
Table 25: Results of the soil sample analysis (Herr & Hens 2014)	58
Table 26: General characteristics of the parcels	62
Table 27: Tansley-survey of each parcel.	63
Table 28: Indicators to monitor impact project	70
Table 29: Total value of ecosystem services for the area and impact of Flandre on the services	84

LIST OF FIGURES

Figure 1: Research steps 2014-2015	3
Figure 2: Research steps 2019	7
Figure 3: Interviewer questioning visitors in the dunes	21
Figure 4: Main reasons to visit the dunes for different age categories	22
Figure 5: Visitors come to the dunes for sledging	23
Figure 6: Quantification carbon sequestration in soil (kg c per ha per year)	38
Figure 7: Infiltration in mm/y	42
Figure 8: Pressure on phreatic ground water reserves (% abstracted vs. infiltrated amount of water)	45
Figure 9: Methodology for the qualitative assessment of protection against floods	47
Figure 10: Qualitative assessment of the protection against floods by dunes	47
Figure 11: Map of the parcels (red) and soil samples (yellow).	56
Figure 12: Vegetation map of the studied area.	57
Figure 13: Target species map (vascular plants).	59
Figure 14: Location of excavated parcels (black numbers) and newly created ponds (blue labels).	61
Figure 15: Mapping of target species (2018-2019).	64
Figure 16: Recent distribution (> 2007) of natterjack toad (<i>Epidalea calamita</i>) along the western part of the Belgian coast (data LIFE+ Flandre Masterplan).	66
Figure 17: Recent distribution (> 2007) of great crested newt (<i>Triturus cristatus</i>) along the western part of the Belgian coast (data LIFE+ Flandre Masterplan). Blue dots are ponds, red dots are recent observations (> 2007).	67
Figure 18: Overview of possible indicators to map impact on ecosystem conditions and services	69
Figure 19: Ecosystem services of different habitat types	85

CHAPTER 1 INTRODUCTION

1.1. BACKGROUND

The LIFE+ NATURE project 'FLANDRE': Flemish And North French Dunes Restoration is a nature restoration project of the Flemish Agentschap voor Natuur en Bos, the French Conservatoire du Littoral et des Rivages lacustres and the French Département du Nord targeting the coastal dunes between Dunkerque (Frankrijk) and Westende (België). It is cofinanced by the European Union.

The aim of the project is to consolidate the NATURA2000 network in both countries by restoring habitat types which are typical for the sediment coasts of the Atlantic biogeographical region en by protecting key species. This is performed by acquisition of coastal dunes, management planning and nature restoration works. Besides, the aim is to increase the public awareness of the area. This is performed in close cooperation between Belgian and French governments, responsible for the acquisition and management of the protected areas. The project will be a first step towards the creation of a crossboundary European nature park, which will be an example of cooperation between European Member Staes for the protection and maintenance of crossboundary Natura 2000 areas.

1.2. AIMS OF THE STUDY

This study focuses on 3 topics:

- Assessment of socio economic impact and on employment within the sectors of nature restoration and management, agriculture, tourism and recreation. Tourism and recreation is assessed by quantifying the amount of visitors, the appreciation of visitors of the areas managed by the French Département du Nord and the Flemish Agentschap, turnover of local restaurants/hotels/pubs;
- Assessment of ecosystem services provided by the coastal dunes and the entire project area (coastal defense, drinking water reserves, others);
- Assessment of the impact of restoration of target habitat types ("2130 fixed dunes with herbaceous vegetation" and "2190 wet dune slacks") and target species (*Apium repens*, *Bufo calamita* and *Triturus cristatus*) within the Action C.1 of the LIFE+ project "Flandre" (only in Belgium, Oostduinkerke).

This study compares the situation at the starting moment of the project (2014-2015) with the situation at the end of the project (2018).

This report describes first the situation at the start of the project (2014 - 2015) and secondly, the assessment at the end of the project (2019).

CHAPTER 2 METHODOLOGY

2.1. EXPLORATORY RESEARCH AND SCOPE

During the first stage, in 2014, an exploratory research was carried out based on knowledge and data on socio economic impacts and ecosystem services delivered by this sort of coastal natural areas. This is based on a study commissioned by the Flemish ANB to assess the benefits of the NATURA2000 areas in Flanders. In this study a series of ecosystem services were valued qualitatively, quantitatively and in monetary terms.

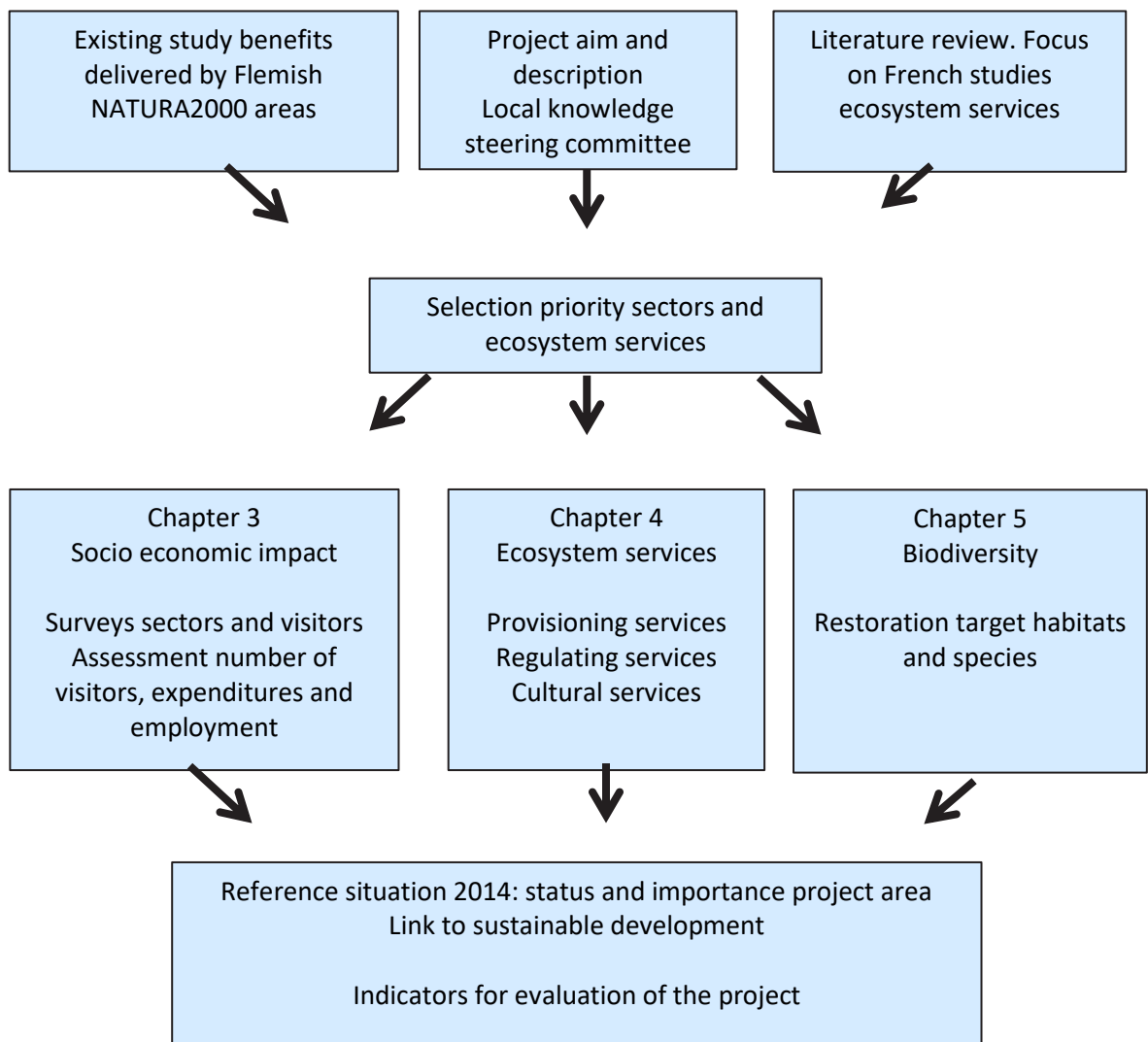


Figure 1: Research steps 2014-2015

Additionally, a literature review was carried out with a specific focus on French literature on ecosystem services with a specific focus on coastal nature and the Northern French coastal area.

2.1.1. IN THE SHORT RUN, DIRECT IMPACTS ARE LIKELY TO BE LIMITED

Based on discussions with the steering committee the most relevant ecosystem services were identified and selected for further investigation.

An important conclusion from this exploratory stage is that the provisioning services (agriculture, wood production) play a very small role in the area. Grazing livestock is present, more specifically Konik horses, highland cattle, sheep, donkeys and Shetlander ponies in the domains of ANB and Haflinger horses, sheep and goats in the domains managed by the Département du Nord. The owners of these animals do not pay a retribution for the use of the grounds. The owners also have additional costs and risks (e.g. health of the animals) compared to standard agricultural activities which makes the profits for this type of activity very small. The project will also have no impact on the amount of livestock grazing. Also wood production is not important. This is why these provisioning services are not considered for further assessment.

Table 1: Summary of scope in different chapters

	Socio economic impact			Ecosystem services	Biodiversity
	Sectors	Visitors	Quantification		
Provisioning services	-	-	-	-	
Regulating services					
Carbon storage soil				x	
Water quantity				x	
Water provision	X			x	
Coastal flood protection	X				
Air quality				x	
Cultural services					
Recreation / tourism		x	x	x	
Real estate / Amenity	X			x	
Health				x	
Employment			x		
Biodiversity		x			X

Secondly, direct impacts due to the project are limited because the project only foresees a limited amount of areas for acquisition and a limited amount of restoration activities for the landscape and infrastructure for recreation.

Table 2: Most important measures foreseen in the project

	Flanders	France		
General				
Acquisition of dune areas	30 ha	58,3 ha		
Management of the acquired areas	X	X		
Specific measures				
	Flanders	France		
	Oostvoorduinen	Dewulf	Perroquet	Marchand
Restoration of a wet dip in the dunes	X	X		
Removal of shrub		X	X	X
Installation of grazing entities		X	X	
Restoration and management of rough herbage on the margins		X	X	
Digging of pools	X	X	X	
Laying of a footpath		X		

2.1.2. IN THE LONGER RUN, POTENTIALLY IMPORTANT INDIRECT IMPACTS

The project can also contribute to a better structure on nature restoration for coastal nature and a bigger public awareness of the area. These are also essential elements to maintain and extend the existing ecosystem services and benefits for the different sectors. In the current situation, physical and organizational obstacles (vegetation types, ownership situation of grounds) prevent a valorization of the full potential of the region and the Natura 2000 sites. In the Life+ project, several measures are taken to eliminate these obstacles. Frequently, the project takes a first step which needs to be continued after. The measures which are foreseen in the Flemish and French part of the area are completely different as the context is also very different. Besides, several initiatives are already ongoing. For example, the area 'les Dunes de Flandre' in France is being considered to receive the quality label 'Grand Site de France'.

There are no simple and simultaneously accurate methods to assess the socio economic impacts of the limited steps which are foreseen in the project to move towards a crossboundary nature park. This study does allow however to estimate the impact of the current situation on ecosystem services and socio economics for the entire area. This allows to identify the important aspects. It is however possible to explore qualitatively how the project contributes to increase the strengths of the area and reduces the weaknesses.

In 2019, the hypothesis regarding the importance for indirect effects was tested through discussions with stakeholders, and assessment of the effects of the works on the delivery of the most important ecosystem services. This is processed in chapters 6 (biodiversity) and 7 (socio-economic impact).

The indicators were listed in 2014 to monitor the project in 2019 (see table below). This method is in line with this objective. Because we expect little extra information from a survey of visitors in 2019, this has not been taken into account, but the preferences of visitors have been tested against a new method, based on uploading photos of habitat types (Van Der Biest, 2017). This is processed when discussing ecosystem services (chapter 7).

Table 3: Indicators identified in 2014 to monitor the impact of the project in 2019

Theme	Indicator	Monitoring evolution Flandre 2014-2018
Ecosystem composition		
Composition habitat types	ha per habitat	x
Ecosystem condition		
Presence target habitat types	ha per target habitat	x
Presence target species	number of locations with target species	x
Ecosystem services		
Soil carbon storage	ton C storage per year	
Water quality	ton N removal per year	
Infiltration capacity	m ³ infiltrated per year	
Water supply	m ³ extracted water per year	
Protection against floods	qualitative index for flood protection	
Air quality	kilo PM capture per year	
Recreation	number of visitors per year	x
Health	healthy life years for local residents in DALY	
Green residential area	increase in real estate value in €	
Adequate protection of the quality of the area		
Knowledge of importance and vulnerability	survey sectors	x
	survey visitors	x
Knowledge of area as a cross-border entity	survey sectors	x
	survey visitors	x
Plans/strategy sustainable Exploitation	survey sectors bevraging belanghebbende sectoren	x
Biodiversity	See chapter 5	x

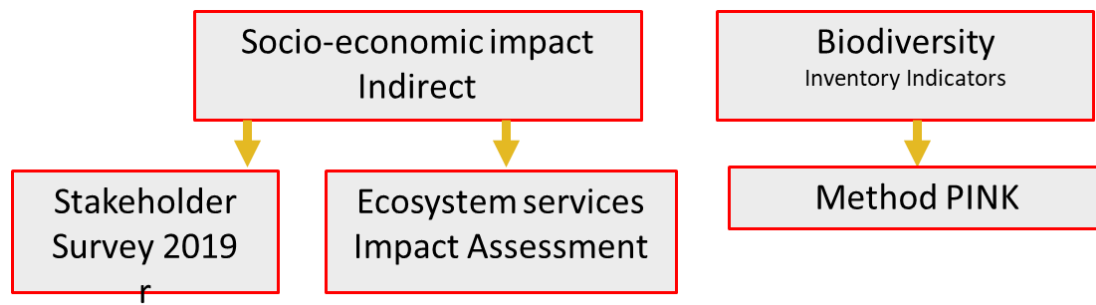


Figure 2: Research steps 2019

2.2. SOCIO-ECONOMIC IMPACT ASSESSMENT

2.2.1. EXPLORATORY ANALYSIS IN 2014: IDENTIFICATION OF POTENTIAL IMPACTS

The analysis of the socio economic impact focuses on the one hand on the expectations and bottlenecks identified by the different sectors involved and on the other hand goes more into depth regarding the impact of tourism. This is performed by analyzing how satisfied visitors of the areas managed by the Département du Nord and the Agentschap voor Natuur en Bos. Based on the number of visitors we estimate the importance for economic sectors such as tourism and horeca. This is based on three different methodologies and data sources.

To identify expectations and bottlenecks, stakeholders from the different sectors (tourism, coastal defense, water provision, real estate) were interviewed individually. The insights gained from these interviews provide some insights on the potential impact of nature restoration measures. By addressing expectations and bottlenecks, the chances for success of the project increase. During these interviews, the entire Flandre area was considered. Focus of the change was on the crossboundary management and promotion of the area, not on small scale interventions in the field.

Secondly, it is important to know how and why the area is visited. By means of surveys with 392 visitors, it was examined how visitors experience the area and the landscape.

Thirdly, a quantitative estimate was made on the socio economic impact of the area in the current situation. Indicators were described to map and follow up the potential success of the project. For this part of the research, more detailed data on recreation and tourism were collected alongside the Belgian coast and Northern France. This allowed to make an estimate of the total amount of visitors, their expenditures and impacts on economy and employment. These data are also used to value the impact on cultural ecosystem services.

2.2.2. ANALYSIS IN 2019: ASSESSMENT OF THE IMPACT OF THE PROJECT

In 2019, the 2014 hypothesis that the project is taking important steps to safeguard the area and its ecosystem services was tested.

Firstly, the assessment of the socio-economic importance of the area and of the ecosystem services was further investigated. New information and insights are incorporated in chapters 4 and 5. This leads to an updated and better substantiated estimate of these services and the socio-economic importance. For most services and elements, new data (eg tourism) confirm the order of magnitude of importance, but the quantification has been adjusted.

For ecosystem services, a review of the approach in the context of a scientific publication (Van Der Biest, 2017) led to new insights and estimates for regulatory services with regard to water quality and quantification for coastal protection. These have been incorporated in Chapter 4. This also led to an estimate of ecosystem services (regulatory and recreation) per habitat type, and these insights have been included in Chapter 7 for assessing the consequences of changes in habitats.

The methods were further tested against the (draft) manual for the socio-economic Impact analysis of the implementation of the Flemish Natura 2000 program (Broekx et al, 2019) and socio-economic evaluation studies of Life + projects.

2.3. IMPACT ON ECOSYSTEM SERVICES

This analysis is based on previous and ongoing research on ecosystem services of nature areas in Flandres such as the benefit assessment of the Natura2000 areas, the research project ECOPLAN and the online tool Nature Value Explorer (www.natuurwaardeverkenner.be) that was specifically developed to explore the impact of specific areas on ecosystem services.

The table below describes which services can be valued qualitatively, quantitatively in biophysical units or in monetary units for Flandres. For the classification of services we build further on the European CICES classification (Common International Classification of Ecosystem Services).

For the important regulating and cultural services a more detailed analysis is performed for the Belgian and French part, as indicated in the column. This allows to take into account the impact of land use, soil type, vegetation, water management and tourism and recreational data on ecosystem services. The best available datasets for the Belgian and French part of the study area were used.

Additionally, methods and data for instance for monetary valuation, were compared with French literature on ecosystem services delivered by similar areas in France.

In 2015, at the start of the project, the main eco-system services were discussed, quantified on the basis of existing insights, methods and data and - as far as possible - monetized in terms of money. For this report in 2019, these results have been updated taking into account new information and data. This led to a confirmation of the results and conclusions regarding the main services, and with an adjustment for some services. These adjustments were incorporated in the discussion of the individual services in Chapter 4, and taken into account in the conclusions in Chapter 4. In Chapter 7, the effects of the project on the eco-system services were estimated based on this information.

Table 4: List of available methodologies to value ecosystem services and focus of this study

Section	Group	Ecosystem service	Qualitative	Quantitative	Monetary	Focus
Provisioning services	Food	Agricultural production: crops, livestock and other products (eg. meat, milk, ...)	X	X	X	
		Wild animals from terrestrial ecosystems				
		Wild plants from terrestrial ecosystems				
		Freshwater animals and plants (e.g. fish)				
		Marine animals and plants, algae (eg. fish, shellfish)				
		Plants, algae and animals from in-situ aquaculture				
	Water	Water provision surface and groundwater	X	X	X	X
	Materials	Wood production	X	X	X	
		Other materials derived from plants				
		Materials derived from animals (eg. fur)				
Genetic, medicinal and cosmetic resources						
Energy	Biomass					
Regulating services	Reducing waste, toxic substances and other	Bioremediation				
		Dilution, filtration and storage of pollutants: air quality by capturing PM	X	X	X	X
		Dilution, filtration and storage of pollutants in soil				
	Regulating water and land flows	Reducing odour, noise, visual impact	X	X	X	
		Stabilisation of water levels (water retention and infiltration)	X			
		Protection against flooding from the river	X	X		
		Protection against flooding from the sea (coastal protection)	X			X
	Regulating physical, chemical and biological environment	Prevention erosion	X			
		Global climate regulation (carbon sequestration soil)	X	X	X	X
		Global climate regulation (carbon sequestration biomass)	X	X	X	
		Regional en local climate regulation (urban heat)				
		Water quality (denitrification)	X	X	X	X
		Water quality (N, P storage)	X	X		
		Pollination and seed dispersal	X	X		
Natural protection against pests and diseases (incl. invasive species)						
Cultural services	Total amount of cultural services values with stated preferences					
	Recreation and amenity	Recreation and tourism	X	X	X	X
		Amenity local residents	X	X	X	X
		Health impacts due to contact with nature	X	X	X	X
	Information and knowledge	Education				
		Research				
Cultural, spiritual and symbolic value						
Non use value						

Qualitative (score), quantitative (biophysical units) and monetary (€) indicators available, focus = services studied in detail within this study

2.4. IMPACT ON BIODIVERSITY

The evaluation of the nature restoration in the Oostvoorduinen in Oostduinkerek is based on methodologies developed in the PINK project (Permanent Inventory of Nature Reserves at the Coast). INBO has developed these methods and they are applied for the study area (Provoost et al. 2010).

CHAPTER 3 SOCIO ECONOMIC IMPACT

3.1. INTRODUCTION

The analysis of the socio-economic impact focuses on the one hand on the expectations and bottlenecks for the different sectors involved and on the other hand on the impact of tourism and recreation. Three methods and data sources were used.

First, in 2014, the expectations and bottlenecks from the different stakeholders (tourism, coastal defense, water provision, real estate) are mapped based on interviews. The results give an impression of the potential impact of restoration measures. During the interviews the area was considered in total. The main focus was the management and branding of one unified area and not the smaller changes in the field.

Second, the appreciation and interests of people visiting the areas managed by the Département du Nord and the Agentschap voor Natuur en Bos were mapped based on questionnaires.

Third, the socio economic impact of the area in the current situation is quantified. Some indicators are set up to monitor the success of the project in the future. This is reported in this chapter. In chapter 7, we discuss the survey of the sectors in 2019 at the end of the project.

3.2. INTERVIEWS WITH ACTORS FROM DIFFERENT STAKEHOLDERS IN 2014

3.2.1. METHOD

→ Respondents

The area is especially important for recreation and tourism, nature conservation, coastal protection and sea defenses and drinking water. The following stakeholders were interviewed: APB Westtoer, the Agency for Maritime and Coastal Services - Coastal Division, the Intermunicipal Water Company Veurne-Craft, the Dunkirk Urban Community, Office de Tourisme de Dunkerque, Centre Permanent d'Initiatives pour l'Environnement Flandre Maritime. A broker in the real estate sector was interviewed. Besides the official tourism Dunkirk were all aware of the project. All were immediately willing to participate in the interview.

→ Research questions

By asking the strengths and weaknesses in terms of the current nature and nature, the current forms of tourism and recreation, coastal protection, water abstraction and employment in the area, we can make a SWOT analysis from the various viewpoints of the sectors surveyed. The analysis provides an insight into the expectations people have of the project, the shortcomings that we see and the external constraints they expect to realize these expectations.

The following results and the themes flow entirely from the talks. They represent the views of the stakeholders again and were not checked for accuracy or completeness. In this way, the perception of the stakeholders' knowledge gaps visible or can be detected when more information is available elsewhere. When the perception of different stakeholders is different, or else it was supposed to, can be anticipated.

→ **Results**

The results are discussed in four parts. First the current situation will be discussed divided in the four topics that were raised by the respondents. The second part comprises the expectations. In the last parts are the concerns and issues about the project as well as the external constraints discussed. Since the collected answers and views of the different actor's very strong alignment layers, they will be discussed globally. Where there were different perceptions, this is indicated separately.

3.2.2. CURRENT SITUATION

→ **Fauna and flora of the dunes**

In France, the area under the Centre Permanent d'Initiatives pour l'Environnement Flandre Maritime is characterized by a high biodiversity. Because of the different habitats in France there are species that occur only in the dunes in northern France and not in Flanders. Secondly, the knowledge of the fauna and flora in this area is still limited, and finds that this rich biodiversity is not sufficiently known and therefore protected too little. The grounds are also partly in private and municipal property.

→ **Accessibility of the dunes**

In France, the dunes are accessible to everyone. There are no rules and the rules that no checks are performed. This will naturally sector a problem because it threatens the protection of nature.

The tourism sector indicates that the dunes in northern France are difficult to access and therefore only be rarely visited. By facilitating access to the dunes via designated routes, one can make the region more attractive for tourism.

Currently tourism Dunkirk has a limited budget. From the administration requested for this budget to strengthen the tourism and attract more young people to the coast. This is done through the creation of Beach to encourage clubs and modernize cafes and restaurants. These developments are inspired by developments on the Belgian coast, which are an example to northern France. The French coast is mostly visited by day trippers. Tourists often stay longer and spend the night not in the region. This choice of political governance is seen from the administration as a choice for quick projects with quick profits. The respondents say that politicians do not wilinvesteren in nature tourism because it only yields on long term ..

Hunting in the Dunes

In France with the exception of the Nature reserve "Dune Marchand", hunting is allowed in the dunes. This is not the case in the Flemish Dune areas which are mostly acknowledged as nature

reserves, They are hunted waterfowl. During hunting season the hunters let the dogs run loose. This led to problems with other dog walkers. This allowed now stray dogs to everyone during hunting season. The conservationists want to prohibit hunting in the dunes, but clash here on a hunting sector is very strong.

Dunes Decree

All Flemish respondents spontaneously took to the importance of the dunes decree. They said that without this decree would probably be no more as coastal dunes coastal towns until today give priority to construction projects at the expense of nature.

Pastures

Currently the pastures in France and Belgium are managed differently. In Flanders they grazed by Scottish Highlanders and Konik horses. In France only horses are used

Clean beach

In France, the beaches are cleaned manually by social workers. They leave dead animals and plants lying on the beach, because these are necessary for the formation of the embryonic dunes. In Flanders, beaches in front of the dikes are cleaned by machines, which makes some new dune formation impossible.

→ **Water production**

Due to the increased population at the coast, the demand for drinking water has increased significantly over the last 50 years. This demand again rises during the tourist season. In order not to exhaust the reserves, it proved necessary to perform groundwater extraction in a sustainable way.

Meanwhile, the areas used for water extraction are managed ecologically. This can be considered as a win-win situation whereby drinking water is produced on the one hand and nature is preserved on the other hand.

The evolution towards a sustainable management of drinking water catchment areas is realized in cooperation with the former Administration AMINAL water (currently VMM). This administration delivers the authorizations to carry out necessary works in the catchment area and sets high standards in terms of nature conservation for these areas. This cooperation proved to be successful because of the mutual trust, thus obtaining the necessary permits for water extraction is usually obtained. The management plan for the catchment area was made in cooperation with the Agency for Nature and Forest.

→ **Coastal flood protection**

The beach and dunes provide a natural defense against floods. To reinforce this natural defense the Flemish Agency for Maritime Services and Coast applies the technique of sand suppletion in recent years. Sand is used from elsewhere to widen the beach locally. They try to do this sand suppletion as ecologically as possible and in consultation with the Agency for Nature and Forest (ANB). Both the Agency for Maritime Services and Coast and the CAC have the ambition to restore and strengthen nature, which is a good basis for cooperation. On the one hand, the CAC manages a large part of the assets of the Agency for Maritime and Coastal Services, on the other hand projects are carried out jointly.

Coastal Protection does not always go along with tourism. For an optimal coastal defense dunes should be able to grow naturally. Beach sand is blown inland and accumulates locally. Due to vegetation at the foot of the dune, the dune can continue to grow. In De Panne, this part of the dune is used as a walking path which has a negative impact on vegetation and which prevents the dune from growing further.

→ **Communication to visitors about management of nature areas**

In France, the authorities hardly communicate about profound management work in nature areas, such as chopping trees. As a result there are often complaints about nature restoration works in France and this limits public support for more fundamental restoration. Because the nature organizations are insufficiently aware of the importance of good communication and due to a lack of time and resources, this remains a bottleneck.

→ **Urbanisation and agriculture**

Due to the extensive building development, the north-northwest wind is interrupted. As a consequence, the moving dunes no longer move, and sea buckthorn and other thicket has a chance to expand.

Increased urbanization and tourist developments have increased the demand for drinking water. Due to more groundwater extraction, the natural water level in the dunes is lower at the expense of biodiversity.

The fertilizer and insecticides used on farmland also decrease biodiversity levels in the dunes.

→ **Tourism**

Currently there is little nature tourism in France. This is hardly encouraged in the tourism sector. Flyers about the nature are only distributed through tourist information offices. The tourist office in Dunkirk sees potential in nature tourism in the region, but has no means to develop it. Some smaller projects, such as a walking and cycling network originating from Flanders (developed by Westtoer), are taken up. Also the coastal municipalities in Flanders do not actively promote nature visits. They only distribute leaflets and cards which are offered by Westtoer.

Westtoer is an active promoter of the nature tourism in Flanders. The hiking maps of the Westhoek are currently the best-selling hiking maps in Western Flanders. Westtoer would like to connect more trails or make nature more accessible. At the moment people can only go around a nature area instead of walking through it as is currently possible in the Houtsaegerdunes. Existing walking routes are small loops in the remaining nature areas in between the buildings. Westtoer confirms that many private areas have been bought in the past for nature restoration. Westtoer is satisfied with the 20-year partnership with the ANB.

Westtoer also wants to expand walking routes into France and is preparing a new Interreg-project entitled "Grenspark Flemish dunes" where they want to encourage recreation across borders. This will be done by establishing a common recreation management plan, by making the cross-border area attractive for horseback riders, by setting up uniform entry points of the area. This helps to

represent the area as a relaxing environment for recreational purposes. On the other hand Westtoer is aware of the limited recreational capacity of the area. Due to the open character of the dunes the presence of many visitors is quickly perceived as too full and the quality of the experience goes down. The experience for a single hiker when visiting the Sahara in the Panne for example, differs in the presence of twenty other hikers. The ecological capacity is low in the dunes. Recreational and ecological capacity supports each other here. This is different in areas with lots of sea buckthorn, where visitors do not immediately perceive other visitors. The recreational carrying capacity is higher in these areas.

Most Belgians have positive experiences as a child staying at the coast. They are very easily attracted by the coast and it stays therefore a region that is visited by many Belgians. In recent years, there is a tendency to stay for short periods of time. The organization "Tourism Flanders" plays an active role and promotes the coast as a four-season destination where people can hike, bike, bath, shop and dine. Mountainbiking is also possible at the coast, but this form of activity is considered both in Flanders and France to have more negative impacts. Mountainbikers are often biking away from the marked paths and damage nature.

According to the interviewees, the dunes are mostly frequented by local residents. The sea and the beach remain the main reason for tourists to come to the coast, they only come to the dunes for a small period of time and to experience a more diverse landscape.

→ **Real estate**

The real estate sector on the coast in Northern France is very different from this at the Belgian coast. On the French coast there is no overnight tourism. Only in recent years, in Bray-dunes which is the first village in France at the Belgian border, also apartment blocks are built on the embankment by Flemish building contractors. These apartments are mainly sold to Belgians. The Flemish real estate sector would like to build further and transform nature into land. The selling price for a house with a view on nature is three times more expensive compared to a house without a view on nature. There is much demand for homes in a quiet area with a view on nature. In the longer term maintaining nature could produce more real estate revenues, but the real estate sector, wants to achieve quick profits. The respondents Westtoer and the Agency for Maritime and Coastal claim that local governments still support building projects and that nature is hardly appreciated. Where nature clearly attracts visitors one sees the importance of nature conservation, as in the Westhoek Reserve and Ijzermondig.

3.2.3. EXPECTATIONS

→ **Collaboration, knowledge and management**

All respondents confirmed the importance of co-operation since this is needed to maintain and restore the nature. It is hoped that due to this project cooperation between France and Belgium will improve and the network will expand between the different actors. This hope is mainly expressed by the French partner. The French partners have the perception that in Flanders protecting and conserving the environment is further developed. They attribute this to the fact that Flanders, compared with France, has only a short coast and recognizes that coastal nature is an added value for tourism. The northern French coast is not considered as a popular holiday destination by French nationals.

The Centre Permanent d'Initiatives pour l'Environnement Flandre Maritime hopes that cooperation and building a network will also help to increase the knowledge of the biodiversity of the area. This is necessary to improve the management of the sites and protect biodiversity. For dune formation, the continuity between the sea and the dunes is necessary. In order to achieve this in a larger scale a crossborder management strategy is required.

To vote or run off to jointly manage more alike to go together in the important area and inform each other about each other's thorough process. This requires time and space of both parties. Within this project, it is hoped that this potential.

Through better cooperation it should be possible to tune these management alike. The drinking water company, which also has a management plan for their catchment area, considers a more aligned management as a positive thing, as long as this does not causes major changes for their area. They fully support the current management and currently see no need to make changes here. Since for the different areas management plans are currently not matched, it is likely that the format for a cross border management plan will be different compared to the current management. In what extent this poses a problem for the different partners because of previous investment, different ways of thinking, or other things remains unclear.

→ **Project "Grand site"**

The prestigious project "Grand Site" is set up to receive the official label "Grand Site de France" for this region by 2020. This French label is given by the Ministry of Ecology, Sustainable Development and Energy and creates the ability to improve the dunes of the northern French coast and to upgrade the image of the region. This will also create jobs. The project focuses on nature, cultural heritage, residents and visitors. The area for which the label is requested is the same area as the LIFE project area. Especially the cross-border nature of the LIFE project will add value and increase the chances of obtaining the label.

The objectives of the Flandre project are fully in line with the Grand site project. The collaboration between northern France and the Belgian coast in the Flandre project is very much appreciated by the leaders of the Grand site project.

Currently, financial support to continue the Grand site project are lacking because of political changes in Dunkirk. The Flandre project can contribute to still achieve this project. Currently the Communauté Urbaine de Dunkerque informs the political leaders and hopes to find additional funding to continue the Grand site project.

→ **Employment**

In France the employment created by nature tourism is rather small. The region is known for its port and industry. Until the 90s there were a lot of jobs in the shipbuilding industry. Also a lot of jobs existed in the steel sector. Due to the reduced car production also the demand for steel reduced. Since 2014 there have been more jobs created in the ship repair sector and there are new companies created. However unemployment is rising and due to the high youth unemployment a lot of young people leave the area. In recent years, the population declined in Dunkirk. The tourism sector does not expect that the LIFE project would create additional jobs in the near future in the region.

A cross boundary nature area is on the other hand attractive for tourism if there is a good communication strategy. Therefore it is important that the tourism sector in France and Belgium informs potential visitors of this beautiful area.

3.2.4. SHORTCOMINGS OF THE PROJECT

→ Regulation

The French interviewees regret that the project does not lead to regulatory convergence between Flanders and France. A similar regulation across the region is important to consider it as one area. In France, the regulation is limited and therefore everything is possible in the dunes. This desire is expressed by the Dunkirk Urban Community, the Office de Tourisme de Dunkerque and the Centre Permanent d'Initiatives pour l'Environnement Flandre Maritime. The same regulations for the entire area would regulate hunting in make it more sustainable in areas where the protection of biodiversity is a priority.

→ Inform about crossboundary nature areas

The Dunkirk Urban Community considers it important that it is communicated to visitors that this is a cross-border area. This can be performed by information signs and the use of a common label. According to the city this is not considered in the project.

→ Mobile dunes versus fixed dunes

For coastal defense fixed dunes are important. According to the Flemish Agency for Maritime and Coastal Services, the Agency for Nature and Forest attached great importance to the development of mobile dunes. This is a difference in opinion and strategy according to the Agency which must be taken into account when drawing up a management plan.

→ More accessible nature for visitors

Although Westtoer largely supported the project, they would very much like to create even more opportunities for visitors to the area. Currently, there is no possibility to bike in the dunes along the coast and the cyclists have to use the main street. This is something that they would like to change.

Also, they would like to realize some infrastructure such as a watch tower, boardwalk or a treetop walkway to attract more visitors. The Agency for Nature and Forest is not yet convinced to install this type of infrastructure according to Westtoer.

3.2.5. EXTERNAL BOTTLENECKS FOR THE REALISATION OF THE PROJECT

→ **Local governance**

The political composition of local governments changes rapidly and politicians are eager to have their own project. This prevents long lasting projects from getting political support according to the interviewees.

In Northern France a major political change occurred in 2015 and some more experienced politicians were replaced by a younger generation. The French interviewees aspire that the younger generation has more vision on sustainability and is willing to support nature conservation projects. Since this political change only took place recently, it is not clear yet whether this will be the case.

In Flanders, the municipalities have a large degree of autonomy to deliver building permits. The short-term profits that are made with new construction projects, makes it still attractive to deliver additional permits. The importance of the dunes for coastal defense and for biodiversity are often not taken into account. Building activities still are performed on the dunes today and it is even considered to build in front of the dike, as the beach is widened due to sand suppletion. According to the Flemish respondents these practices are a major bottleneck for sustainable coastal developments in Belgium.

→ **Characteristics of the project**

The administration of Tourism Dunkirk considers the duration of the project as a bottleneck. Projects are always limited in duration, making the cooperation after the end of the project automatically more difficult. The example of the Interreg project "From Coast to Coast" which focused on the commemoration of the First World War routes, was given. In this project, an app was developed that was no longer updated after the completion of the project and is no longer used.

Even networks that arise during projects which are considered as strengths of a project, ask a lot of effort from all partners. This is trial and error. To create a sustainable cooperative network, that lives on after the project, it is necessary to invest time and have common goals. Often, each partner uses a project for previously planned activities for which one has no means to be carried out. When each partner focuses on its own purpose, this makes cooperation more difficult. This could possibly be a bottleneck in the project.

→ **Language and culture**

During meetings of cross-boundary projects between France and Flanders the working language predominantly is French. This is according to one interviewee not ideal. It is believed that this creates some frustration for the Flemish partners. Second, the culture of the Flemish and French are also different and during this type of short term projects, little time and attention is spent on this aspect. This makes that the contacts after the project are not solid enough and it makes it difficult to actively continue cooperation after the project.

The tourism administration in France is looks with admiration towards the developments and the working method in Flanders. The efficiency of the Flemish colleagues is greatly appreciated. On the other hand the same approach for the French colleagues is difficult to achieve. They have a different organization structure and operate with less staff.

3.2.6. CONCLUSION

The results show that the project is supported by all sectors that were surveyed and it is strongly in line with their own vision. The main bottleneck for the project considered by all respondents is the local government. According to the respondents nature conservation is not a priority at the local level. On the Belgian side local governments are mainly interested in construction projects and on the French side, focus is on the development of beach tourism and modernizing the catering front. It is expected that the support from the local authorities is rather low. For the realization of cross-boundary nature, it is necessary that also local authorities support this project. It is recommended to further analyze this bottleneck and to also interview local authorities, and in a later stage find ways of cooperation and to set up common goals with these local authorities.

3.3. SURVEY VISITORS IN 2014

To set up a management plan for the area, it is important for the execution of the project to find out how and why this area is used. We investigated the experiences of the visitors and how they perceive the landscape. The results are based on surveys with visitors during the Easter holidays in 2015.

3.3.1. METHOD

For the study we wanted to get answers to the following questions:

1. Who are the visitors?
2. Why do they come to the dunes?
3. The extent to which the visitor is aware of the bigger crossboundary character of the area and whether he or she makes use of it?
4. Which type of landscape is the visitor expecting and preferring ?

Based on a survey of approximately 10 minutes, these questions are answered. By asking open questions we surveyed his / her own situation and got personal answers. In order to make a meaningful analysis, the responses were categorized according to characteristics of the respondents.

The first three questions are directly part of the survey. For question four we used pictures of the different types of landscape of the area. The interviewees were given six pictures and were asked to score the pictures from 1 to 6. They were allowed to repeatedly give the same score. They were also asked why they gave these ratings to the pictures.

The survey found place at seven places in the area where normally many visitors are passing through. These locations were recommended to us by people who know the area well.

- Leffrinckoucke, la dune Dewulfe, Junction 22 of the trail
- Zuydcoote at the entrance to the dunes Marchand
- Braine-dunes, entrance to the dunes Perroquet
- The Westhoek entrance kiosk havenlaan, De Panne
- Ter Yde - Hannecartbos, entrance Noordzeedreef, Oostduinkerke
- Visitor center "De Doornpanne" Oostduinkerke
- IJzermonding, bird observatory

3.3.2. RESULTS

All visitors on the French side were interviewed during the weekend of 11-12 April. When visitors came in group, not all visitors were surveyed separately. A total of 33 questionnaires were carried out. This number is relatively low. This may be due to the bad weather, the lower awareness of the area or the fact that the Easter holidays were not yet started. In Flanders, on Monday April 13th, Tuesday April 14th and Wednesday, April 15th, 119 surveys were conducted by two people. Each location in Flanders was surveyed half a day and in the Westhoek a whole day was used to perform the survey. These days were during the Easter holidays and the weather was nice. On these days approximately 80% of pedestrians and 50% of the cyclists were interviewed. The respondents were interested to participate in the survey, and this is often because of their involvement in the area. Nobody refused to cooperate in the survey. In most cases, visitors were in a group and one person in the group who mostly felt involved, answered the questions, usually with input from the other

people in the group. That is the reason why the number of surveys is much lower than the number of surveyed visits (Table 1)



Figure 3: Interviewer questioning visitors in the dunes

The table below shows that the number of respondents varies greatly from place to place. Almost half of the surveys were conducted in Flanders. Wednesday, April 15th was a day with very nice weather and there were significantly more people compared to the day before. The Westhoek is also referred to as the most preferred place by the respondents (see below), which explains the high number of surveys.

Table 5: Number of questionnaires and number of visitors

Location	Number of surveys	Number of visitors surveyed
Ter Yde - Hannecartbos	11	27
Hannecartbos	2	3
Dewulfe	3	5
Ijzermunding	7	21
Marchand	13	31
Doornpanne	17	44
Perroquet	18	46
Westhoek	83	218
Total	152	392

→ **Who are the visitors?**

The visitors are of all ages, with a minority of people under 30 years (14%). Half of the visitors (53%) were in their thirties and forties and 32% of the respondents were older than 50. If people in a group reply to the survey, the age of the person who mostly answered was asked. Children do not appear in the data.

Most people visited the area together with other adults (47%), 34% had children. 19% of respondents visited the area on his or her own. 64% of the respondents were living more than 80 km of the area. Half of this group has a second house at the coast. Only 12% of the visitors live within 10 km of the area.

→ **Awareness of the area, number of visits and visitor frequency**

Most visitors know the area because it is close to their first or second house (33%), because family or friends have told them about it (22%) or because they grew up in the neighborhood (16%). A small group of visitors said that they have discovered it by chance, or that they had heard about it in the media. Most (70%) know the area for several years.

Most visitors come to the area several times a year (43%), some even several times a month (19%). 10% of the visitors come several times a week to the area. These are people who live nearby or grew up near there. The interviewees visit the area the most during the holidays (40%), especially the group with children. 27% of the people visting the area alone or together with other adults visited the area during the entire year.

→ **Why are they visiting the dunes?**

The dunes are mostly visited to experience nature, secondly to have a walk. These two activities, hiking and nature experience are very close to one another. Younger visitors prefer activities such as jogging and cycling.

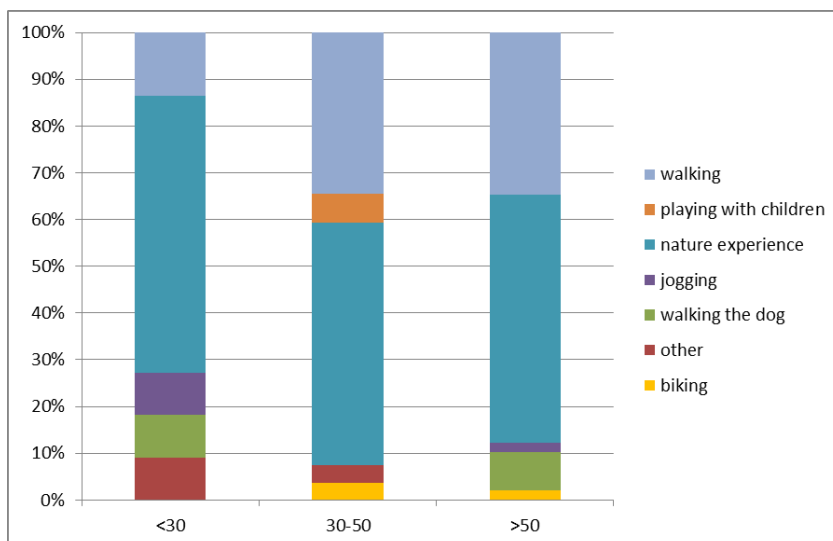


Figure 4: Main reasons to visit the dunes for different age categories

Adults in the second age category (30-50 y) regularly came to play with their children in the dunes. One group even brought a sled.



Figure 5: Visitors come to the dunes for sledding

Although experiencing nature was the main reason for visiting the dunes for many visitors, this is not considered the same as experiencing biodiversity. The question "Are there plants or animals that attract you to come here?" was posed. With the exception of two respondents who were specifically there to see certain bird species at the dunes, there was no intrinsic interest in the native fauna and flora. 10% of the respondents say that they are attracted by the large herbivores, the rabbits (3%) and birds in general.

Not the fauna and flora but the dune landscape, the nature, the open views and the variety was repeatedly mentioned when visitors were asked about what attracts them to come to the area. The table below mention the key words that were mostly appreciated in the region (Table 2).

Table 6: Answer to the question "what attracts you to come here?" expressed in percentages

What attracts you to the area?	%
Dune	28
Nature	19
Vast landscape	18
View	15
Relief	13
Variety of the landscape	8

To the question "What is for you the difference between a walk in this area and a stroll on the beach?" the same key words were used as well as the quietness of the dunes and the warmer climate (with less wind). This confirms that a visit to the dunes is complementary to a beach visit and visitors like these two places because of the different experience. Depending on the weather hikers chose for the beach or the dunes.

Table 7: Answers to the question "What is for you the difference between a walk in this area and a stroll on the beach?" expressed in percentages

Difference with the beach	%
Variety	13
Bike paths	1
Nature	16
Relief	20
Quietness	22
Playing in the dunes	1
Views	11
Warmer in the dunes	4
Wind shelter	13

When it was asked what people considered less attractive in the area, only a third of the respondents answered. Two points were very frequently (28%) mentioned, namely the presence of waste and the fact that one sees more buildings. Also dog excrement (15%) was often mentioned. 4% of the respondents felt that there was too much infrastructure.

When asked what they would like to improve in the dunes only 10% had an answer. For them infrastructure should improve, for example, to create better pathways or by increasing the supply of water and sanitation.

→ **To what extent is the visitor aware of the bigger crossboundary picture and do they make use of it?**

Most visitors (60%) only visit the area where they were questioned and do not visit other dunes in the area. 33% of respondents also visit other nearby dunes or uses the entire dune complex.

Visitors who knew several dune areas were asked which area they preferred. In 50 % this was the place that they were visiting. 59% of visitors had a preference for Westhoek, the other regions were significantly less preferred (Table 7).

Table 8: Preferred areas compared to the location of the survey

Preferred area	Location of survey	Dewulfe	Doornpanne	Hannecartbos	Ijzermording	Marchand	Perroquet	Ter Yde	Westhoek	Total
Calmeynbos			1				1		1	1
Franse duingebieden							1			1
Hannecartbos			1	1						2
Perroquet							3		1	4
Ter Yde								2	1	3
Westhoek		1	1		1			2	14	19
Total		1	3	1	1		5	4	17	32

Why they had a preference for the location was for most people difficult to explain. 15 of the respondents gave the following reasons: the presence of forest, bunkers, dead wood and more animals. The limited infrastructure and the naturalness were mentioned once.

→ Landscape preferences

At the end of the survey a sheet with pictures of various dune habitats and beach was shown. They were asked to score the photos from 1 (least attractive) to 6 (very attractive). A person could repeatedly give the same score. They were also asked why they attributed these scores.

Based on all scores, the average score for each photograph was calculated and the six photos were placed in order of preference. Because the quality and atmosphere often plays a role in its assessment, two sets of 6 photos were used. In both sets wet dune slacks got the highest score. The white dunes were also assessed very attractive. Wet hollow dunes were found especially attractive because of the variety of species and colors. The presence of water has also been stated on several occasions as a positive attribute. The white dunes were considered especially attractive because they are so typical for the region.

Interestingly, the beach photos in the two series were rated as unattractive. Since it is assumed that especially the beach and the sea attract the people to the coast, this was not expected. On the other hand these were the only photos where one could see buildings in the distance. This was a strong negative point in these pictures. In addition, the survey was conducted in the dunes.

Bushes were appreciated average in the two series of photographs. They see these landscapes not as typical landscapes of the region. Many of the respondents said they were from regions that where they have forest and therefore they are often not attracted to visit a forest because they can do it at home. Open dunes, grassland and dune mosaic grassland landscape types are judged by the visitors as monotonous and boring.

Table 9: Dune landscape photos series 1 – Average scores of the visitors and positive or negative perceptions







Landscape picture	Name, average score, perception
	<p>Wet hollow dune Score: 5,6/6 Positive: landscape variety, colourfull, presence of water, more animals, natural landscape, flowers, high biodiversity</p>
	<p>White dune Score: 5,2/6 Positive: typical for the region, wild, pristine Remark: fear to damage nature as a visitor</p>
	<p>Dune forest Score: 5,2/6 Positive: paths, very green, presence of trees and shade, quietness Negative: not typical</p>
	<p>Dune grassland Score: 3,8/6 Positive: typical for the region, vast, variety in grasses Negative: monotonous</p>
	<p>Beach Score: 2,1/6 Negative: human interventions visible such as buildings and signs, more people, busy, less nature</p>
	<p>Grassland-shrubs mozaic Score:1,7/6 Negative: boring, monotonous</p>

Table 10: Dune landscape photos series 2 – Average scores of the visitors and positive or negative perceptions

Landscape picture	Name, average score, perception
	<p>Wet hollow dune Score: 5,7/6 Positive: water is attractive, a lot of variation</p>
	<p>White dune Score: 5.3/6 Positive: typical for the region, wild, beautiful</p>
	<p>Dune forest Score: 3,6/6 Remark: Normal, average, nothing special</p>
	<p>Open dune shrubs Score: 3,6/6 Positive: forest nearby dunes are nice</p>
	<p>Grassland-shrubs mozaic Score: 3,5/6 Negative: nietnot typical for the region</p>
	<p>Beach Score: 2,1/6 Negative: a lot of people, buildings, busy</p>

Dune forests were only appreciated average in the two photo series. These landscapes are not considered typical landscapes of the area. A large share of the respondents indicated that they originate from areas with a lot of forest and this is why they are not attracted to these landscapes as they can also visit them back home.

Open dune shrubs, grassland-shrub mozaic and dune grasslands are landscape types considered monotonous and not very attractive.

→ Importance of the dunes

Finally it was asked why the dunes were considered important. This was done to capture as many opinions and concerns as possible. Recreation (26%) and nature protection (26%) were clearly the two most important motivations. Other reasons were natural heritage (15%) and coastal protection (13%). Also the importance to maintain the landscape views and quietness of the area was mentioned. 7% of the interviewees indicated that the dunes are important because it is not allowed to build houses there and this is considered as a stopping point for further urbanization.

The willingness to spend time on this question confirms the strong interest and connection of the people with the area.

3.3.3. CONCLUSION

The survey demonstrates that the dunes are frequented by a large public of all ages. Both local people and tourists strongly appreciate the dunes. They visit the dunes mainly to experience nature and do some walking. Biodiversity is not a very important reason.

Visits to the dunes are complementary with a visit to the beach. The quietness, protection against the wind, relief and vast landscapes are characteristics that are highly appreciated and which cannot be found at the beach.

3.4. QUANTITATIVE ESTIMATE OF SOCIO ECONOMIC INDICATORS

3.4.1. INTRODUCTION

Based on available literature and discussions with people from different sectors, this analysis is focused on a quantification of the socio economic impact of tourism and recreation. Also the importance of the project areas specifically is assessed.

The importance of the study area for agriculture and forestry is marginal and it has little added value to assess the impact of this type of activities. Tourism and recreation are on the other hand already a very important societal benefit of these areas. The realization of a crossboundary nature area offers the opportunity to maintain or increase these benefits in the future. At the same time, tourism and recreation is also considered a threat for the sustainable management of these areas.

Little quantitative information exists on the amount of visitors to these areas and their socio economic importance. The objective is to bring together all available data and assess the socio economic importance based on these data. This gives some insights on the expected impacts of the project and the potential to monitor those impacts in the future.

3.4.2. METHOD AND DATA

The indicator for the socio economic analysis of tourism and recreation is based on the number of visitors. This number can be based on monitoring or extrapolation of monitoring data elsewhere. Based on average expenditures per visit and employment rates per euro expenditure, indicators can be derived to assess the importance for the local economy and employment.

Ideally, visitor counts are available for the different subareas and a detailed monitoring strategy is being developed with manual or automated counters (O'Brien, 2010). This information is not available for the project area. It is outside the scope of this study to perform these counts.

We estimate the order of magnitude based on data from literature and a combination of data sources and methods.

3.4.3. UPDATE FOR NEW DATA IN 2019

Since 2015, there have been no additional area-specific studies to easily estimate the total number of visits, spending or employment effects. We therefore use the methods from 2014, but with an update for partial steps from the calculations with new data (number of residents, number of overnight stays by tourists, second residences, number of day visitors, spending by day tourists and leisure travelers,).

Due to new and better data on second residences, the updated estimate in 2019 for the Belgian part is lower than the first estimate in 2015. In the estimate for 2014, the share of the number of visits from second residences was a major source of uncertainty, mainly regarding the number of overnight stays in this category. For 2018, there is data for this for the entire coast (Westtoer, 2016, Weekers, 2018 and Weekers, 2017) and data on their spending. That is why this category is listed as a separate category in the tables below. The new data shows that this subcategory was overestimated in the 2015 calculations.

New area-specific information is also not available for the French part. The 2019 set of studies on ecosystem services in France (EFESE, Evaluation Française des écosystèmes et des services écosystémiques)¹ (Ifremer, 2019) confirms the importance of coastal areas for tourism and recreation, but does not provide area-specific data that we can use in this study. For the French part, we use the same assumptions and data as for the first estimate in 2014, but, by analogy with the estimate for the Belgian part, apply a bandwidth for the number of visits.

We note that on the basis of this information we cannot make a detailed comparison of the situation in 2014 and 2018 with regard to the number of visits, or use this information to estimate the effect of the LIFE + Flandre project. For this, firstly, the estimates of the number are based too much on assumptions or estimates, in order to follow up evolutions on this basis in a short time, and to isolate the impact of projects within this. Secondly, there are annual variations in the number of visits due to external factors such as weather, safety of other holiday destinations, etc. Thirdly, the measures are too recent to expect effects in the dates of 2018 or earlier. Fourthly, for some dates (eg overnight stays by tourists) the methodology has changed, so that comparisons of data 2018 with 2014 are no longer possible.

¹ <https://www.ecologique-solidaire.gouv.fr/evaluation-francaise-des-ecosystemes-et-des-services-ecosystemiques>

3.4.4. RESULTS SOCIO ECONOMIC IMPACT IN 2019

→ Flemish part of the project area

The table below gives an overview of indicators for the Flemish part of the project area. Two visitor centres in the project area (De Nachtegaal in De Panne and Doornpanne, Koksijde) attract approximately 100.000 visitors per year (75.000 for De Nachtegaal and 25.000 for de Doornpanne). Based on a general rule of thumb that 5 to 10% of the people visiting an area also visit the visitor centre (Barez, 2010), we estimate the total number of visits at 1 to 2 million annually. The number of visits to these centres more than doubled the last 10 to 15 years.

A second method is based on the information about visits to forest and nature and at the coast more in general. For the Flemish coast we distinguish between visits of local inhabitants and people having a second house nearby, tourists (visits with overnight stay) and day visits by people living further away.

These data are based on information for every city at the coast for recent years (2011-2019). Local visits are based on an average number of visits per person per year to nature and forest (Broekx et al., 2014). The visits by local residents are estimated on the basis of information about the proximity of habitation, the average number of walks per person (including detours and short walks) and the walking possibilities near the house. This also takes into account the attractiveness of landscapes. A specific problem for the coast is that we cannot distinguish between dunes and sea or beach.

The Westkust (from De Panne to Middelkerke) attracts annually approximately 16 million tourists and day visits. The question is which share of these people visits the project area and considers a further restoration as an added value. No exact numbers exist to assess this number. We use the information about motives and activities performed during day visits at the Westkust (Westtoer, 2011 en 2018). A low estimate only includes visitors interested in the activity "observation fauna and flora" (2,5% for the visitors of the Westcoast (Westtoer, 2018). It is to be noted that this share is lower compared to the East Coast (3,9%). The high estimate of the visits is based on the assumption that half of the visitors that perform the activity of "long walk at the dunes and the beach" ($28\% / 2 = 14\%$) also visit the natural areas. This share also corresponds to the share of the people indicating that good possibilities to hike are an important motive for a visit.

We apply these percentages both for day visitors and tourists. Together this leads to a range of 1.1 to 3,7 million visits to the Flemish part of the project area or 500-1700 visits per hectare per year. Both approaches illustrate the importance of the area for tourism and recreation. Compared with other natura 2000 areas in Flanders, these figures would give the area a maximum score for the importance of recreation. On the other hand, it also illustrates the potential pressure from tourism and recreation on the natural areas.

Table 11: Indicators for the socio economic importance of the project area, Flemish part

	Data	Unit	Flemisch part of the area			
			Low	Hihg	Average	%
Visits method 1						
Visits to visitor centres		X 1000	100	100	1000	
Extrapolation to area		X 1000	1.000	2.000	1.500	
Visits method 2						
Local/West-Flandres (1)		X 1000	650	1.309	985	41%
Day visits (2)		X 1000	183	1.022	602	25%
Second residences (3)		X 1000	149	832	491	21%
Tourism (4)		X 1000	92	515	303	13%
Total		X 1000	1.073	3.679	2.381	100%
Visits/ha**			488	1.672	1.082	
Expenditures	€/visi t	Mln €				
Local/West-Flandres(1)	5,5		3,6	7,2	5,4	7%
Day visits (2)	45		8,2	46,0	27,1	35%
Second residences (3)	42		6,2	35,0	20,6	27%
Tourism (5)	78		7,2	40,4	23,8	31%
Total	32		25,2	128,6	76,9	100%
Employment	FTE/ mln. €	FTE*				
Direct	11,2		283	1.440	862	71%
Indirect	4,6		116	591	354	29%
Total	15,8		399	2.031	1.215	100%

* FTE : Full time equivalent

** 2200 ha

Sources (for data on visits, tourism, expenditures)

(1) Broekx et al, 2014

(2) Westtoer, daguitstappen 2018

(3) Weekers, TSA 2016, op basis Westtoer, 2016

(4) Statistiek Vlaanderen, Toerisme Vlaanderen

(5) Weekers, TSA 2016

Based on the country of origin from all tourists and day visits, we estimate that 7% of all visitors are French. For the day visits this is 19%.

The associated economic impacts are based on data from toerisme Vlaanderen, Westtoer and FOD economie and are updated for 2019. Because of the high share of tourists, the average expenditures per visit are high (32 €/visit). The total expenditures for the area are estimated between 25 and 128 million euro. Based on indicators of the direct and indirect employment per million euro expenditure, we estimate the impact on employment at 400 to 2000 full time equivalents (FTEs). The best indicator for the local impact on employment is the share of the direct impact on employment, estimated at 280 to 1440 FTE.

→ **French part of the project area**

Based on the number of visitors to the visitor centre “Dunes de Flandre” (50.100 /year) the number of visitors at the coastal zone is estimated at 2 million/year of which 500.000 visit the dunes (Barez, 2010). The estimates are too rough and not sufficiently documented to compare with the Flemish part of the area. No details are available on the composition of the number of visits. During the interviews it was indicated that the number of visits in the French part is lower compared to the Flemish part as less tourists and second dwellers visit the area.

We use a +/- 33% bandwidth to illustrate the uncertainty on this estimate, as well as the uncertainty on local visits for the Belgian part of the area. On average this amounts to 460 visits / ha year, which is in line with the low estimate for the Belgian part.

With a visitor number of 460 visits/ha/year, the area belongs to the most intensively used nature areas in France, comparable to urban forests. (Chevassus, 2009)

We use the average figure for Flanders for the estimation of spending and employment, which corresponds to the figure for spending of day-trippers on the Belgian coast (€ 29 / visit). We note that the spending per tourist for French parks (such as Puy de Dome is twice as high, € 150 / visit according to Landrieu, 2009). For the low estimate of the employment effects, we use a French figure for FTE per million € for the low estimate, which is lower than the Belgian figure. For the high estimate we use the same figure as for the Belgian part.

This results in a bandwidth of 11 to 22 million euros in spending, and an employment of 98 to 340 FTEs.

Table 12: Indicators for the socio economic importance of the project area, French part (2019)

	Extra Info	Unit	French part		
			Low	Hihg	Average
Visits					
To visitor centre		X 1000	100	100	100
Extrapolation for area		X 1000	330	665	500
Visits/ha**			304	613	460
Expenditures	€/visit	Mln. €			
Total	32		10,7	21,5	
Expenditures	FTE/mln. €	FTE			
Low estimate (3)	9,2		98		219
High estimate (4)	15,8			340	

* FTE: Fulltime Equivalent

** 1085 ha

Sources (for data on visits, tourism, expenditures, employment)

- (1) Based on Barrez, 2016, and +/- 33% bandwidth for low and high estimate
- (2) Based on average for Flemish part
- (3) Based on data for France
- (4) Based on data for Flemish part

3.4.5. CONCLUSION

The table below summarizes the indicators for the socio-economic impact, based on a central estimate from the tables above. These numbers are a rough but clear indication that the socio economic impact of the project area is very high for tourism and recreation. We estimate total spending at more than 90 million euros, with a direct, local employment effect of 1,600 FTEs. They confirm earlier studies on the importance of the dunes for this sector (RA, 2006). The numbers also confirm that the importance for the Flemish part is higher for tourism and recreation.

Table 13: Indicators for the socio economic importance of the total project area (2019)

Indicator	Unit	Total area	Flemish part	French part
Visits/ year	X 1000	2.880	2.381	500
Visits/ year per ha		877	1.082	460
Expenditures	Mijoen €/ jaar	93	76,9	16
Employment impact	VTE / jaar			
Direct (local)		1.595	1.440	155
Direct + indirect		2.250	2.031	219

Average estimates based on low and high estimates in tables 11 and 12 above

The numbers illustrate that for the socio economic impact assessment of the project on a longer term, it is important to examine how the project contributes to the further expansion of sustainable tourism at the coast.

The indicators require a lot of data and interpretation, which makes it impossible to easily quantify the exact impact of the project. The amount of visits also depends for example on weather conditions. The evolution of visits to visitor centres are the most easy to follow up but additional data is required for interpretation (e.g. the supply of excursions to the area in the city centres). A qualitative evaluation of the contribution to the strategy for sustainable coastal tourism and recreation seems more evident.

In chapter 7 we estimate how and to what extent the LIFE + Flandre project contributes to the sustainable further development of this service of the area, and the associated socio-economic impacts, including employment.

CHAPTER 4 IMPACT ON ECOSYSTEM SERVICES

4.1. INTRODUCTION

In this chapter, the selection of most important ecosystem services for the study area are being evaluated.

Table 14: Overview of selected ecosystem services.

	Ecosystem services
Provisioning services	-
Regulating services	
Soil carbon sequestration	x
Water quality regulation	x
Water provisioning	x
Coastal protection	x
Air quality	x
Cultural services	
Recreation / tourism	x
Green residential area	x
Health	x

4.2. METHODOLOGY

4.2.1. QUANTIFICATION OF REGULATING SERVICES

For the mapping and quantification of ecosystem services, spatial data (GIS maps) is required for each of the parameters that affect ecosystem services (hydrology, land use, vegetation, soil characteristics, ...). The data should be as detailed and recent as possible, so local factors and recent changes in the ecosystem can be taken into account. Especially in the dunes large differences in abiotic conditions and vegetation type may occur due to the varying terrain and the dynamic character of the environment (influence of winds, tides and waves).

For the Belgian side, maps were provided by the ECOPLAN project (www.ecosysteemdiensten.be), or were derived from coast-specific studies (e.g. information on groundwater depth and vegetation in Houtsaegerduinen, Westhoek and Noordduinen came from the project "Evaluatie van het gevoerde beheer en opmaak van een beheerplan voor het VNR De Duinen en Bossen van De Panne" (Provoost et al. 2011). All maps were converted into rasters of 5x5m.

For France, the "benefit transfer" method was used for most services. This was done by extrapolating the results from the Belgian part of the study area based on habitat type. Such a

“benefit transfer” is possible because of the very similar and typical geomorphological structures and dynamics of the dunes along the French and Belgian coast. The benefit transfer was done based on habitat type (made available by Conseil régional Nord-Pas de Calais) as it reflects abiotic conditions in a way. The habitat map is furthermore highly detailed on both sides which makes the extrapolation more accurate. The description of the different classes and the indicated link with the EUNIS classes (European Nature Information System) were used to identify for each habitat type in France the most similar type of habitat according to the Belgian classification (defined based on NATURA2000 code or as described in the project of Provoost et al. 2011). For those services that are highly dependent of their environment, habitat type cannot be used as single variable to perform the extrapolation. Instead, a combination was used of the benefit-transfer method and local data of the parameters dependent of their environment (see e.g. water quality regulation, where the supply of nitrogen depends on land use and manuring in the surrounding area). In other cases, quantitative data of the local importance of the service itself was used (e.g. water provisioning), without extrapolation from model results in Belgium.

Table 15: Overview of maps used in the ecosystem service models

Map	Source
Soil texture	Digitale bodemkaart Vlaams Gewest (ALBON)
Average highest groundwater table	INBO (beheersevaluatie De Panne) + ECOPLAN
Average lowest groundwater table	INBO (beheersevaluatie De Panne) + ECOPLAN
Land use	ECOPLAN
Land cover	ECOPLAN
Habitat type 2010 (Belgium)	INBO (beheersevaluatie De Panne)
Habitat type 2009 (France)	Conseil Régional Nord-Pas-de-Calais
Groundwater abstractions	Databank Ondergrond Vlaanderen
Atmospheric deposition	Vlaamse Landmaatschappij
Height	Digitaal Hoogtemodel Vlaanderen (AGIV)
Agricultural use	Agentschap voor Landbouw en Visserij
Occupation agricole (France)	Etat français (data.gouv.fr)

→ Limited update in 2019

In 2015, at the start of the project, the main ecosystem services were discussed and quantified on the basis of existing insights, methods and data. For this report in 2019, these results have been updated taking into account new information, e.g. in the context a scientific publication (Van Der Biest et al, 2017). In this context, the quantification of the regulatory service for water quality has been revised, as has its monetary valuation. In addition, the regulatory service on coastal flood protection has been further elaborated and partly monetised. This new information and updates are discussed in this chapter. Broadly speaking, however, the publication of Van Der Biest et al, 2017 confirms the relative importance of the other services, as they are described and quantified in this chapter.

Furthermore, the results from have been interpreted with a distinction according to habitat types, and this is included in the analysis of the impact of the project in Chapter 7.

4.2.2. MONETARY VALUATION

For the monetary valuation, the value of ecosystem services is expressed in monetary terms (€/year) based on a number of methodologies such as benefits transfer, market prices, revealed preferences and marginal abatement costs.

For every relevant service the international literature is screened and based on the best available data a low and high estimate are made. The results are among others based on methodologies developed for the ANB study “Baten van de NATURA2000 gebieden in Vlaanderen” (Broekx et al., 2013), the Nature Value Explorer (Liekens et al., 2013) and based on a screening of literature on valuation methods in France (Chevassus au Louis, 2009; Projet EFESE 2015 (Évaluation française des écosystèmes et des services écosystémiques)). The update takes into account the new info in Van der Biest, 2017, as discussed above.

4.3. SOIL ORGANIC CARBON STORAGE

4.3.1. DESCRIPTION

Storage of carbon in the soil can be realised in two different ways: sequestration of non-mineralised carbon from dead organic matter in anoxic conditions in the soil, and burial during sedimentation in tidal flats. The more atmospheric CO_2 is stored in the soil, the less it can contribute to global warming.

Soils under natural conditions (e.g. forest, natural grassland) have generally higher C-stocks compared to soils under intensively used land (e.g. agricultural farming). Especially wetlands and historic peat formations may hold large quantities of carbon. The development of dune slacks with peat formation provides opportunities for carbon sequestration. Tidal marshes (slikke and schorre) may store large quantities of carbon as a result of sedimentation, but also constitute important sources of greenhouse gasses to the atmosphere.

4.3.2. QUANTIFICATION

The quantification of this services is largely based on the method that was applied in the project “Estimate of the benefits provided by the Flemish NATURA 2000 network”. For more information on the method we refer to the report of Broekx et al. 2014. For wetlands, tidal flats and grasslands the method was slightly adapted based on more recent insights. For wetlands, Broekx et al. (2014) used an indicative value of 4,2 ton C/ha/year. In this study, the indicative value was replaced by the standard formula used for other habitats which takes into soil texture, groundwater depth and type of vegetation (grassland, shrub or forest). Furthermore, a distinction was made between temporary and permanent agricultural grassland, and between nutrient rich and nutrient poor grassland. For tidal flats, carbon storage was calculated as the sum of storage by accumulation of litter and additional storage by burial of organic rich sediment. Tidal marshes are regularly flooded, each time leaving behind a thin layer of sediment. The amount of carbon thus stored depends on the carbon fraction of the sediment (1,84%; IDOD databank MUMM), bulk density of the sediment (1,76 g/cm³; IDOD databank MUMM) the sedimentation speed (2 cm/y for bare tidal flat, 0,5 cm/y for vegetated marsh; OMES databank). For tidal marshes with well developed vegetation (schorre), carbon stored by accumulation of litter is summed up with storage by sedimentation. Storage by accumulation of litter on schorre is set equal to storage in a permanent grassland with high soil wetness on a clayey soil. In bare tidal flats (slikke), only burial by sedimentation is taken into account as vegetation is poorly developed. C loss through emissions of CO_2 , CH_4 en N_2O are

subtracted from total yearly storage. For bare tidal flats an indicative value of -5,7 ton C/ha/y was thus calculated; for tidal flat with pioneer vegetation and low marsh (floods every high tide) -2,7 ton C/ha/y and for high tidal marsh (floods only with spring tide) -7,5 ton C/ha/y.

Carbon sequestration is highest in soils of young and productif ecosystems. As an ecosystem ages, an equilibrium (~100 years) is reached at which yearly sequestration decreases gradually. To trake this into account, we assumed yearly C sequestration is 2,5% of the difference between maximum stock under today's land use and/or management and the maximum stock after realization of Life+. This calculation thus requests knowledge of the age of the ecosystem. In the absence of this information, the average yearly sequestration rate is calculated as the maximum stock divided by the age at which an ecosystem reaches equilibrium (100 years).

4.3.3. MONETARY VALUATION

The monetary valuation of carbon sequestration is based on a review of international literature (De Nocker et al, 2010) and a further update in 2014 (Liekens et al, 2014). These numbers are based on the avoided abatement cost method: if more carbon is sequestered in nature areas, emission abatement costs can be avoided elsewhere to achieve the environmental targets for carbon. These numbers are based on the costs of emission reduction technologies which are necessary to achieve that the average global temperature rises below a maximum level of 2 °C compared with pre industrial levels (1780). Different studies provide a range of marginal avoided abatement costs between 20 euro/ton CO₂-eq. and more then 200 euro/ton CO₂-eq. by 2050. We use fort he reason of simplicity only one value for the refence year 2020 (60 euro/ton CO₂-eq. or 220 euro/ton C). This number is closely approaching values in the report Quinet (205 euro/ton C) (Quinet, 2009). These values are consistent with very recent recommendations for external costs for CO₂ applied in the European Union (Ricardo-AEA, 2014).

4.3.4. RESULTS

The results of the calculations are summarized in the table below. The low and high estimate both start from the same reference carbon stock in the soil and assumre that the annual sequestration levels correspond with resp. 1% and 2.5% of the total. The high estimate corresponds with assumptions made for the study (Broekx et al, 2014).

The capacity to store carbon is low in the dune area compared to other vegetation types because of the soil texture of the sands and the dry soil. Both factors aeriare the soil very well and this causes organic material to disappear easily. Additionally, due to the unfertile soil, the productivity of the vegetation in the dunes is low, which causes a lower production of organic matter and consequently less carbon is sequestered in the soil. An exception to this are the peatlands that appear due to seepage at the foot of the dunes. Peatlands are known to accumulate large quantities of carbon by the poor decomposition of organic material in very wet conditions. Especially in Flanders and the French dunes fairly extensive peat packs are found.

In total 2868 tonnes C per year can be stored in the project area, of which 912 tonnes per year in France and 1956 tonnes in Belgium. This means a total estimated value of 0.6 to 1.6 million / year. The spatial distribution between and within the areas are shown in the map below.

Table 16: Results for the ecosystem service carbon sequestration

	Unit	Total project area		Belgian part		French part	
		Laag	Hoog	Laag	Hoog	Laag	Hoog
Total stock C in soil project area	K tonnes C	287	287	196	196	91	91
Yearly sequestration	Tonnes C/j.	2.868	7.170	1956	4.890	912	2275
Valuation	€/ton Cj.	220	220	220	220	220	220
Total value	K €/y.	631	1.577	430	1.076	201	502
Value/ha	€/ha	192	480	196	489	185	462

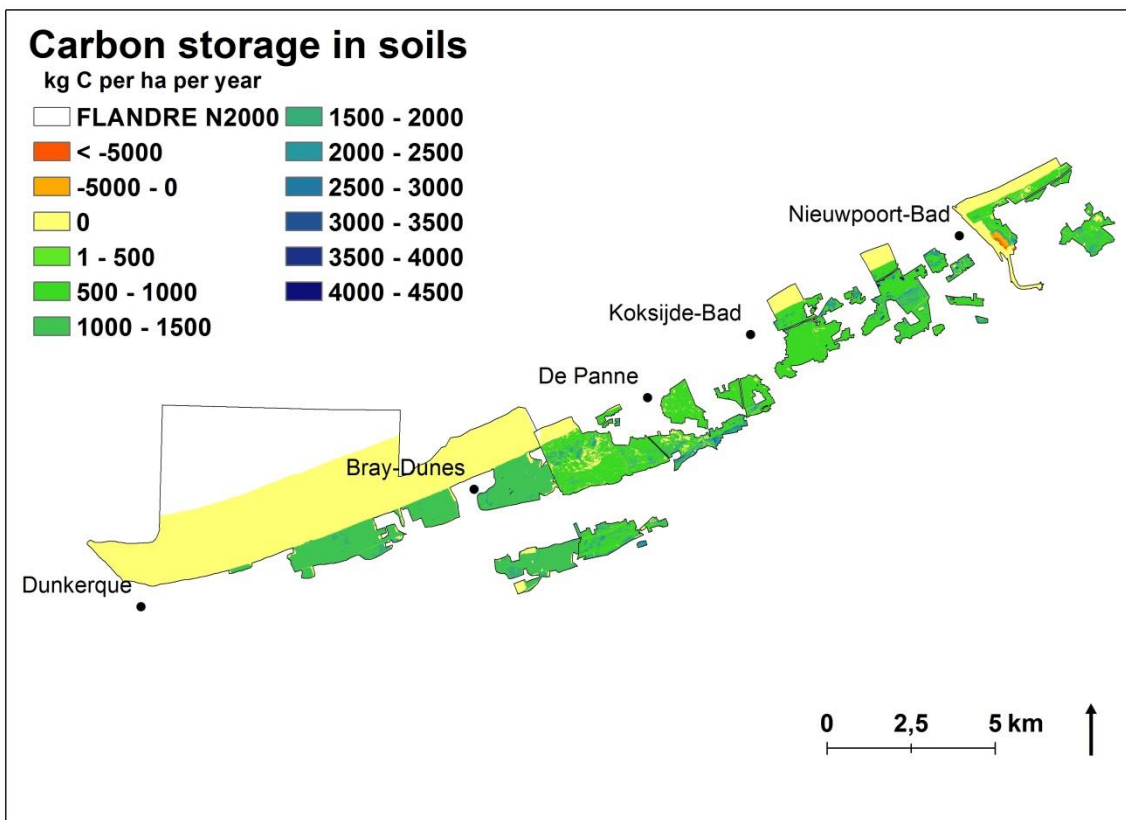


Figure 6: Quantification carbon sequestration in soil (kg c per ha per year)

Our results are comparable with other literature on carbon sequestration in coastal dunes in the United Kingdom (Beaumont et al. 2014) (582 ± 262 kg C/ha.year in dry dune grasslands and 730 ± 262 kg C/ha.year in wet dune areas). These data are based on the average sequestration during a period of 160 years. Our low estimates indicate a total sequestration of 900 kg C/ha.year in dry dune grassland up till 1500 to 2500 kg C/ha.year in wet dune areas. The differences can possibly be explained by the longer period of data for the United Kingdom, and the declining annual sequestration levels as the ecosystem ages (very low after reaching a certain equilibrium at +/- 100 years time).

4.4. WATER QUALITY REGULATION

4.4.1. DESCRIPTION

Since several decennia, Flanders implements an active policy to reduce nitrate concentrations in ground and surface waters (MIRA-T vermessing, 2012). Several measures have been taken to reduce concentrations. Most important sources of high nitrogen concentrations are from manuring in agriculture, diffuse emissions in surface waters (industrial and households) and atmospheric deposition (traffic, industry, households, ...). Field measurements provided by VMM (2014) demonstrate low nitrate concentrations in the Belgian part of the study area, both in surface and in ground water (< 25 mg/l). The most important reason is the absence of important agricultural activity with manuring. Agriculture is present in the surroundings of the dunes. Dunes however are located higher in the landscape so that no groundwater is expected to flow from agricultural areas into the dunes. The dunes however are subject to atmospheric deposition, varying between 10 and 17 kg N/ha/y. Especially the dunes close to the polders suffer from the atmospheric N-deposition. The high permeability of coarse dune sand (low capacity to hold nutrients) make dunes extra sensitive to leaching of nutrients to groundwater. Nitrate supply may also cause acidification of the soil and release of nutrients bound to the calcium in the soil. The presence of certain types of vegetation and specific soil conditions such as calcium content and wetness may thus provide a benefit for water quality regulation.

Besided disturbance of the ecosystem (transition to shrubs) and pollution of ground and surface water, high concentrations in coastal waters also cause eutrophication and algal blooms. Burial of nutrients through sedimentation and removal through denitrification in tidal flats may thus play an important role in water quality regulation.

The main mechanisms through which nutrients are removed from the system are: nutrient uptake by plants (cycling), burial through sedimentation in tidal flats and the biochemical process of denitrification. Besides the removal of nutrients, natural vegetation also has a positive effect on water quality in comparison with agriculture since manuring is not applied (avoided leaching).

Plants take up nutrients and thus constitute a temporary removal of nutrients from the ecosystem. Nutrients become available again as dead organic material mineralizes, or they are removed from the system on the longer term when organic material is poorly degraded in anoxic conditions. Vegetation poor dunes (such as shifting dunes along the shoreline) are also able to remove nutrients from the system by binding nitrates and phosphates to calcium and/or iron. Winds blow fresh, calcium rich sand from the beach into the dunes, or create sand blow outs which brings deeper calcium rich sand to the surface. These wind dynamics thus increase potential for nutrient retention. They also prevent soil acidification and leakage of N and P caused by dissolution of lime. The dissolution of lime provides excessive nutrients to plants, which start to grow faster and start to develop humus rich soils in which P binds to a complex of iron and organic matter. This binding however is less stable in comparison with P bound to merely calcium or iron and P can be released again more easily. In tidal flats nutrients are mostly stored by burial of organic rich sediments, providing an important benefit for the coastal water quality.

The benefits of this service is the prevention of nutrient leakage to ground and surface water and the prevention of coastal eutrophication.

4.4.2. QUANTIFICATION

→ Update methodology 2019

When updating the results in 2019, an alternative method was used for quantifying water quality regulation compared to the 2014 study and the ECOPLAN method. The methodology is based on a meta-analysis of studies on nutrient retention and denitrification in dunes. Also the methodology for monetization was adapted to better reflect the dune-specific demand for clean water. The freshwater lens in the dunes from which drinking water is abstracted has a relatively low concentration of nutrients due to the absence of agricultural practices with usage of fertilizers. The concentrations in the groundwater are below the level at which alternative measures for water purification are employed. Therefore, the same economic method as used in agricultural areas (shadow price for water purification) cannot be used. We here used the costs associated with intestinal cancer caused by intake of nutrients, which corresponds well to the lower estimate but is much lower than the high estimate of the first method.

→ Quantification

(In the study area, N is mainly available via atmospheric deposition caused by industry, traffic and agriculture (on average 11 kg N / ha.year, VMM, 2011.)

Nitrogen in dune ecosystems can either be retained in the ecosystem by plants and organic matter, or lost by leaching, nitrification and subsequent denitrification, and grazing (Olf et al., 1993). N retention is strongly influenced by the presence of calcium in dune sand and uptake by vegetation. Calcareous soils (young sand deposits), are characterized by higher nitrification rates in comparison with soils with a decalcified top layer (ten Harkel et al., 1998). With low degrees of denitrification, this causes nitrate leaching to groundwater (ten Harkel et al., 1998; Pinay et al., 2007). Nitrification rates are smaller in more developed soils with a decalcified top layer and lower pH. Incorporation in plants is also higher in well-developed soils, which directly take up ammonium from atmospheric deposition and where nitrate is partly lost through mineralisation and nitrification of dead organic material.

ten Harkel et al. (1998) showed that in foredunes in the Netherlands about 70% of the atmospheric deposition (ammonium) leaves the soil as nitrate, while at non-grazed, dry innerdunes (grasslands which are decalcified down to 40e50 cm depth) only 13% leaches to groundwater. In dune slacks of older successional stages (as found in the study area), where groundwater flow reaches the surface, N removal by denitrification is estimated to account for 5% of the atmospheric deposition (Adema and Grootjans, 2003).

Dune shrub with *Hippophae rhamnoides* lives in symbiosis with N-fixing bacteria and nearly triples the amount of leaching to groundwater compared to atmospheric deposition (Stuyfzand 1984). In the absence of literature values for dune shrub with *S. repens*, we used the denitrification value for old dune slacks (5%), as this vegetation type often evolves from dune slacks. Average N leaching from forests within the study area is estimated 29% (Staes et al., 2017).

4.4.3. MONETARY VALUATION

As the method from Ecoplan 2014 and assessment for 2014 is not the best in the context of the dunes, an alternative method has been used (Van Der Biest, 2017). The monetary value of N retention is based on the benefits to society from health problems (intestinal cancer) associated with N intake through drinking water (Van Grinsven et al., 2010). The benefits of the ecosystem service are for the health care insurance (avoided expenses) and the patients and their families (avoided private health care costs and suffering). For Belgium, this value is estimated at a range of 0,6 to 2,4 V kg N, accounting for uncertainties in the exposure assessment (% of population using drinking water from the controlled tap water network).

4.4.4. RESULTS

The table below indicates that the scope and value of this service is rather limited (compared to other services). We estimate the total value of this service at 2 to 7 keuro for the area / year. The benefits per ha are similar for the French and Belgian part.

We note that these results are lower than estimated at the first estimate for 2014, due to both lower quantification and lower values for monetization.

Table 17: Results for the service of water quality regulation (update 2019)

	Unit	Total project area		Belgian part		French part	
		Low	High	Low	High	Low	High
Yearly retention	Ton N/y.	3,0	3,0	2,0	2,0	1,0	1,0
Valuation	€/kg N/y.	0,6	2,4	0,6	2,4	0,6	2,4
Total value	K €/y.	1,8	7,1	1,2	4,8	0,6	2,3
Value/ha	€/ha	0,5	2,2	0,5	2,2	0,5	2,1

4.5. STABILISATION WATER LEVELS/INFILTRATION

Stabilisation of water levels refers to (1) water retention by soils and (2) infiltration and replenishment of ground water reserves. Water retention and infiltration are actually supporting functions for the delivery of several other services such as drought prevention and water provisioning. For dune areas, infiltration is an important ecosystem function. Water retention in the upper soil is more important in upstream areas. Wetlands and valley bottoms have the capacity to temporarily store water and release it gradually. This may prevent downstream flood events and buffer periods of prolonged drought. Within dunes, this service is less important. We therefore only consider infiltration.

4.5.1. DESCRIPTION

Infiltration or seepage of precipitation into the soil is a crucial process in dunes. On the one hand, it provides pure water for consumption, and on the other hand, it constitutes a buffer against intrusion of sea water into the fresh water reservoir. The relatively long residence time of groundwater within the soil gives opportunities for pollutants and nutrients to be removed by adsorption, soil chemical processes and microbial denitrification. Part of the groundwater will flow to the surface again in low lying seepage areas, thus supporting the typical habitats of dune valleys,

and ecosystem services associated with wet soils (such as carbon storage and water quality regulation by denitrification). To avoid double counting this service is only quantified and not monetized. The monetary value of this function is reflected in the value for water provisioning.

4.5.2. METHODOLOGY

The same methodology was applied as in Broekx et al., 2013. For more information we refer to his report.

4.5.3. RESULTS

Open areas in dunes (such as in shifting dunes) have a high capacity for infiltration because of the absence of vegetation. While the root system of vegetation improves infiltration on clayey soils, in sandy soils it reduces infiltration. Part of the precipitation is captured by leaves where it evaporates without reaching the soil. Water that does reach the soil may furthermore be taken up by plants through their roots and be evaporated. Forests are the largest consumers of rain water amongst the natural land use types. Infiltration is about half of that in unvegetated dunes. Under cultivated land, infiltration reduces to half of that in forests. Paved surfaces reduce infiltration due to evaporation and discharge into the sewage system (in urbanized areas).

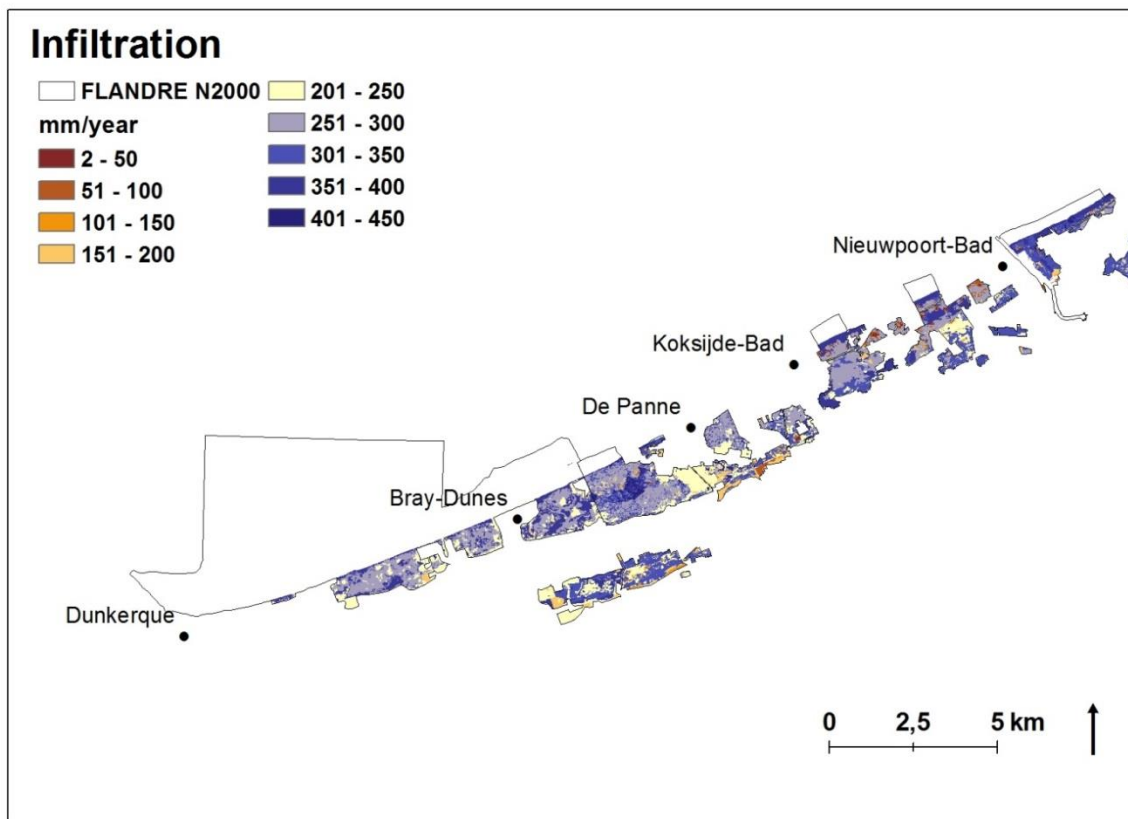


Figure 7: Infiltration in mm/y

About 121 million m³ per year infiltrates directly within the study area, of which 69,7 million m³ in Belgium and 51,6 million m³ in France. The importance of infiltration is discussed in the next chapter.

4.6. WATER PROVISIONING FROM GROUND WATER

4.6.1. DESCRIPTION

Dunes are relatively important for the service of water provisioning for consumption because of the presence of an undep and exploitable fresh water reserve. The high permeability of the dune sand promotes fast replenishment of the ground water. Ground water in dunes is furthermore relatively pure and - except for the need to remove iron (Calcoen and Opstaele 2005) - fit for consumption. The forest management plan for the water provisioning area of Sint-André (Calcoen and Opstaele 2005) estimated that about 16% of the drinking water production in West-Vlaanderen is provided by abstraction of dune water (Provoost and Hoffmann 1996). Large quantities of water abstraction however cause important trade-offs with other services such as climate regulation (carbon sequestration in wet soils) and with biodiversity. It also increases the risks for contamination of the fresh water reservoir by intrusion of salt water. The presence of a fresh water reservoir in the dunes constitutes a buffer between fresh and salt water by continuous seepage of fresh water to the sea and to the polders. This prevents salt water from underneath the beach and the polders to flow into the fresh water reserve (Vanlerberghe & Vanhoutte 2001). Salinization by overexploitation of ground water has some additional risk such as degradation of natural vegetation types, agricultural losses, failure to comply with Water Framework Directive goals and costs for desalinization of drinking water. In 2002, the drinking water company in the study area started with artificial infiltration of pre-treated sewage water in order to avoid these risks. Although this reduces the risks, Zwaenepoel et al. 2004 argue that a complete arrest of the exploitation of natural sources of groundwater is needed to completely restore the dune ecosystem and to achieve the habitat targets. It can be expected however that water abstraction from the dunes will become more important given population growth and increased tourism. In this study we quantify the ecosystem service but we emphasize the need for a balanced ratio between the rate of water abstraction and the replenishment rate of the reserve. The impact of water abstraction on other services is taken into account through the effects of ground water level reduction on carbon sequestration and denitrification, and the occurrence of certain types of vegetation.

4.6.2. METHODOLOGY AND MONETARY VALUATION

Water provision depends on two main supporting ecosystem functions: water purification and infiltration (see paragraphs water quality regulation and infiltration). The methodology for the quantification is entirely based on the infiltration equivalent method developed in Broekx et al., 2013.

4.6.3. RESULTS

Within the French part of the study area no water abstraction installation is found. However, at a distance of 1 km from the study area an important abstraction (3,9 million m³ per year) is found which is dependent of the infiltration taking place in the study area and causes lowering of the ground water table. The map below shows that amount of abstracted water is larger than the amount of water infiltrating (abstraction pressure more than 100%). Although it is not possible to accurately predict the amount of water that is abstracted from the study area, we estimate it to be between 0,1 and 0,4 million m³.

About 5,1 million m³ per year is abstracted from the Belgian part of the study area, of which 2,5 million m³ comes from artificial infiltration at St-André. About 3,7% of the total volume of water that infiltrates naturally in the area is thus being used for water provisioning. In certain areas this causes severe pressure on the local ecosystem as the abstraction rate exceeds infiltration rate (Figure 8, dark blue zones).

The total value of the service is estimated at 0,2 to 0,6 million euro/y, or 62 to 180 €/ha. The benefits for the Belgian part are assumed to be higher as water abstraction is taking place in the area itself, although the value for the French part may be underestimated due to the uncertainty on the estimate. The numbers however are in line with estimates from literature which calculated the added value of nature and forest for water provisioning. Abildtrup, 2013 shows that on average 1 extra ha of forest in France reduces the costs for water provisioning in households with 138 euro/ha. The benefits provided by areas with high importance for this service are estimated at 40 to 120€/ha. These high estimates reflect the importance of the dunes for water provisioning along the coast, which is also underlined by the presence of the installations for artificial infiltration at St-André.

Table 18: Results for the ecosystem service water provisioning

	Unit	Total study area		Belgian part		French part	
		Low	High	Low	High	Low	High
Gross abstraction	mln. m ³ .y.			5,1	5,1		
Artificial infiltration St-André	mln. m ³ .y.			2,5	2,5	0	
Netto abstraction	mln. m ³ .y.	2,7	3,0	2,6	2,6	0,10	0,40
Value	€/ m ³	0,075	0,2	0,075	0,2	0,075	0,2
Total value	K €/y.	203	600	195	520	8	80
Value/ha	€/ha	62	183	89	236	7	74

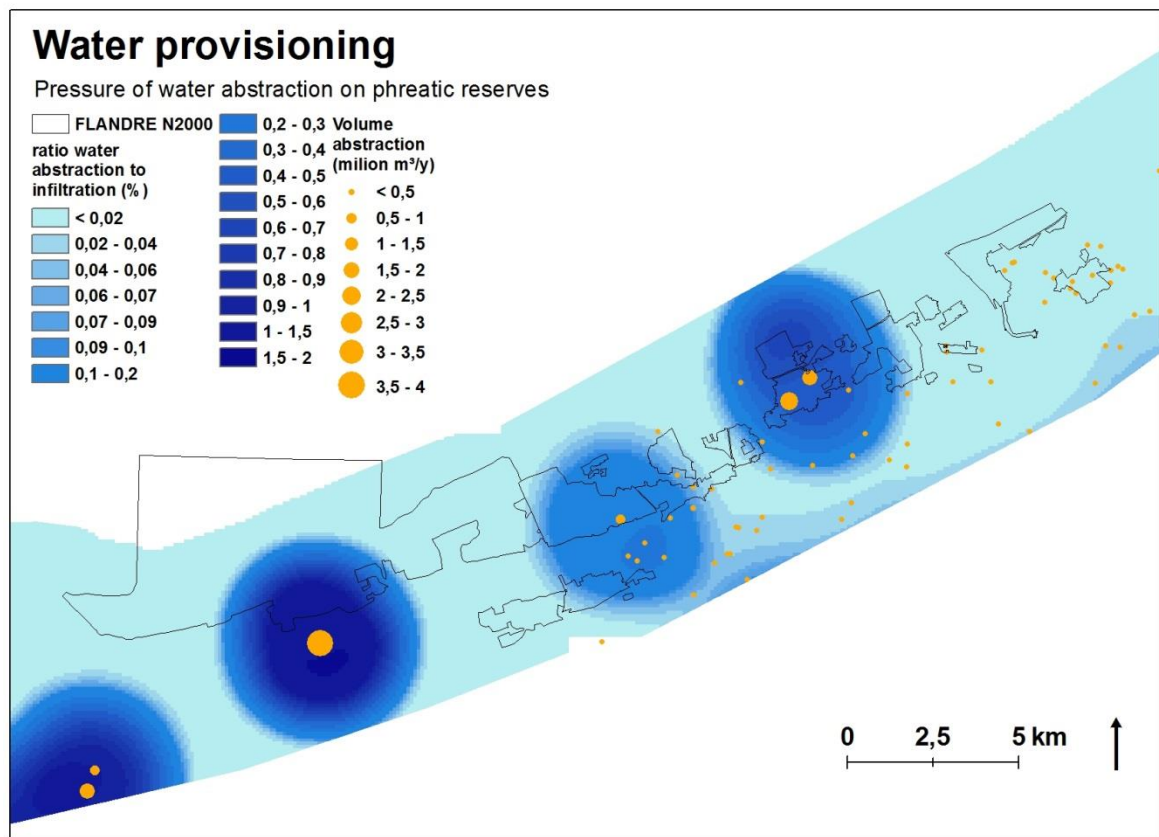


Figure 8: Pressure on phreatic ground water reserves (% abstracted vs. infiltrated amount of water)

4.7. PROTECTION AGAINST FLOODS

4.7.1. DESCRIPTION

Protection against floods within the study area mostly concerns floods from the sea. In Belgium dunes play a crucial role in the protection against floods as the largest part of the coastal zone is located 2 m below the level of an average yearly storm (+5,5m TAW). About half of the Belgian coastline (33km in total) and half of the French coastline east of Dunkerque (± 7 km) is being protected by dunes located within the special protection area (taking into account only the first row of dunes adjacent to the beach which constitutes the major defence). Large parts of the dunes have historically been lowered for the purpose of housing, recreation, etc. both in Belgium as in France between Dunkerque and the border. Any kind of nature protection status (Natura 2000, Dune Decree, ...) may does have a crucial function to prevent further lowering of the dunes, and stimulate natural dune dynamics that allow rejuvenation and regeneration of the dunes.

4.7.2. METHODOLOGY AND INTERPRETATION FOR THE STUDY AREA

Not only dunes but also beaches play a role in the protection against floods. Risk calculations (estimated damage and casualties) performed in the frame of the Masterplan Coastal Safety take

into account the entire coastal defence (beach and dune), making it impossible to quantify the precise contribution of the dunes. This service is thus only assessed in a qualitative way.

The extent to which dunes protect against floods depends on the height of the dune, the width of the dune massive and the level of fixation by vegetation. Wide, low dunes provide a higher level of protection than narrow, high dunes, on the condition that the storm level does not exceed the height of the dune. High, narrow dunes will lose their stability faster when the dune foot is being eroded by incoming waves, leading to breach formation. Vegetation increases the level of protection because they hold the sand together with their roots and they reduce wave energy with the above ground parts of the plants. Especially in embryonic dunes this mechanism plays a crucial role as pioneer vegetation helps stabilize the dune foot and create conditions for rapid dune accretion (sand trapping by plants). This mechanism is relatively more important in narrow dunes compared to wide dunes.

The presence of a special protection area has multiple effects on coastal safety:

- Reduction of the risk for damage and casualties (absence of buildings on the coastline)
- Arrest of excavation and lowering of the dunes
- Natural accretion of dunes is stimulated by sediment trapping in pioneer vegetation (areas of restricted access and prohibition of machinal beach cleaning at the dune foot allow embryonic dune formation)

Within the Masterplan Coastal Safety numerical models were used to calculate the amount of the material damage and the number of casualties on the coastline and in the hinterland due to flooding and/or breach formation during a storm of +7m TAW (return period 1/1000 y). Within the study area no breaches were formed in the numerical simulations. Damage on the coastline itself was expected to be rather small given the few number of houses found on the dike. The special protection area thus is very efficient at reducing flood risks.

As risk calculations in the Masterplan take into account both beaches and dunes, an additional qualitative assessment of the dunes in the protection against floods was done in this study. The dunes are assessed based on sections of approximately 100m wide (parallel to the coast). Only the first line of dunes actually protect against floods and is thus taken into account. Dunes further away from the coast that do not form a whole with the first row of dunes (interrupted by buildings) are not taken into account. For each section, the width of the dune row (perpendicular to the coastline) and the average height of the dunes was calculated based on the digital elevation model of Flanders (2008). A score was then derived for both width and average height. This score is based on the safety standards applied in the design of the coastal defence in Katwijk, The Netherlands (Koopal 2013). A suitability index was calculated which takes into account the importance of the width of the dune row: score height + 2 x score width. The final score was then rescaled to a value of 1 to 5.

Height (m TAW)	Score height		Width (m)	Score width
0 – 6,5	1		0 – 50	1
6,5 – 7,5	2		50 – 100	2
7,5 – 8,5	3		100 – 150	3
8,5 – 9,5	4		150 – 200	4
> 9,5	5		> 200	5

Figure 9: Methodology for the qualitative assessment of protection against floods

The dune massive in the Belgian part of the study area offers a high to very high protection against floods. Only at one location the dunes offer less protection, that is near the military area at Lombardsijde. There, the dunes have been lowered locally. Along the entire coastline of the French part of the study area, the dunes are at least 1 km wide and offer a very high protection against floods.

The effect of the Life+ project on coastal safety can only be assessed by comparing height and width of the dunes now and after realization of the (management) measures. It can be expected that these measures will have only a very restricted effect on coastal safety on a short term of only 4 years. The planned measures will mostly have an effects on the degree of fixation of the dunes, rather than on the width and/or height of the dunes. On the long term, fixation and accretion will however lead to an increase of coastal safety.



Figure 10: Qualitative assessment of the protection against floods by dunes

4.7.3. QUANTIFICATION AND MONETARY VALUATION FOR A PART OF THE PROJECT AREA (CASE STUDY)

→ Introduction

For a part of the project area, the "Westhoek reserve in the Panne" (340 ha, 1260 meters of coastline), the benefits of this service are further quantified and monetised (Van Der Biest, 2017). This concerns one aspect of this service with regard to avoided maintenance costs. We report this here because it is relevant as an illustration of the importance of dynamic dunes.

Flood protection includes two aspects: (1) the mass of sand deposited in the past that now forms a physical barrier against waves and water; and (2) the maintenance or improvement of this mass of sand through the supply of fresh sand, and the capacity of the system to keep up with the sea level rise. The first is usually estimated by quantifying the damage costs and the number of flood victims (TEEB 2010; Koks et al. 2014). The second can be valued using the replacement costs for artificial dune foot nutrition. Because this study focuses on the dynamic processes of erosion and sedimentation in the dunes and their contribution to human well-being, it was decided to use the replacement costs for dune foot feeding to appreciate the benefit of coastal safety maintenance.

→ Quantification

The volume of sand accumulated per year in shifting dunes along the shoreline is used as indicator for the maintenance of coastal safety. Several studies have shown that *Ammophila* species require a certain amount of sand burial each year in order to remain vigorous (De Rooij-Van Der Goes et al., 1995; Keijsers et al., 2015). Without supply of fresh sand, soil starts to develop and marram grass degenerates because of the occurrence of nematodes. The presence of marram grass can thus be used as indicator of active sand transport.

Based on literature for Belgium, the Netherlands, France, the minimum and maximum estimates for coastal safety maintenance are estimated at a sedimentation of 2 and 5 cm / y. These inland shifting dunes however do not form a continuous complex with those from the shoreline but are separated by a strip of fixed dunes parallel to the coast. The occurrence of marram grass here can be attributed solely to eolian and management related (trampling, grazing) forces continuously reworking the present sand, rather than deposition of fresh sand from the beach. Accumulation of fresh sand, and thus coastal safety maintenance, is only taken into account for the embryonic and shifting dunes in the frontal dune zone. To estimate the benefit, the surface area covered with embryonic and shifting dunes along the shoreline should be multiplied with the yearly sedimentation rate.

Based on the literature, we estimate that the annual deposition of sand for these dunes is 400-1000 m³ / ha. This leads to a high benefit for these specific dunes.

→ Monetary value

The cost to replace natural supply of sand by artificial nourishments is used as indicator for the economic value of sand accumulation. According to Deltafact (2012) 1 m³ of dune foot nourishment costs 16 €. The economic value for coastal safety maintenance by dunes corresponds relatively well with the costs to maintain an existing dyke (60 to 150 € / m / year) and increase its

height as adaptation to sea level rise by 2100 (5,000 € / m) (MDK 2016). When spreading these expenses over the period 2017 to 2100, this would lead to a cost of € 0.15 to € 0.26 million / year for the entire stretch of the reserve (1260 m).

If we divide this total benefit over the total area of the reserve (340 ha), we estimate an annual benefit of € 441 to € 765 / ha / year, on average for the area. However, the benefit per ha for the seaward dunes is much higher, and amounts to € 15 to € 26 k / ha (see also figure 21 in chapter 7).

4.7.4. EXTRAPOLATION OF THE ESTIMATES TO THE PROJECT AREA

To illustrate the importance of this service, extrapolation was made to the total area, based on the average value per hectare, as calculated above. It has to be noted that this extrapolation is very uncertain. We also note that this is only part of the total service, and only covers the avoided maintenance costs. The chance that we will overestimate this service in its entirety with this extrapolation is therefore limited.

Table 19: Results for the service of coastal flood protection (update 2019)

	Unit	Total project area		Belgian part		French part	
		Low	High	Low	High	Low	High
Case study	€/ha			441	765		
Extrapolation *	K €/j..	1.449	2.512	971	1.682	479	830
Value/ha	€/ha	441	765	441	765	441	765

* extrapolation of value/ha of case study to total project area

4.8. AIR QUALITY

4.8.1. DESCRIPTION

Vegetation filters various contaminating components from the air. Suspended particulate matter comes into contact with leaves and branches, deposits and will then be rinsed through the rain to the bottom. The contribution of vegetation on the filtering of polluting components is dependent on the type of vegetation, the type of contamination, the location and implantation of the vegetation. Natural environments can thus play a role in improving air quality by, among other capturing particulate matter.

This service is relevant to the study area as it is a region with a relatively high degree of air pollution (Van Steertegem, 2009). There is a general consensus that the current air quality has a major impact on public health (Torfs et al, 2006; Buekers et al, 2012.). This effect is primarily associated with exposure to particulate matter.

4.8.2. QUANTIFICATION

To quantify the impact of nature on air quality we build on the indicators of Oosterbaan, 2006, as reported in Broekx et al., 2013. These numbers indicate how many particulate matter can be captured by vegetation types. In general terms, the most effective vegetation goes from conifers to deciduous trees, shrubs and herbaceous plants over to grass. This principle is widely recognized but the exact extent of the amount of suspended particulate matter is highly uncertain, which is reflected in the range of low and high estimate.

The amount of captured fine dust also depends on the concentrations in the ambient air. Based on a study of the spatial variation of particulate matter concentrations in Belgium we can conclude that the differences between coastal and average for Flanders are too small and too uncertain to correct the indicators (Mahieu, 2012). The differences between regions are thus explained by differences in vegetation. This study is a refinement of the method from Broekx et al., 2013, because there is made use of more detailed vegetation maps. The same indicators are used for the Belgian and French territory.

4.8.3. MONETARY VALUATION

The particulate matter capture is measured based on indicators for the avoided damage costs of emissions of particulate matter in Flanders. These indicators are based on a European methodology to quantify external or social cost of air pollution (mainly health). We use this key figures from a study in which this methodology is applied to emissions in Flanders, taking into account weather, population density, demographics and socio-economic data for Flanders and border regions (De Nocker et al., 2010). We take into account the composition of the captured particles and take the external costs of emissions from low chimneys (eg. Houses) as the best proxy for avoided costs for capture by vegetation. This results in a cost avoided of € 54 / kg PM (Broekx et al., 2013).

There are no specific data available for the coastal area. Because of the proximity of the French project these figures can also be applied here.

4.8.4. RESULTS

The average fine dust amount captured in the project area amounts to 18 to 36 kg of particulate matter / ha, which corresponds approximates levels for coastal habitats with low vegetation and pasture. The analysis on the basis of the vegetation maps confirms, on average, the previous analysis based on land-use. There are hardly any differences in capture per hectare between the French and Flemish part.

As the social costs of particulate matter are so high, this benefit is relatively important for both parts (960 to 1,920 € / ha). Compared to the average for other nature reserves in Flanders, this benefit because these coastal areas are less wooded a quarter lower.

Table 20: Results for the ecosystem service air quality

Air quality	Eenheid	Total project area		Belgian part		French part	
		Low	High	Low	High	Low	High
Fine dust capture	Tonne/y	58,7	116,9	38,9	77,8	19,8	39,0
Unit value	€/tonne	54	54	54	54	54	54
Total value	K €/y	3.169	6.311	2.102	4.204	1.067	2.107
Value/ha	€/ha	965	1921	955	1911	983	1942

4.9. POLLINATION

The provision of pollinators (mostly bees) is especially important in the surroundings of agricultural crops that depend on pollination (fruits, legumes, ...). To assess the importance of this service in the study area, maps of agricultural use of Flanders and France were consulted. It was decided not to further regard this service in the absence of important areas of pollination dependent agriculture in or near the dunes.

4.10. RECREATION AND TOURISM

4.10.1. METHOD

The number of visits is already quantified in the previous chapter. Based on an international literature review, we estimate the societal value of a visit between 3 and 9 €/visit (Broekx, 2014; ; Sen, 2011). A French literature review (Chevasus, 2009) has a similar value of 4 €/visit.

4.10.2. RESULTS

The high number of visits to these areas is also reflected in high values of 4 to 40 million € per year for the whole area. Because the Flemish part attracts more visitors, its value is higher.

Table 21: Benefits for recreation and tourism for the Belgian and French part

Recreation and tourism	Unit	Total project area		Belgian part		French part	
		Low	High	Low	High	Low	High
Visits*	x1000	1.403	4.344	1.073	3.679	330	665
Unit value	€/visit	3	9	3	9	3	9
Total value	K €/y	4.209	39.092	3.219	33.107	990	5.985
Value e/ha	€/ha	1.281	11.900	1.463	15.049	912	5.516

* for details, see chapter 3

We can alongside these visits also analyze the importance of hunting for the French part. Based on overall figures for France (Chevasus, 2009) this annual benefit is between 55 to € 69 / ha. We do not report this service separately because this effect is uncertain (not region specific) and is negligible given the bandwidth on tourism and recreation in its entirety.

4.11. AMENITY

4.11.1. METHOD

Houses with a view on and in close proximity of green and open space offer higher quality of life leading to a higher market value of these houses. This effect has been amply demonstrated in the literature.

We restrict ourselves to the added value for properties within a distance of 100 meters from the regions, with a view on these areas. Also houses that are further away have added value because of the proximity to recreational areas, but these benefits are already accounted for in the recreation and tourism service.

4.11.2. RESULTS

The value for Flanders is determined based on a GIS analysis. About 3,500 houses are within 100 meters of the area. This high number per hectare reflects the fragmentation of the dunes areas and their interdependence with residential areas. Based on a review of international literature, we estimate the effect of these houses at 2% to 4% which equates to 180 to € 360 / house / year.

For France we have not made this analysis. Because the population density is similar, we believe that the key figures for Flanders also apply to France.

This leads to a benefit for amenity between 1 to € 2 million.

Table 22: Benefits for amenity value for the Belgian and French part of the study area

Amenity	Unit	Total project area		Belgian part		French part *	
		Low	High	Low	High	Low	High
Houses within 100m	x 1000	5,5	5,5	3,68	3,68	1,81	1,81
Unit value	€/house	180	360	180	360	180	360
Total value	K €/j.	989	1.977	662	1.324	327	653
Value/ha	€/ha	301	602	301	602	301	602

* based on benefits transfer and calculations flemish part

4.12. HEALTH

4.12.1. METHOD

There are many scientific studies that show that on average more green in the living environment leads to better physical and mental health. We quantify and value this effect based on epidemiological studies from the Netherlands, which shows for 18 different health indicators relationships between the amount of green within 1 to 3 km from the residence (Maas, 2008). The effects are greatest for mental health and green within a distance of 1km to the environment. We quantify these effects as avoided DALYs ("disability-adjusted life year" or "lost quality of life").

The economic valuation takes into account less sickness, fewer loss of productivity and less welfare loss by less suffering for the patient (De Nocker et al., 2010). The reduction in "lost quality of life" is valued at 87,000 euros per DALY (Stassen et al., 2007).

These benefits partially overlap with those for recreation and living environment (mental and physical recovery by contact and movement with green recreation) but there are no accurate calculation rules to correct this. To avoid double counting, we only keep half of the low estimate of these benefits.

4.12.2. RESULTS

We estimate that 71.000 inhabitants live within 1km of the Belgian part of the project area, and enjoy health benefits due to the proximity of the project area (cardiovascular, diabetes,...) and mental health (anxiety, depression). This corresponds to a health impact of 1,9 to 5,7 DALY per 1000 inhabitants.

Table 23: Benefits health for the Belgian and French part

Health	Unit	Total project area		Belgian part		French part (e)	
		Low	High	Low	High	Low	High
Inhabitants (a)	X 1000	106	106	71	71	35	35
DALYs (b)	DALY/y.	205	606	137	406	68	200
After correction doublecounting (c)	DALY/y.	102	102	68	68	34	68
Unit value (d)	k€/DALY	87	87	87	87	87	87
Total value	K €/y.	8.839	8.839	5.916	5.916	2.923	5.916
Value/ha	€/ha	2.691	2.691	2.689	2.689	2.689	2.689

(a) inhabitants within 1 km of the area who have health benefits

(b) total health benefits based on Maas, 2008 and Broekx, 2014

(c) DALY.year after correction for doublecounting recreation and amenity

(d) based on Stassen et al., 2007

(e) based on benefits transfer data Belgian part

We estimate the total health benefit at 12 to 36 million euro or 170 to 500€/inhabitant. After correcting for doublecounting, we estimate the benefit at 5.9 million € or 2.700 €/ha.year.

4.13. OVERVIEW ECOSYSTEM SERVICES

The table below summarizes the value of the studied ecosystem services. The area has little provisioning services but has some important regulating services and cultural services. These services are not traded on commercial markets and under pressure from socio-economic developments.

The survey also shows that the services for this important area can also lead to pressure on the area and risks of overexploitation (water collection, tourism and recreation). Certain features such as fragmentation and proximity to residential areas translate into high levels of cultural services for environment or health, but are also referred to as problematic (eg. for landscape quality).

Table 24: Summary overview of ecosystem services

Service	Unit	Entire project area		Flemish part		French part	
		Low	High	Low	High	Low	High
Provisioning services		-	-	-	-	-	-
Regulating services							
Soil carbon storage	K €/y	631	1,577	430	1,076	201	502
Water quality	K €/y	1,8	7,1	1,2	4,8	0,6	2,3
Water supply	K €/y	203	600	195	520	8	80
Coastal safety	K €/y	1.449	2.512	971	1.682	479	830
Pollination		-	-	-	-	-	-
Air quality	K €/y	3,169	6,311	2,102	4,204	1,067	2,107
Cultural services							
Recreation / tourism	K €/y	4.209	39.092	3.219	33.107	990	4.500
Amenity	K €/y	989	1,977	662	1,324	327	653
Health	K €/y	8,839	8,839	5,916	5,916	2,923	2,923
TOTAL	K €/y	19.491	60.915	13.495	47.834	5.995	11.597
Value/ha	€/ha	5.933	18.543	6.134	21.743	5.526	10.689

- = not important for study area

na = not available, impossible to quantify or value

CHAPTER 5 NATURE RESTORATION, ASSESSMENT 2014

Restoration actions in the 'Oostvoorduin' in Oostduinkerke will be evaluated based on methods used in the project 'PINK' (permanent inventory of nature reserves along the coast, Provoost et al., 2010). INBO has developed these methods and applied them within the recently finished project PINK II.

5.1. INTRODUCTION

In this chapter, the initial situation is described before restoration measures are taken. Finally, we will evaluate the success of the restoration of target habitat types ("2130 fixed dunes with herbaceous vegetation" and "2190 wet dune slacks") and target species (*Apium repens*, *Bufo calamita* and *Triturus cristatus*) within the Action C.1 of the LIFE+ project "Flandre". The measures under this action will be taken under the Belgian part (Oostvoorduin, Oostduinkerke). Narrow-mouthed whorlslug (*V. angustior*), included in Annex 2 of the Habitats Directive is not surveyed as part of this study. This species is known from a recent location in the north of the Oostvoorduin (waarnemingen.be). The distribution is not known in detail, but in practice this is an impossible task to accomplish. We expect the excavation, as part of the restoration action, will initially mean a deterioration of habitat quality (Packet 2014). However, over time, with the increase in vegetation structure, the population of *Vertigo angustior* may grow.

5.2. METHODS

Figure 14 shows the plots where restoration actions took place. As part of the project 'PINK II', these plots and the whole area were mapped according to the dune vegetation mapping method developed in PINK I (Provoost et al. 2010). Also the target species (vascular plants) were mapped using the methods developed within the same framework. Finally, the overall composition of species was investigated. In a separate project, commissioned by the Flemish Agency for Nature and Forests, 4 soil samples were taken in order to determine the nutrient status of the project area (Herr & Hens 2014). The location of these samples is also shown in Figure 14. Their codes are adjusted in accordance with the codes of the parcels.

Currently, suitable ponds for great crested newt and natterjack toad are not available in the project area. Therefore we haven't conducted an inventory of these species within the description of the initial situation. Ponds will be surveyed at the end of the projects.

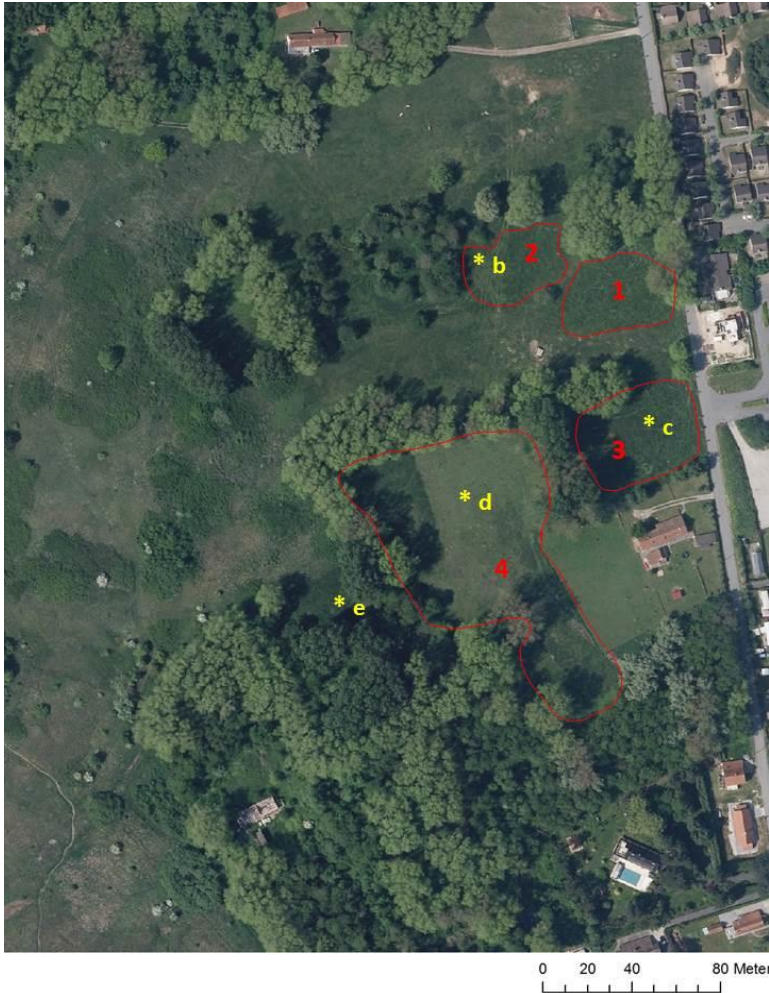


Figure 11: Map of the parcels (red) and soil samples (yellow).

5.3. RESULTS

The vegetation map is shown in Figure 15. For detailed explanation of the codes, we refer to the 'PINK' report (Provoost et al., 2010). Figure 16 shows the results of the target species mapping. The first letter of the vegetation code is a 'c' for all four parcels, which means tall grass vegetation. *Arrhenaterum elatius*, *Poa trivialis* and *Holcus lanatus* are the most dominant species. Together these species cover about three quarters of the vegetation. These grasses are accompanied by a number of common species of eutrophic grasslands such as *Trifolium repens*, *Ranunculus repens*, *Taraxacum sectio vulgaria*, *Potentilla reptans*, *Geranium molle* and *Plantago lanceolata*. The moss layer is dominated by *Brachythecium rutabulum*. Plots 1 and 2 are part of a polygon coded 'cg', indicating the presence of dune grassland species. The levelled parts of this parcel contain common dune grassland species such as *Achillea millefolium*, *Rumex acetosella* and *Luzula campestris*. The ridges were little or never fertilized and therefore are richer in species. Here we find *Galium verum*, *Vicia lathyroides*, *Carex arenaria*, *Syntrichia ruraliformis* and target species *Trifolium scabrum* and *T. striatum*. During the site visit, also wax caps (*Hygrophorus* species) were found. The soil sample b taken in this part, indeed shows relatively low values of available phosphorus (Table 1). The threshold of 15 mg / kg is exceeded only in the layer between 35 and 45 cm below the surface. In parcel no 2 target species are found. The eastern part of parcel 1 contains an *Allium oleraceum* population. The Oostvoorduinen is the only site along the Flemish coast for this species. A.

oleraceum is a European species, often found in more or less disturbed calcareous and humic soils, moderately rich in nutrients. In the Flemish region, the species is only known from a few places. Also in the Netherlands it is a rare species, found in Zuid-Limburg, the river area, in Zeeland and in the dunes of Holland. The origin of the population in the Oostvoorduin is uncertain, but given the location near the old agricultural areas, it is likely that the species is a garden escape. Still, conservation of the species is desirable.

Parcel 3 is mapped as 'cx'. The second letter indicates the presence of species of productive grassland such as *Lolium perenne*, *Poa trivialis* and *L. italicum*. In botanical terms, this is the poorest part of the site. Besides the common species mentioned above, none of the representatives of the nutrient poor dune grasslands is present. Table 1 also shows that this site has the highest values for the available phosphorus, up to 45 mg / kg in the layer between 35 and 45 cm.

Finally, plot 4 is mapped as 'cg1d'. The part 'g1' indicates the presence of common dune grassland species such as *Plantago lanceolata*, *Achillea millefolium*, *Luzula campestris*, *Festuca rubra* or *Hypochaeris radicata*. The letter 'd' indicates species characteristic for disturbed soils and is used here due to the high abundance of *Senecio jacobaea*. In this plot also some *Primula veris* plants were found.

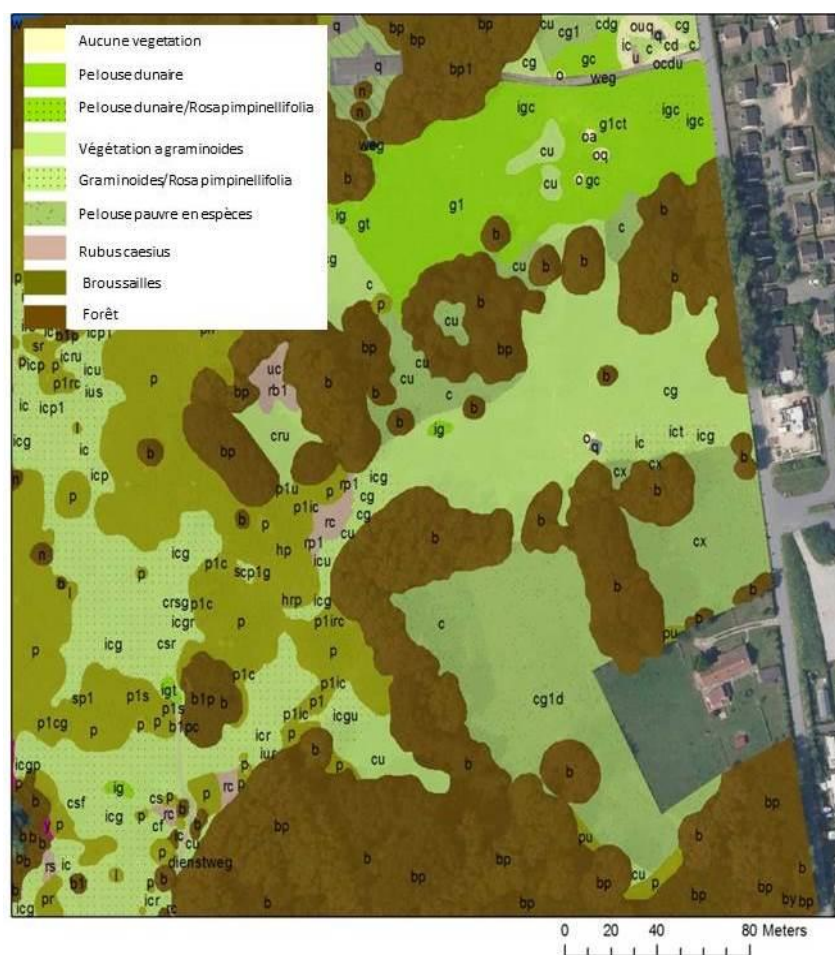


Figure 12: Vegetation map of the studied area.

Table 25: Results of the soil sample analysis (Herr & Hens 2014)

Sample	Thickness of ploughed layer (cm)	Depth (cm – MV)	Acidity pH H ₂ O (1/5)	Olsen P mg P/kg	P total mg P/kg
b	45	0-10	6,09	11.9	199
		35-45	6,98	20.2	151
		55-65	8,87	7.3	135
c	45	0-10	5,97	20.4	419
		35-45	6,57	44.9	264
		55-65	8,76	26.2	211
d	45	0-10	6,67	24.9	305
		35-45	7,43	19.7	263
		55-65	9,19	6.4	132
e	55	0-10	5,73	19.9	234
		45-55	5,41	25.4	131
		65-75	7,92	14.7	99

Bold figures for Olsen P (plant accessible phosphorous) indicate values exceeding 15 mg / kg, the threshold for nutrient poor grassland. Red figures mean significant exceeding of this threshold (> 20).

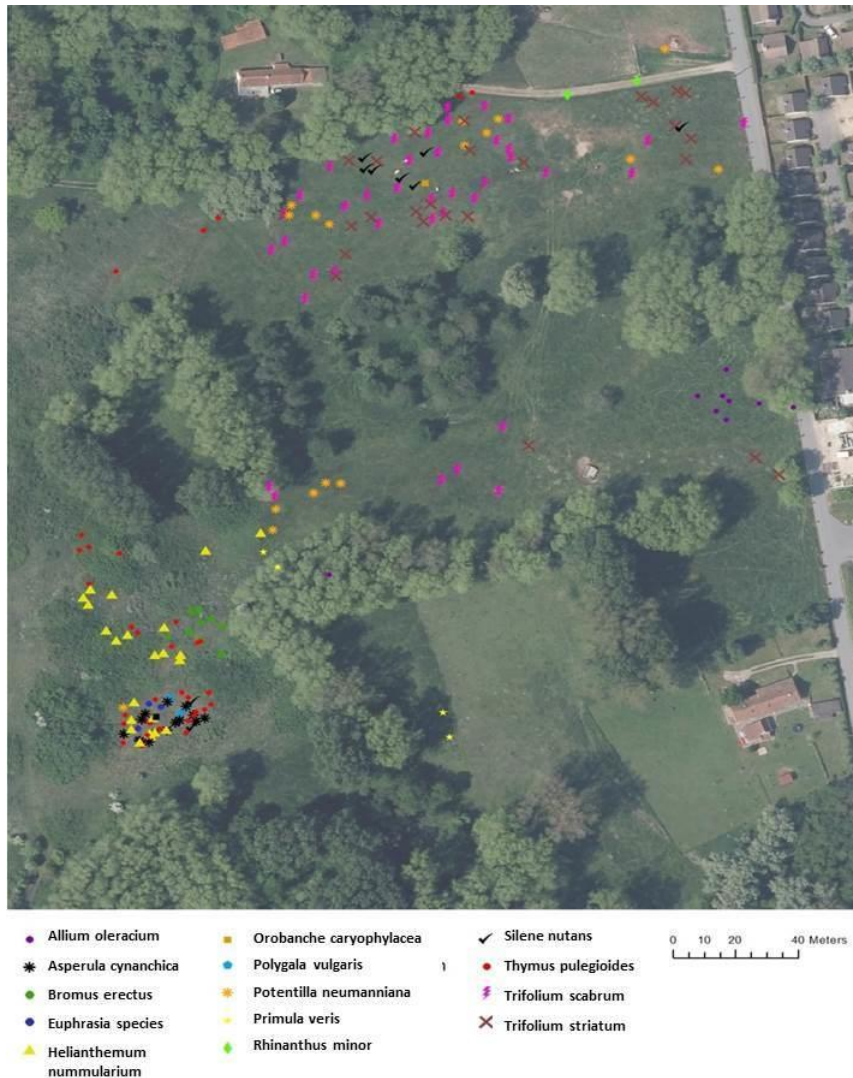


Figure 13: Target species map (vascular plants).

5.4. CURRENT AND POTENTIAL VALUES

Parcels 1 and 2 can be considered as poorly developed forms of habitat type 2130 'fixed dunes with herbaceous vegetation (grey dunes)', as defined in the EU Habitat Directive. Plots 3 and 4 cannot be considered as European habitats. For all plots, removal of the humic layer, rich in phosphorus is recommended. In plot 1, it would be appropriate to respect the population of *Allium oleraceum*, by transplantation if necessary. The potential for restoration of dune grassland in dry areas of the site is large, given the proximity of many target species. Yet a long development path is expected. The most characteristic species do not form a seed bank in the soil and have poor dispersal abilities. One option is to transfer hay from neighbouring parcels to the newly created dunes. In general, the vegetation of wet habitats develops faster. Many species of this habitat type form a seed bank that can potentially be exposed by excavation. Other species such as orchids, *Parnassia palustris* or *Pyrola rotundifolia* have very fine seeds that can easily be transported by wind. The transfer of hay to these parts will probably not be necessary.

CHAPTER 6 NATURE RESTORATION, ASSESSMENT 2019

6.1. METHODS

In this report, the results of the excavations in the Oostvoorduinen, which were carried out within the framework of action C1 of the LIFE+ project 'Flandre', are discussed. This action intended at restoration of habitat types 2130 'Fixed dunes with herbaceous vegetation' and 2190 'Humid dune slacks' and target species 1614 *Apium repens* (creeping marshwort), 1202 *Epidalea calamita* (natterjack toad) and 1166 *Triturus cristatus* (great crested newt). We compare this results with the initial situation, described in the first report of the current study (De Nocker 2015).

In 2017, 2018 and 2019, the site was visited several times during which the presence of target species was checked. We focused on establishment of plant species and presence of *Epidalea calamita* in the ponds. Therefore we looked for egg strings and listened for calling males. For *Triturus cristatus* no further inventory efforts were made since the species is not present in Oostduinkerke and the newly dug ponds are not yet optimal habitat for the species.

On may 21th 2019 a vegetation survey was carried out in each parcel 1-4 (fig. 1). All vascular plants and mosses were noted and their abundance was estimated using the Tansley scale. These records are used to check whether the vegetation meets the criteria for a good local conservation status (LCS) of Natura 2000 habitat types used within the Flemish region ('LSVI,' Oosterlynck et al. 2018). Zone 5 on figure 1 is a disturbed site were trees were cut. No survey was done here.

Locations with target species were mapped in detail using hand-held GPS with 2 to 5 m accuracy (PINK method, Provoost et al. 2010 en 2015).



Figure 14: Location of excavated parcels (black numbers) and newly created ponds (blue labels).

6.2. RESULTS

6.2.1. TANSLEY-SURVEY AND CONSERVATION STATUS

Table 1 summarises surface areas and number of species found in the different parcels. In total, 176 plant species were found. The numbers per parcel vary proportional to the surface area in parcels 2, 3 en 4 while parcel 1 is considerably more species rich. Overall, 34 dune slack species and 29 species typical for dune grassland were found. The proportion of both species groups varies. In parcel 1, dune grassland species predominate, while parcel 4 has the most dune slack species. In parcels 2 and 3, the numbers of species of both groups is similar.

Table 26: General characteristics of the parcels

	Parcel 1	Parcel 2	Parcel 3	Parcel 4
Area (m ²)	1710	1700	3770	10160
Number of species	102	83	97	125
Number of dune slack species	9	9	15	26
'LCS'-key species	1	2	2	4
Number of dune grassland species	18	12	12	17
'LCS'-key species	6	4	4	3

Within all parcels, 6 'LSVI' key-species were found for habitat type 2190: *Blackstonia perfoleata*, *Carex viridula*, *Centaurium littorale*, *Juncus subnodulosus*, *Pyrola rotundifolia* and *Parnassia palustris*. They occur in small numbers however, mostly sporadic (s) or rare (r). Only *Juncus subnodulosus* is occasionally (o) found in parcel 1. In order to fulfill the LCS criteria, at least three species need to be at least numerous. This means the vegetation is still developed sub-optimally and cannot yet be considered as having a good conservation status. Also target species *Carex flacca*, *Carex distans*, *Gnaphalium luteo-album*, *Schoenoplectus tabernaemontani*, *Scirpus setaceus*, *Samolus valerandi* and *Hippurus vulgaris* are characteristic dune slack species. All these species are in full expansion at the site. As a consequence, good conservation status will probably be reached within a few years. The other LCS criteria; tall herb, scrub and woodland encroachment and dessication are evaluated in favour of good conservation status.

Table 27: Tansley-survey of each parcel.

	1	2	3	4		1	2	3	4		
Acer pseudoplatanus	r	s	r	r	Gewone esdoorn	Lolium perenne	s	s		Engels raigras	
Achillea millefolium	r	s	s	s	Duizendblad	Lotus corniculatus	f	r	r	Gewone rolklaver	
Agrostis capillaris	f		s		Gewoon struisgras	Luzula campestris	r	s		Gewone veldbies	
Agrostis stolonifera		o	f	o	Fioringras	Lycopus europaeus			r	Wolfspoot	
Allium vineale	r				Kraailook	Lythrum salicaria			r	Grote kattenstaart	
Alnus glutinosa	o	a	o	f	Zwarte els	Marchantia polymorpha			r	Parapluitjesmos	
Alopecurus geniculatus			s	r	Geknikte vossenstaart	Matricaria recutita			s	Echte kamille	
Anthoxanthum odoratum		s			Gewoon reukgras	Medicago lupulina	s		o	Hopklaver	
Anthriscus caucalis	r	s			Fijne kervel	Melandrium album			s	Avondkoekoeksbloem	
Apium nodiflorum			s	s	Groot moerasscherm	Mentha aquatica			s	Watermunt	
Arabidopsis thaliana		s	s	s	Zandraket	Mercurialis annua	s			Tuinbingelkruid	
Artemisia vulgaris	r	s	s		Bijvoet	Myosotis arvensis	s	r		Akkervergeet-mij-nietje	
Atriplex prostratus			s		Speiesmelde	Ononis repens			s	Kruipend stalkruid	
Avenula pubescens	s				Zachte haver	Papaver dubium			r	Kleine klaproos	
Batrachium psec.			s	s	Waterranonkel spec.	Papaver rhoeas	r	s		Grote klaproos	
Bellis perennis			s	s	Madeliefje	Papaver argemone	r			Ruige klaproos	
Betula pubescens	s	s	o		Zachte berk	Parnassia palustris				Parnassia	
Blackstonia perfoliata					Zomerbitterling	Phleum arenarium	r			Zanddodden gras	
Brachythecium albicans	r				Bleek dikkopmos	Phleum pratensis	r			Timotee gras	
Brachythecium rutabulum	o	r			Gewoon dikkopmos	Phragmites australis	o	s	r	Riet	
Bromus hordeaceus	o	o	s	s	Zachte dravik	Picris echinoides	s			Dubbelkelk	
Bromus sterilis	lf	r	s		Ijle dravik	Plantago lanceolata	r	r	s	Smalle weegbree	
Bryum pseudotriquetrum			s	r	Veenknikmos	Plantago major		r	f	Grote weegbree	
Bryum spec.			a		Knikmos spec.	Poa annua	r	o	r	o	Straat gras
Calamagrostis epigejos	s		o		Gewoon struisriet	Poa pratensis	r		r	o	Veldbeemd gras
Calliergonella cuspidata				r	Gewoon puntmos	Poa trivialis	o	o	f	o	Ruw beemd gras
Capsella bursa-pastoria	s	s			Gewoon herderstasje	Polygonum amphibium			s		Veenwortel
Cardamine hirsuta		r	r	r	Kleine veldkers	Populus alba	r	s	r	r	Witte abeel
Cardamine pratensis				r	Pinksterbloem	Populus canescens			s	r	Grauwe abeel
Carex arenaria	a	f	o	f	Zandzegge	Populus x canadensis	r	s	s	r	Canadapopulier
Carex distans				s	Zilte zegge	Potentilla anserina			r		Zilverschoon
Carex flacca	lf			r	Zeegroene zegge	Potentilla reptans	r	r	r	r	Vijfvingerkruid
Carex hirta	s	r	o	o	Ruige zegge	Prunella vulgaris		s	r		Gewone brunel
Carex pseudocyperus				s	Hoge cyperzegge	Prunus spec.	s				Pruim spec.
Carex riparia				r	Oeverzegge	Pseudoscleropodium purum	r				Groot laddermos
Carex viridula		s	s	r	Dwergzegge	Pulicaria dysenterica	s	s		s	Heelblaadjes
Centaurium erythraea	o		s	r	Echt duizendguldenkruid	Pyrola rotundifolia			s		Rond wintergroen
Centaurium littorale				r	Strandduizendguldenkruid	Quercus robur	r	s	s		Zomereik
Cerastium arvense		s			Akkerhoornbloem	Ranunculus acris			s		Scherpe boterbloem
Cerastium fontanum	o	f	r	r	Gewone hoornbloem	Ranunculus bulbosus	r				Knobboterbloem
Cerastium glomeratum	s	s	s		Kluwenhoornbloem	Ranunculus repens		s	r	r	Kruipende boterbloem
Cerastium semidecandrum	o	r	r		Zandhoornbloem	Ranunculus sardous			s		Behaarde boterbloem
Cirsium arvense		r	r	r	Akkerdistel	Ranunculus scleratus		s	r	r	Blaartrekkende boterbloem
Cirsium vulgare	s	s	r	s	Speerdistel	Rhinanthus angustifolius			r	s	Grote ratelaar
Claytonia perfoliata	s	r	s	r	Witte winterpostelein	Rorippa palustris		r	r	r	Moeraskers
Convolvulus arvensis	o				Akkerwinde	Rubus caesius		s	s		Dauwbraam
Conyza canadensis	f	a	a	a	Canadese fijnstraal	Rumex acetosa			s	s	Veldzuring
Corylus avellana	r				Hazelaar	Rumex acetosella	o	r	s		Schapenzuring
Crepis capillaris	r		s	r	Klein streepzaad	Rumex conglomeratus			s		Kluwenzuring
Dactylis glomerata	r	s	s	s	Kropaar	Rumex crispus	r	r	o	r	Kruizuring
Diplotaxis tenuifolius	s				Grote zandkool	Rumex obtusifolius	s	s	r	s	Ridderzuring
Drepanocladus aduncus		lf			Moerassikkelmos	Sagina procumbens		r	o	f	Liggende vetmuur
Eleocharis palustris		o	a	f	Gewone waterbies	Salix alba	a	a	a	a	Schietwilg
Elymus athericus				r	Strandkweek	Salix cinerea	o	o	o	?	Grauwe wilg
Elymus repens	f	o	r	o	Kweek	Salix repens	r	o	o		Kruipwilg
Epilobium ciliatum		f			Beklierde basterdwederik	Samolus valerandi		s	f	f	Waterpunge
Epilobium hirsutum					Harig wilgenroosje	Saxifraga tridactylites	r	s	s		Kandelaartje
Epilobium parviflorum	r	o	f	r	Viltige basterdwederik	Schoenoplectus tabernaemontani		r	r	r	Ruwe vies
Epilobium tetragonum	r	o	o	o	Kantige basterdwederik	Scirpus maritimus			r		Heen
Equisetum arvense	r	r	o	r	Heermoes	Scirpus setaceus	s				Borstelbies
Erodium cicutarium subsp. dunense	s				Duinreigersbek	Senecio inaequidens	s	s	s		Bezemkruiskruid
Erophila verna		r			Vroegeeling	Senecio jacobaea	f	r	o	r	Jakobskruiskruid
Eupatorium cannabinum					Koninginnenkruid	Senecio sylvatica			s		Boskruiskruid
Festuca arundinacea	o				Rietzwenkgras	Senecio vulgaris	s	r	s	s	Klein kruiskruid
Festuca rubra	o	r	s	r	Rood zwenkgras	Silene dioica				s	Dagkoekoeksbloem
Galium aparine				s	Kleefkruid	Sonchus arvensis				s	Akkermelkdistel
Galium verum		r			Geel walstro	Sonchus asper		r	s	s	Gekroesde melkdistel
Geranium dissectum				s	Slijpladige ooievaarsbek	Sonchus oleraceus	s	r	s		Gewone melkdistel
Geranium molle	r	r	s	s	Zachte ooievaarsbek	Stellaria media	s	r		r	Gewone vogelmuur
Glechoma hederacea				s	Hondsdrif	Stellaria pallida			s		Duinvogelmuur
Gnaphalium luteo-album	o	f	f		Bleekgele droogbloem	Symphytum officinale			s		Gewone smeewortel
Hieracium umbellatum		s	s		Schermhavikskruid	Syntrichia ruraliformis	r				Groot duinstertetje
Hippophae rhamnoides	s				Duindoorn	Taraxacum s. vulgaria	r	r	r	r	Paardenbloem
Hippurus vulgaris				s	Lidsteng	Trifolium arvense	r	s	r	r	Hazenpootje
Holcus lanatus	o	f	f	o	Gestreepte witbol	Trifolium campestre	r		o	r	Liggende klaver
Hydrocotyle vulgaris			o	r	Watermavel	Trifolium dubium	o	r	f	r	Kleine klaver
Hypericum perforatum		s			Sint-janskruid	Trifolium pratense	s	s	r		Rode klaver
Hypericum quadrangulum			s	r	Geveugeld hertshooi	Trifolium repens	f	o	a	f	Witte klaver
Hypnum cupressiforme	r				Echt klauwtjesmos	Trifolium scabrum	s	s	r		Ruwe klaver
Hypochaeris radicata	o	o	o	r	Gewoon biggenkruid	Trifolium striatum			s		Gestreepte klaver
Juncus articulatus	r	r	r	o	Zomprus	Typha latifolia			r	r	Grote lisdodde
Juncus bufonius	r	o	o	o	Greppelrus	Urtica dioica	r	r	r		Grote brandnetel
Juncus inflexus	s	s	s	s	Zeegroene rus	Urtica urens	s				Kleine brandnetel
Juncus subnodulosus	o	r		r	Paddenrus	Veronica arvensis	f	o	r	r	Veldereprijs
Juncus tenuis	r	r	r		Tengere rus	Veronica hederifolia	s				Klimopereprijs
Lathyrus pratensis	s				Veldlathyrus	Vicia hirsuta	s	r	r	r	Ringelwikke
Leontodon autumnalis				s	Vertakte leeuwentand	Vicia lathyroides	r	r	s	s	Lathyruswikke
Lolium italicum				s	Italiaans raigras	Vicia sativa	r	r	r	o	Smalle wikke

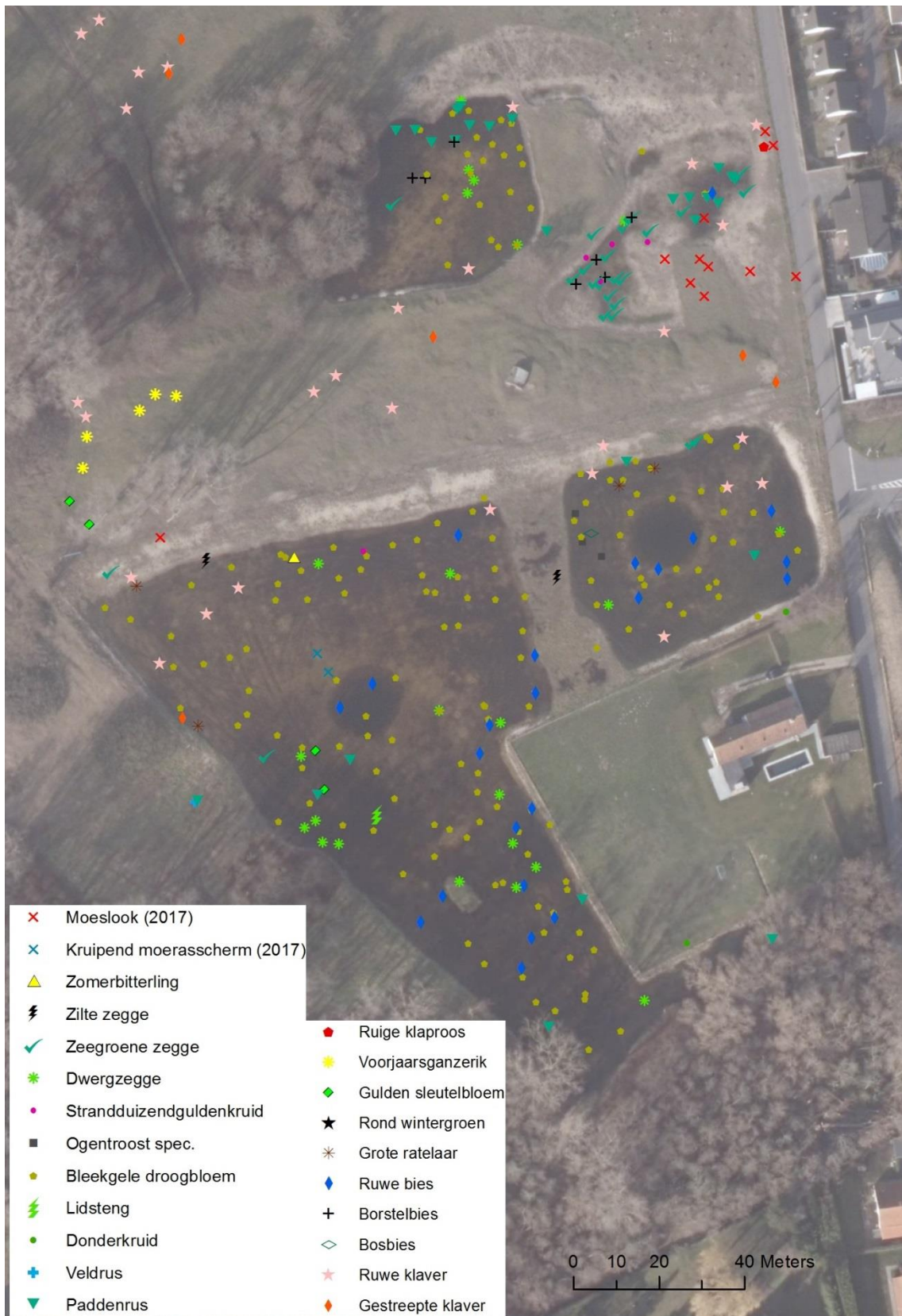


Figure 15: Mapping of target species (2018-2019).

Despite of the long inundation of the site, a large number of dune grassland species is found. Ten LCS key-species for dune grassland are present. They occur sporadically (s) or are rare (r). Only *Cerastium semidecandrum* occurs occasionally (o) in parcel 1. Consequently, the parcels do not meet the criteria for good conservation status for habitat type 2130 dune grassland either. Given the abiotic conditions (wet), no further development towards species rich dune grassland is expected, except for parcel 1. Since the slow development of this habitat type (Provoost et al. 2010), it will probably take several years before these potentials lead to good conservation status. The vegetation also contains many ruderal species. This was expected since the site used to be an arable field. Further development accompanied by mowing management will probably lead to decline or disappearance of these species. This will result in a drop of species overall numbers, while the conservation value of the vegetation increases.

6.2.2. TARGET SPECIES

During field visits, 23 target species were found in the area (figure 2). On July 18th 2019, Jean-Louis Herrier found one individual of *Parnassia palustris*, what makes a total of 24 species. With the exception of *Allium oleraceum*, *Apium repens*, *Euphrasia spec.* and *Scirpus sylvaticus*, all this species were also found during the inventory of May 21st 2019. *Allium oleraceum* was still present in 2017 but could not be distinguished from *A. vineale* during the survey in May 2019. *Apium repens* was no longer found, despite of thorough search in parcel 4 in 2019. In 2017, two plants were found NW of pond ty_037. Also *Euphrasia spec.* and *Scirpus sylvaticus*, both found in parcel 3 in 2017 were not seen in 2019. *Euphrasia* is still present however as it was found later that year, again by J.-L. Herrier.

The number and distribution of target species indicates a positive evolution of the dune slack vegetation in the excavated zones. Most of the species probably germinated from the soil seed bank. Species belonging to the genera *Carex*, *Juncus*, *Scirpus*, *Schoenoplectus*, *Trifolium* and *Apium* are known to have long living seeds. This explains the often fast development of a species rich vegetation, often rich in target species, in the case of nature restoration in wet environments. However, species with fine seeds such as *Parnassia* and *Pyrola* have managed to colonise the site probably through wind dispersal. This indicates potentials for colonization of other wind dispersed species such as orchids once the vegetation is closed and soil development progresses.

6.2.3. AMPHIBIANS

During field visits in 2017-2018 and 2019, natterjack toad (*Epidalea calamita*) was not found within the area. The species is not known to occur in Ter Yde south of the Hannecart forest (Figure 3). Migration of the species is not evident through the woodland and through the surrounding urban area.

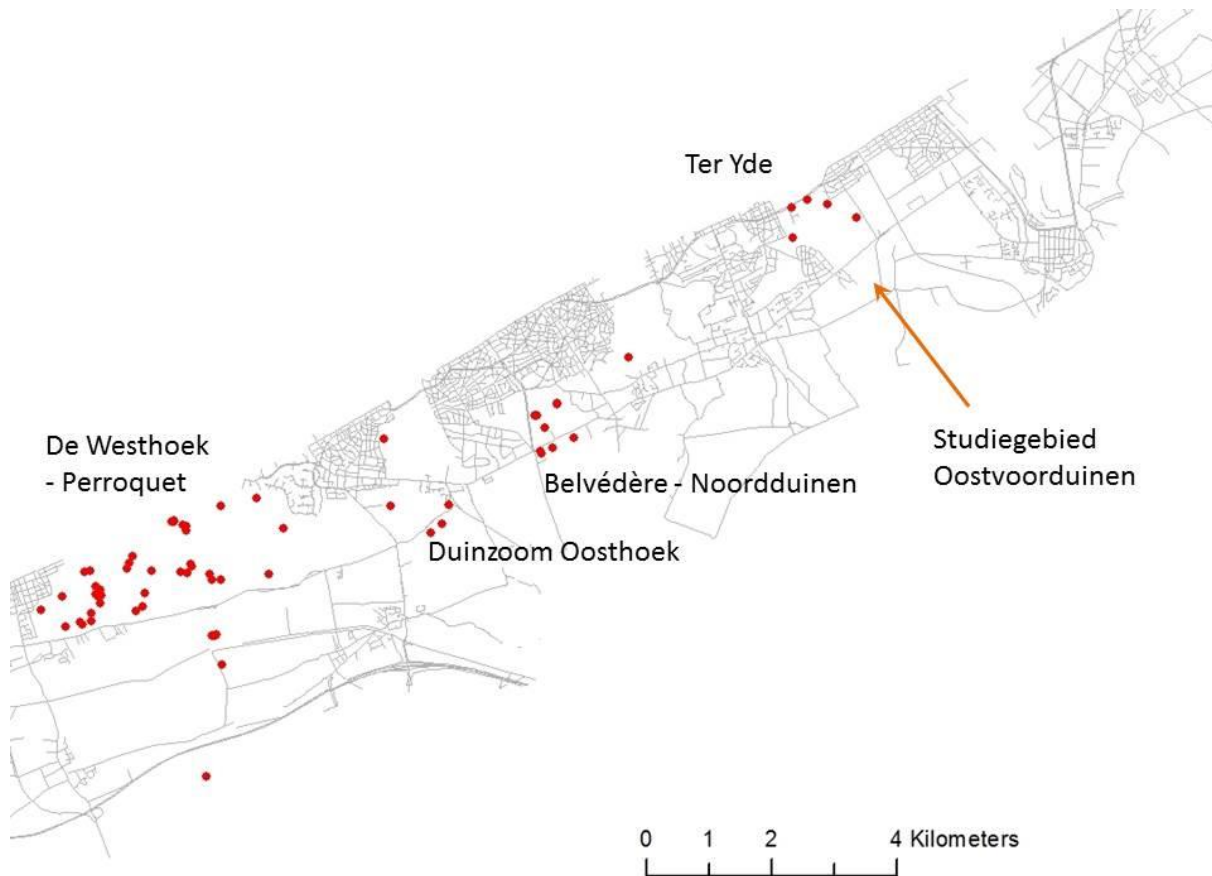


Figure 16: Recent distribution (> 2007) of natterjack toad (*Epidalea calamita*) along the western part of the Belgian coast (data LIFE+ Flandre Masterplan).

Also great crested newt (*Triturus cristatus*) was not observed, but this for this species no extra surveillance was done because it is currently absent in Oostduinkerke (Provoost et al. 2011; Jooris et al. 2013). Also the new ponds are less suitable for the species because of the pioneer character. The distribution map in Bauwens & Claus (1996) do indicate records of *Triturus cristatus* in Oostduinkerke for the period 1975-1994. Within the framework of the project 'Coastal Management Evaluation' ('Beheerevaluatie kust') migration of the species was checked from the Oosthoekduinen in De Panne (the closest population) in the direction of Koksijde via de Belvédère (Figure 4). However, no *Triturus cristatus* was observed in the investigated ponds.

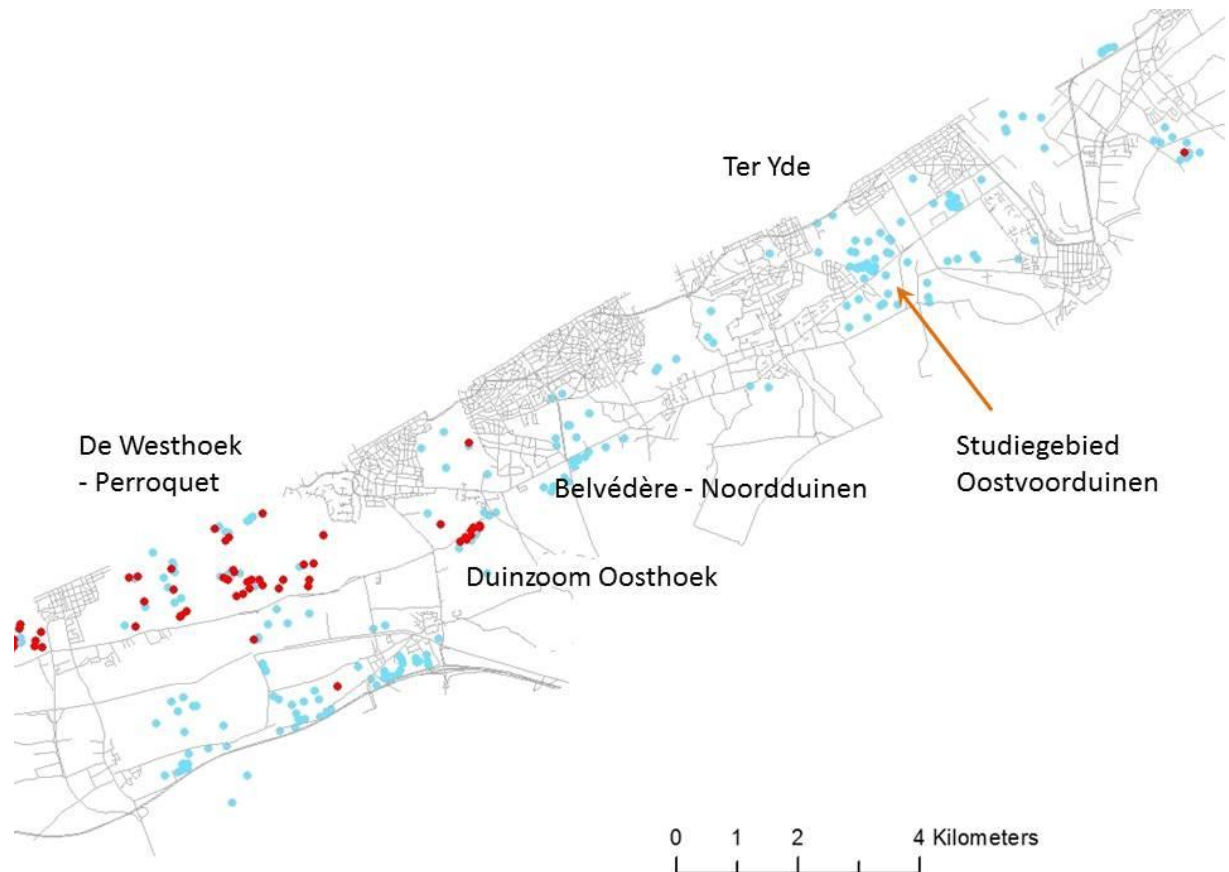


Figure 17: Recent distribution (> 2007) of great crested newt (*Triturus cristatus*) along the western part of the Belgian coast (data LIFE+ Flandre Masterplan). Blue dots are ponds, red dots are recent observations (> 2007).

6.3. CONCLUSIONS

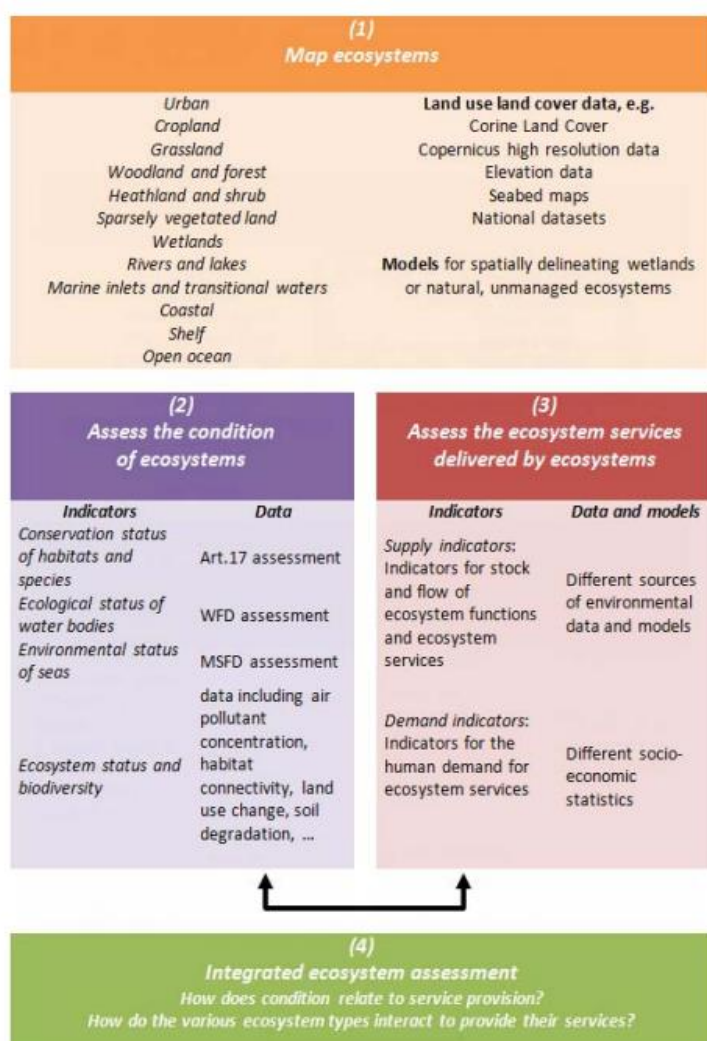
The excavations in the Oostvoorduinen within the framework of action C.1 of the LIFE Flandre project resulted in a substantial increase of nature conservation values compared to the initial situation in 2015. Many interesting plant species characteristic for dune slacks (habitat type 2190) as well as dune grassland (habitat type 2130) were able to establish. Considering the pioneer character and the small population sizes of the target species, the site does not yet meet the criteria for a good conservation status of these habitat types. We expect this will be the case for dune slacks within a number of years. For dune grassland, potentials are limited and a much slower evolution is expected.

The project was less successful in respect to EU-Habitat Directive's Annex species 1614 *Apium repens*, 1202 *Epidalea calamita* en 1166 *Triturus cristatus*. In the ponds none of these amphibians were found. *Apium repens* did appear, most probably from the soil seed bank, but could not establish so far. Probably the pioneer environment is not beneficial for the species. On the long term, when soil development has taken place and vegetation is somewhat ore closed, permanent establishment is more likely, at least if the site will be grazed. On short term however, a mowing regime is recommended until a more stable vegetation has established.

CHAPTER 7 SOCIO ECONOMIC IMPACT OF THE PROJECT

7.1. INDICATORS FOR THE ASSESSMENT OF THE PROJECT

The diagram below provides an overview how this project can influence the ecosystem services and the socio-economic condition. The immediate effects of the project are rather limited because the project includes a limited acquisition of land and limited interventions in the landscape or facilities for recreation. The table below lists the elements which can be monitored to assess the evolution. Given the uncertainties in the methods and data, the effects are expected to be small. It is advised to perform a screening of the expected effects and also the accuracy at which indicators can be assessed should be taken into account.



Source: Maes, 2014

Figure 18: Overview of possible indicators to map impact on ecosystem conditions and services

Table 28: Indicators to monitor impact project

Theme	Indicator	Monitoring evolution Flandre 2014-2018
Ecosystem composition		
Composition habitat types	ha per habitat	x
Ecosystem condition		
Presence target habitat types	ha per target habitat	x
Presence target species	number of locations with target species	x
Ecosystem services		
Soil carbon storage	ton C storage per year	
Water quality	ton N removal per year	
Infiltration capacity	m ³ infiltrated per year	
Water supply	m ³ extracted water per year	
Protection against floods	qualitative index for flood protection	
Air quality	kilo PM capture per year	
Recreation	number of visitors per year	x
Health	healthy life years for local residents in DALY	
Green residential area	increase in real estate value in €	
Adequate protection of the quality of the area		
Knowledge of importance and vulnerability	survey sectors	x
	survey visitors	x
Knowledge of area as a cross-border entity	survey sectors	x
	survey visitors	x
Plans/strategy sustainable Exploitation	survey sectors bevraging belanghebbende sectoren	x
Biodiversity	See chapter 5	x

The indicators and the method have already been discussed above, in Chapter 2, methodology. This includes the analysis of the impact on ecosystem services (see point 3) and interviewing actors (point 2).

In addition, we assess impacts on the status and quality of the area, with possible effects on ecosystem services. Here, the project may indirectly contribute to better and more adequate protection of the coastal nature and a greater awareness of the area. These are essential elements to preserve and strengthen the existing ecosystem services and benefits to various sectors. Specific for this area is that the most important services (recreation, tourism) also pose a threat to the area, and good plans are needed to enable a sustainable balance between protection and exploitation of the area.

However, there are no simple and objective methods to properly map the quality of the area and on this basis to estimate changes in ecosystem services and socio-economic impacts. The survey of actors does offer clues to test the impact of structural changes, though it is difficult to measure it properly. The indicators relate to knowledge of the area, its importance and vulnerability.

7.2. INTERVIEWS WITH ACTORS FROM DIFFERENT STAKEHOLDERS IN 2019

7.2.1. INTRODUCTION

The focus of the 2015 study was on the indirect consequences, because the project was limited to the purchase of a number of sites and the implementation of some interventions in the dune areas concerned. Given that the (in) direct consequences will only come into view in the long term, the current report aims to chart how the sectors concerned have experienced FLANDRE during the past four years. From this research into the perspectives of the sectors involved, we can help shape a vision for the future and formulate a number of interesting recommendations that could be used for future European cross-border nature restoration projects.

The methodology is discussed in the next section, followed by the results to end with the conclusion. The survey of those involved in 2015 was reported above (chapter 3.2).

7.2.2. METHODOLOGY

Semi-structured interviews were chosen in such a way that the results could largely come from the sector responses. In this way there is more openness for the sectors to display their own perceptions dynamically.

The sample was determined based on the previous report in 2015 for which a number of French and Flemish sectors were surveyed. The real estate sector was also questioned at the time, which this time would not be useful as no impact is currently expected on that sector. A total of 7 sectors were asked: 5 Flemish sectors (IWVA, Province of West Flanders, MOW, Westtoer, Natuurpunt) and 2 French sectors (CPIE, CUD). The interviews took place in their working environment.

The themes identified in the results stemmed from an interaction between the questionnaire and the sector responses. This report was written on the basis of these themes:

- Involvement and cooperation;
- Knowledge development and sustainable management;
- Visibility and communication to the public;
- Accessibility;
- Bottlenecks, recommendations and vision for the future.

The first themes (involvement, collaboration, knowledge development, sustainable management) highlight the interaction between FLANDRE and the sectors, while the following themes (visibility, communication to the public, accessibility) reflect the interaction between FLANDRE and the public. The latest themes (bottlenecks, recommendations, vision for the future) stem from the experiences and findings of the sectors surveyed about the LIFE + project FLANDRE.

7.2.3. RESULTS PER THEME

→ Involvement and cooperation

A first theme that the sectors involved mentioned during the interviews is their degree of involvement in FLANDRE. In addition, the cooperation between Flanders and France was designated as important.

All sectors surveyed indicated that they were involved with FLANDRE from the start, but the degree of their involvement differed between the non-nature-oriented and nature-oriented sectors. The non-nature-oriented sectors identify their low involvement with FLANDRE through their membership of the steering committee and their attendance at these meetings. They were largely aware of the project and their role in this was primarily that of the spectator on the sidelines.

"We are primarily the owner and that is different from the nature-oriented stakeholders, who are going to discuss more substantively, we had more the role of spectator".

They would not have wished for a higher level of involvement, since the consultations were mainly focused on specific ecological and technical expertise and they were not so much involved with FLANDRE in their daily operations. On the other hand, in the past four years the nature-oriented sectors report being slightly more involved than the non-nature-oriented sectors through their active contribution to the management plans and their inventory of species. This was especially the case in the sectors where FLANDRE had no impact on their areas:

"There was little impact on our areas. It is mainly where expansion is done, nature conservation or management work, but that was in other areas, so there will have been more impact. "

The nature-oriented stakeholders indicate that they have been slightly more actively involved in FLANDRE through their participation in meetings and the inventory of species. They have also made proposals on the opening up of certain dune areas, commented on reports, and actively participated in the activities of the coastal working group.

"As a nature association we have a diversity of interests among our members and at those meetings you see all stakeholders who also want to do something for that, so that is of course interesting if you want to work towards a compromise towards management".

What improved the involvement of the sectors were the field visits that were found to be very instructive. The experience of walking through the area and getting an explanation about this immediately gave a more concrete picture of the situation and even a stronger sense of concern.

→ **Knowledge development and sustainable management**

A second theme that the sectors surveyed mentioned in connection with FLANDRE was the development of knowledge and the sustainable management of the dune areas concerned.

All sectors involved indicate that they have learned a lot from FLANDRE and they also each have their own vision of knowledge development. For example, a stakeholder indicates that the fragmentation of the areas has led to a fragmentation of knowledge about these areas.

“We have to work to make people understand that there are too many separate areas, which is also a kind of fragmentation of knowledge. And we want to strengthen the knowledge about this ”.

Among nature-oriented stakeholders, the knowledge about species in particular has been expanded through this project. According to a stakeholder, the management works would also indirectly have led to more knowledge about the importance of biodiversity, mainly because there was more opportunity to make an inventory of the species in the dune areas concerned. The French sectors indicate that there is a lack of knowledge in France due to a lack of specialists.

“Working in the FLANDRE areas means we have more knowledge about the species in those areas. There is a very big difference between France and Belgium in terms of knowledge: Belgium has many specialists who do a lot of inventories on the coast and France does not. ”

Conversely, the expansion of knowledge has also led to a more sustainable design of the sites:

“For example, that involved measures to safeguard the natterjack toad population, to improve it in the context of the Noordduinen. Due to the fact that those species are there, one must take those species into account when designing that site. ”

By contributing this ecological knowledge (both within and outside of FLANDRE), knowledge about management has been expanded in the non-nature-oriented sectors. For example, a stakeholder indicates that they now know that it is better to remove exotics. Another stakeholder indicates that she has learned about sustainable management and believes that we learn primarily together and from each other.

“We have more feeling for why and we have to take that into account more and more. The [dune area] must be accessible, but you must also have as little impact as possible on nature. Exotic removal was part of that, that is something we would not have thought about in the past ”.

“On apprend ensemble parce que c’est un projet de coopération. Qu’est ce que j’ai appris est qu’on a vu de bons réalisations et de bons exemples de gestion écologique et là où on avait des dunes impénétrables avec trop de végétation, on a retrouvé de vrais beldunes de sables ou de vrais beldunes pelouses qui sans cette gestion seraient disparus”.

The sectors indicate that the local population develops some knowledge about sustainable management through FLANDRE, but according to them this is mainly the case with the interested nature lover and not so much with the general population. According to a stakeholder, this knowledge also contributes to the attitudes, perceptions and behavior of residents and visitors in the dunes: how to handle waste, where to walk and where not. According to most stakeholders, there is a need for support in which all citizens are involved. This can be achieved, for example,

from their specific area of interest (walking, cycling, mountain biking, horse riding) and / or from the constantly changing role (resident, nature lover, tourist, employee, visitor) that they occupy in and across the dune area.

The sectors surveyed hold the same opinion regarding the sustainable management of the beach and dunes. In particular, they believe that the impact of FLANDRE on management plans is quite large and that sustainable management in FLANDRE is a priority for the conservation of protected species.

"The impact on our management plans was great. There was the removal of exotics, there are sometimes some establishments: paths, fences, grazing that ensure that the afforestation is prevented. So we actually have good results with that".

"Une plus-value liée sur l'acquisition frontière pour étendre les surfaces des espaces naturels et la deuxième pointe technique, c'est les actions de gestion écologique et la restauration du paysage traditionnelle des dunes".

"You have to focus on the conservation of these species. That is the legal obligation, which could, for example, be that one creates a number of puddling situations, creates pools, that as much as possible leaves the fall wood in the deciduous forest. "

With regard to sustainable management, the themes of exotic removal, grazing, coastal protection, water treatment, manual beach cleaning, agriculture and hunting were identified as critical points. Around beach cleaning it is stated that this is still done mechanically in some places, which is problematic, because the natural material that the sea leaves behind on the beach is therefore removed

"Le nettoyage, en France c'est mécanique sur les plages urbaines et manuelle sur les plages naturels. Parfois sur les plages naturels, c'est quand même du mécanique et ça c'est très mauvais. Il faut arrêter et il faut trouver des solutions, et on doit laisser sur la plage la laisse de mer".

"Beach cleaning in Belgium is a problem where they still do it mechanically"

"In the meantime I think we have already decided that mechanical waste disposal is not allowed, but people are afraid to let it go its own way because then suddenly it will no longer be a beach".

Coastal protection is also still a critical point:

"The moment they leave the dunes in front of the dike, they become dunes again, but they are scooped off every year. They are going to have to make a choice at a certain point in time: either it will cost too much or the need for natural sea walls will become so great".

A stakeholder has a moderate opinion about grazing, while another stakeholder suggests that grazing should also take place in one large area.

"Manual mowing requires too many man-hours, only for sensitive parts that is necessary. Grazing, we are fully convinced that that is important. We also see the results, we see that there is a much better dispersion of important plants. "

"The grazing in the Doornpanne is now limited in separate blocks, in the future one large grazing could take place".

An interesting vision and possible solution proposed by a stakeholder is to also consider human activities as forms of management that also take place free of charge.

“If we remove shrubs, we immediately want to put horses, cows on it, but we don't immediately think of people, and for me, people are also important in management. We also have to think about seeing the activities of people such as walking, cycling as management ”.

According to a stakeholder, intensive agriculture should be replaced by extensive agriculture. Another stakeholder considers it important to take into account the breeding season and the night's rest of certain animal species during management work.

In addition, hunting in France remains a problem of national order. Clear regulation is needed to perpetuate sustainable hunting. All stakeholders are unequivocally opposed to admitting the hunt, but they also state that it is almost impossible to change the situation in France in the short term, and certainly not through a cross-border nature project: they all find this a regrettable matter. Both hunting on the beach (danger to visitors) and in the dunes (migratory birds) is considered problematic by the French stakeholders:

“Il faudrait interdire la chasse en France parce qu'on a plus en plus de monde, des randonneurs, à pied, au vélo et au cheval et il peut arriver des accidents, en France on peut même chasser sur la plage à partir du mois d'août et là il y'a encore des randonneurs”.

It is also indicated that the mentality in both countries is very different and therefore a cross-border project can make little contribution to improving the situation. The situation with regard to hunting is therefore very complex, and especially because every municipality in France has different regulations regarding hunting. To be able to change this, according to a stakeholder it will have to be tackled at a European level and, in France, the hunting rules are different per department in France.

“The mentality in Belgium and France is very different, a joint vision on this will be very difficult. I think FLANDRE cannot find a sustainable solution to this. The solution is not to hunt in the French dunes or at least not for protected and rare birds. ”

“Many advantages have been added, but the old disadvantages remain: in France, for example, that hunting continues, that you receive twice as many subsidies for a nature reserve as you allow the hunters. That they shoot the migratory birds is a European problem. ”

“The disadvantage is that hunting is allowed in France. Another disadvantage is that everything that is nature is done at department level in France, while that is our government. So in terms of powers, liberties, that is not easy ”..

In short, the influence of FLANDRE has given the sectors surveyed more opportunities to develop their ecological knowledge about which they are very positive. In addition, the non-nature-oriented sectors have been more and more conscious of sustainable management in recent years, which, in their view, was not only strengthened by FLANDRE, but also runs parallel to the requirements arising from conservation objectives. However, this knowledge development does not apply to the wider public, for which they believe there is an even greater need for social support. There are also

many critical points, among which manual beach cleaning, natural coastal protection and sustainable hunting are not yet a reality everywhere.

→ **Visibility and communication to the public**

Whereas the foregoing themes mainly highlight the interaction between FLANDRE and the sectors themselves, we now discuss the views of stakeholders on the visibility and communication of FLANDRE to the public: these are the residents, employees and visitors of the dune areas concerned. Since the public itself has not been questioned, it is a general assessment.

The Flemish sectors indicate that there were mainly recruitments and that, as a result, visually virtually nothing has changed in the FLANDRE area, which is why, according to a stakeholder, it is also difficult for citizens to understand what a cross-border project such as FLANDRE entails.

"On paper, it seems like an improvement, but when you see it, it's hard for citizens to grasp".

However, a lot has happened in the area of management work for the French sectors and they find that very positive.

"Les acquisitions sur les frontières, il n'y a pas de visibilité sur ça, mais le débroussaillage qui était fait dans plusieurs hectares des dunes, là il y'a des différences très visibles et très positifs, par exemple le débroussaillage à la dune Dewulf et à la dune Marchand aussi, et à la côté de Flandres, à la dune Westhoek".

If something has changed, such as in the case of deforestation - a clear visual intervention - there were sometimes critical responses, according to a stakeholder. Afterwards, understanding followed, since deforestation also provided personal benefits such as obtaining a view from the owner-occupied home.

"A lot of people are having a hard time with that deforestation, hey, they come to complain about the wheelworm that cannot make a nest in that tree and I cannot explain to them that dunes, if you do not maintain them in a certain way, that they rare as a biotope. "

However, there were other visible changes at the same time, such as the redesign of the outdoor space with a stakeholder - a WinVorm project that was selected as 'most integrated in nature' through a competition and supervised by the province - that offers opportunities for nature education, nature experience and nature games.

For this citizen there was possibly a lack of visual visibility of the FLANDRE process during this project, on the one hand because of the limited visual interventions in the landscape, and on the other because the project focused on nature and not on people. This is in contrast to the European Vedette project, which, according to the stakeholders, is visible to the citizens through the social aspects that are given a place in it.

With regard to communication and awareness-raising about FLANDRE to the citizens, the stakeholders questioned stated that this was limited but sufficient. They considered the information present to be qualitatively sufficient, but often too complex for the layman to grasp. Specifically, it concerns the exhibition about FLANDRE, the multilingual information boards, the organized excursions and the film screening already planned. Some of the partners surveyed were

not aware of the existence of the FLANDRE webpage and therefore they suspect that citizens are not aware of this. The question was to what extent the wider public is aware of the existence of FLANDRE. As a possible solution, it was suggested to let the communication go through the municipal channels.

“Via the channels it is usually the interested citizens. Opponents close themselves up earlier, for example residents who would suffer from a bridle path in Oostduinkerke or a mountain bike path towards nature lovers”.

The signs are mainly considered interesting because they are on the site itself and because they show the underlying motive or 'why' of the works to the citizens, it is recommended to do so in a uniform manner at every location and at a location simple, more accessible so that every citizen can understand.

“Les panneaux du ANB sont intéressants parce qu’ils se trouvent sur le site et les gens prennent connaissance sur le pourquoi. Ce qui est intéressant est d’avoir des panneaux sur lesquels on explique les choses dans la même façon et avec de la pédagogie simple et facile à comprendre”.

An anecdote from a stakeholder indicates that it is clearer in France that it is a collaboration with Belgium because of the bilingual signs compared to the fictional signs in Flanders. According to this stakeholder, this means that visitors to the Flemish dune areas do not see at first sight that this is a collaboration between France and Belgium.

“The information boards are bilingual in France. When we see that, we immediately see that the [project] crosses borders, in Belgium it is always in four languages so it is not clear”.

In short, the visibility of FLANDRE for the public was minimal in Flanders and slightly higher in France. Communication to the public is considered sufficient by the sectors surveyed, but can be done more clearly for all locations with the same information board, the process from beginning to end could also be better communicated, and a wider audience can be reached from the municipal channels about the how and why of FLANDRE.

→ **Accessibility**

Perhaps the most important theme cited in the interviews includes the accessibility of the dune areas for visitors.

According to the sectors surveyed, the employment and tourism situation has remained about the same over the last four years in the FLANDRE area. Little was said about this except that there is an increasing shortage of managers and coast guards. The project also has no impact on the number of visitors to the visitor center.

What did come to the fore is a fairly large tension that arises on the coast between the protection of nature and the possibility of recreation for humans. Especially on the Flemish coast there is still too often the separation between people and nature in the form of tourist beaches on the one hand and the protected dunes on the other. A solution could, according to all stakeholders, lie in finding a healthy balance between nature protection and recreation, a theme that is more sensitive in Flanders than in France in view of the large differences in the number of visitors, area and regulations (certainly in the field of horse riding and VTT).

"Il faut interdire la présence des gens sur les sites les plus rares et les plus fragiles et par contre, les gens puissent découvrir soit à pied, VTT ou de cheval. Comme l'interdiction totale ne marche pas, il faut qu'on trouve des solutions dans les bons endroits, on doit trouver un compromis".

"Where access and recreation could not cause irreversible disadvantages for nature, that should be allowed as much as possible. And if you have zones that really can be protected, they must be able to close ".

"There is a tension between recreation and nature, but if we do not let people in, there is also less support for nature. Especially around cycling in nature it is very limited in Flanders, that is a point of discussion on the West Coast. It is the middle ground search ".

Regarding the opening of the dune areas, a trend is reported towards an increased admission of visitors to the dune areas, which is generally regarded as positive in the sectors surveyed. All sectors are in favor of allowing people into the dunes and regard the construction of better walking paths and safer cycling routes as conducive to connecting the different areas. The integration of beach, sea, dunes and inland is considered important by a stakeholder. However, there are some discussions going on around riding trails and mountain bike trails, because riders and mountain bikers have specific needs that some see as a disruption. According to two stakeholders, a solution for this lies in organizing structured consultation between the various parties so that they can look for a compromise together:

"In the past there was a demand for less access, that you are going to close everything, now it is more access, opening up and you cannot respond to all wishes such as bridleways and mountain bike paths. That must be done in consultation ".

"In De Panne we used to have a lot of problems with riders who wandered off the paths until we sat together with the riders association and the nature association, suggested a route i.s.m. De Panne municipality and now we never have problems anymore. "

In order to guarantee a sense of freedom among visitors to the dune areas, the sectors believe that they must be fully disclosed with a limited amount of human intervention. This is in contrast to the marketing of nature with too many structures for tourism. In line with this, the sectors surveyed are of the opinion that it is insufficient to limit the hiking opportunities to the periphery of the dune areas. In addition, there is also an eye for increasing the awareness of visitors about water extraction and climate, and to attract walkers in the open dune areas as stated by two stakeholders:

"Every week, educational walks on water extraction and climate are also organized to raise public awareness."

"Not through the project alone, but if of course through that project we can open up new areas and expand our hiking network, we might be able to get even more hikers to the coast."

The organization of educational walks and the creation of new hiking trails therefore certainly offers opportunities to increase awareness of sustainable management and ecology, and opening up new areas can offer an extra incentive. A very interesting point is the way in which areas are closed off: one stakeholder suggests placing information boards instead of closures, while another stakeholder suggests leaving a strip of sea buckthorn as a natural fence:

"If people see that thread, they feel trapped, if they don't see it, they feel free. So when choosing your dewatering you can also make sure that there still remains a strip that forms a natural buffer".

"Barbed wire does not always help ... We are now trying to provide more information, because we have learned from the past that only blocking does not work".

"The fence has been removed and a retaining wall has been placed over which people can look at the polders: the experience must be slightly better than before".

From this we can conclude that accessibility by the surveyed sectors is considered an important point of discussion. All sectors agree that the dune areas should be opened to the public as much as possible with the protection of sensitive areas where necessary. The degree of opening varies among themselves and depends on the location, the intensity and the form of recreation. It is important that the visitors are sufficiently informed and made aware of the why of certain actions and closed areas. According to the sectors surveyed, closures should be present as little as possible, instead one could opt for information boards and natural fencing.

7.2.4. ISSUES, RECOMMENDATIONS AND VISIONS FOR THE FUTURE

In the following, the sectors surveyed present both the bottlenecks and a number of interesting recommendations and their desired vision for the future.

→ **Bottlenecks**

The main bottlenecks identified by the sectors are in the area of duration, politics, finance and governance:

"For the future, what could be better: financial support and a faster political decision".

"Have a political mandate to make things go forward."

But private ownership also hinders FLANDRE's progress:

"It remains a bottleneck in a number of files, for example. connecting the Westhoekduinen with the Perroquet, but that border is in between, there is a campsite in between. There are some options, but the various owners must want to come along".

Furthermore, cooperation between two countries in particular is not evident according to all sectors surveyed. This is to a lesser extent due to the language difference, and more to the mentality that is different and to the different way of working:

"The mentality is very different between France and Belgium, but on the other hand that is also a great opportunity, because we learn more from the other partners, precisely because we work differently".

As a possible solution, a stakeholder indicates that work must be done bottom-up, whereby local associations must be strengthened so that something can change from within. Another stakeholder proposes to harmonize the facilities and management between the two countries.

"It is still a limit, there are attempts to change that, in the sense that bilingual walks are also organized. The easiest thing is always bottom-up: make the local associations over there and the people working on it stronger. "

"Il faudrait trouver des solutions pour faire disparaître les frontières et les différences entre la France et la Belgique: il faut essayer d'harmoniser le plus possible les aménagements et la gestion entre les deux parties".

Although this was not an objective within FLANDRE, cooperation with the coastal municipalities was a final, but not unimportant, bottleneck for all sectors surveyed.

"On the coast it is not easy to work together with the municipalities, there is a much too great tendency to market everything. More and more, the municipalities are starting to see that people are not coming to the coast for the buildings, but for the sea and the dunes. "

→ Recommendations

Naast bovenstaande knelpunten, geven de bevroagde sectoren vooral heel wat interessante aanbevelingen voor de toekomst.

Een eerste aanbeveling bestaat uit het betrekken van zowel mens als natuur in projecten zoals FLANDRE. Alle stakeholders geven aan dat het niet voldoende is om enkel te denken vanuit het ecologisch belang, maar dat men het maatschappelijk belang zou moeten meenemen hetgeen ook zeker nodig is om een maatschappelijk draagvlak te creëren.

Een tweede aanbeveling dat hierop aansluit is het verderzetten van grensoverschrijdende projecten tussen België en Frankrijk waarin natuur en mens een evenwaardige plaats krijgen en waarvoor een gezamenlijk beheerplan wordt opgemaakt.

"Wat Vlaanderen bijvoorbeeld kan doen is een LIFE project voorstellen die opnieuw grensoverschrijdend is en hen aansporen om mee te doen op dat pad".

"Een gezamenlijk beheerplan waarin mens en natuur een evenwaardige plaats krijgen en waarin concrete acties uitgewerkt zijn".

Dit zou volgens hen ook de enige manier zijn om de relatie tussen België en Frankrijk in stand te houden op de lange termijn.

"Without subsidies or a project, it is difficult to maintain the relationship between Belgium and France in the future".

What could also be an interesting solution according to a stakeholder is calling in the EGTC to achieve and maintain permanent cooperation. This is already happening between Flanders and the Netherlands.

"Peut-être, pour maintenir une coopération régulière même si il ya pas de projet ou si il y'a une rupture entre les projets, le EGTS peut nous aider à obtenir une coopération permanente".

A third recommendation that is formulated is about the need to create social support by - as mentioned before - local tuning and setting accents, while always keeping the whole in mind. It

would help to strengthen local associations and organize informative meetings on a regular basis. There is also a need for more consultation options between the recreational and nature sectors: "It would not be bad if there were specific consultations with the tourism recreational sector for the areas about our expectations in this regard once a year. This is possible during the province's outdoor recreation advisory committee, for example. "

A fourth recommendation recommends good communication with the population about opening up and offering opportunities for participation and involvement in the project.

"That they communicate well about what is happening to the general public, show the evolution: after 5 or after 10 years, how has that evolved? That is usually already local, but not so much over the entire area. This can also be done via the Visitor Center or the coastal municipalities. "

A final recommendation lies in the need for financial resources and the involvement of political structures in the project:

"Use sufficient resources: if you can deploy one or two nature watchers full-time per nature area, then we no longer need all that thread, then you can leave that completely open."

"C'est vraiment important d'informer et d'associer les structures politiques dès le début du projet".

→ Visions for the future

After discussing the bottlenecks and recommendations, we present here the future vision that the sectors surveyed describe. They all support a common vision of one large nature reserve in which not only the dune areas are interconnected, but also the interior with the dunes and the sea. They consider it very positive, efficient and cost-effective to think broader than their own area, to participate in cross-border activities, and to learn from other areas close by and across borders.

"Connections, connections: do not see nature areas as islands, but try to connect them. Not only connect the dune areas along the coast, but also connect them with the interior. And handle the claim wisely in the areas in the sea! "

"More knowledge, clearer rules, better management and good cooperation: I think we are heading in the right direction".

"It is certainly positive that people think more broadly, that you as owners are not stuck in your own area, but that you see what is happening elsewhere, and that it becomes one large region. In the past you only went to the border and now I am going to look beyond the border. "

The main hope is therefore to continue European cross-border LIFE projects between France and Belgium in order to continue the cooperation between the two countries and to realize an integrated and sustainable coastal policy that brings both people and nature forward and that is signed by the municipalities. A stakeholder indicates that there is, for example, no project around beach cleaning that would be desirable.

"Si c'est possible, il faut continuer à faire des acquisitions frontalières et ensuite il faut idéalement qu'on trouve d'autres projets LIFE interrégional pour faire continuer cette coopération entre Flandres et la France. Je pense qu'il manque un projet de coopération sur la

nettoyage de la plage”.

From the above, we can conclude that FLANDRE has led the sectors to have a vision that goes beyond the cross-border to a vision that also includes the connections between the Flemish interior, the dunes and the sea. Here they find it important to work step by step towards the vision in such a way that it does not stop at a vision, but that it is also realized in practice:

“It's not because a map has been signed that you can already change specific things in the field. That starts with small things, these are all steps forward towards a vision ”.

For this, according to the stakeholders, there is a need for a joint management plan that covers the entire area and in which a balance is found between nature conservation and human needs.

“Without a new project, I think the link between the two countries will diminish. And I think a solution for this is to have a joint management plan. The ideal, after three years in 2022, we are going to do one management plan together for all those dune areas. ”

“On voudrait travailler dans l’avenir avec un Masterplan transfrontalier sur la gestion, qui serait incliné en chartre signé par les communes, ça peut nous aider de créer des autres projets de territoire avec une coopération durable pour encore mieux connecter les dunes”.

From the foregoing we understand that the bottlenecks can be found in the areas of financial and political constraints, the different mentality between France and Belgium, the absent involvement of the municipalities and the private ownership of some locations. The sectors surveyed formulate as recommendations the continuation of cooperation between Belgium and France, the equal involvement of both people and nature and the creation of social support through the awareness, information and education of visitors to the dune areas. In the sectors surveyed, FLANDRE has already led to a joint vision of the future of one large, cross-border nature reserve with a common management plan in which an integrated coastal policy is achieved and a balance is found between people and nature.

7.2.5. CONCLUSIONS OF THE SURVEY IN 2019

The results of the 2019 survey show that the stakeholders surveyed are very positive about the LIFE+ project FLANDRE as it has strongly inspired them to a joint vision for the future towards one large, cross-border nature reserve. They therefore want a similar follow-up project and the idea to work with a common management plan for both countries in which an integrated coastal policy is achieved and a balance is found between people and nature. The interviews with stakeholders revealed a number of interesting themes and perspectives that were found to be important in relation to FLANDRE.

The most valuable and positive impact of Flandre is the facilitation of the cooperation between France and Belgium. Both Flemish and French stakeholders wish to continue this improved cooperation in the long term in next European cross-border nature conservation project. It is not unimportant to mention that cooperation between the stakeholders and the coastal municipalities in FLANDRE was almost absent.

With regard to sustainable management, the stakeholders surveyed mainly refer to manual beach cleaning, natural coastal protection and sustainable hunting as critical points that are not yet implemented everywhere. According to them, there is a need for a project focussing on beach cleaning and consultation with every coastal municipality. In addition, the accessibility of the dune

areas is also mentioned as an important theme. Stakeholders consider it necessary that the dune areas are made accessible to the public as much as possible with the protection of sensitive areas where necessary. According to them, this could also contribute to the social support: another necessity that was mentioned, and that can be realized through the awareness, information and education of visitors to the dune areas via the municipal canals.

7.3. IMPACT ON ECOSYSTEM SERVICES

7.3.1. INTRODUCTION

The table below provides an overview of the ecosystem services as discussed in chapter 4. The area has hardly any producing services but has some important regulatory services and cultural services. Even if we take into account the uncertainties in estimation and valuation, the overview indicates that the value of these services, expressed in euros / ha, is important if we compare them with other areas and land uses. The table also illustrates the importance of cultural services. We note that the share of the most important services is similar for the Belgian and French part.

These services are not marketed and are under pressure from socio-economic developments. The overview also shows that the services that are important for this area often also give rise to pressure on the area and risks for over-exploitation (water extraction, tourism and recreation). Certain characteristics such as fragmentation and interdependence with residential areas translate into high values for cultural services for the living environment or health, but are also identified as problematic (eg for landscape quality).

7.3.2. ASSESSMENT OF THE IMPACT OF THE PROJECT ON ECOSYSTEM SERVICES

The table below summarizes the effects on ecosystem services.

→ Carbon storage and water quality

These services are relatively less important in the dune area (3% of total), which is related to the characteristics of these areas with coarse sand with high permeability (degradation of organic matter), nutrient-poor soils and relatively low supply of nutrients in dunes due to low agricultural and industrial activity.

The impact of the LIFE + Flandre project on these services is minimal.

→ Infiltration and water supply

This is an important service for the dune areas, which is partly budgeted (water extraction). Other aspects, such as the importance to limit salinization, are not included.

The assessment indicates that the impact of the LIFE + Flandre project on infiltration will be positive, because removal of shrubs leads to less evapotranspiration and more infiltration.

Table 29: Total value of ecosystem services for the area and impact of Flandre on the services

Ecosystem service	Unit	Value of the ESD		Impact of Flandre project	
		K €/y	%	Short term	Long term
Provisioning services		-	-	-	-
Regulating services					
Soil carbon storage	K €/y	1.104	3%	=	=
Water quality	K €/y	4	0,0%	=	=
Water supply	K €/y	402	1,0%	+	+
Coastal safety	K €/y	1.981	6%	=	++
Pollination		na	na		
Air quality	K €/y	4.740	13%	--	-
Cultural services					
Recreation / tourism	K €/y	21.650	43%	+	++
Amenity	K €/y	1.483	4%	=	+/=
Health	K €/y	8.839	30%	=	+/=
TOTAL	K €/y	40.203	100%	=	+
Value/ha	€/ha	12.238		=	+

- (1) Based on the average of the low and high estimate for the service for the total project area
 - = not important for the studied area
 na = not available, not quantifiable or impossible to express in monetary value

→ Protection against coastal flooding

This is an important service for the dune areas, and a part of this value (avoided maintenance costs) could be estimated, although with great uncertainty. It is important to continue to ensure this ecosystem service.

The assessment indicates that the impact of the LIFE + Flandre project on coastal safety will be positive. The management plans provide for the protection and restoration of the dynamic dunes, which offers potentially large benefits (Van Der Biest, 2017). The height and width of the dunes will not change in the short term due to the projects, but in the longer term the effects of more dynamic dunes are important and make the area more resistant to sea level rise. The restoration of young vegetation types (such as marram grass) improves the retention of sand. Removal of dune foot cover can improve dune formation capacity.

→ Air quality

The capture of particulate matter is an important service of vegetation, which is explained by the current high concentrations of particulate matter in the ambient air and high population density.

The assessment indicates that the impact of the LIFE + Flandre project on air quality will be negative. Measures related to deforestation and removal of shrubs lead to less vegetation and less capture of particulate matter. In the short term this is a loss of this service. From the perspective of sustainable development, the importance of this service can be expected to decrease in the longer

term, if air quality improves by taking source-oriented measures. That is why it is less important to ensure this ecosystem service.

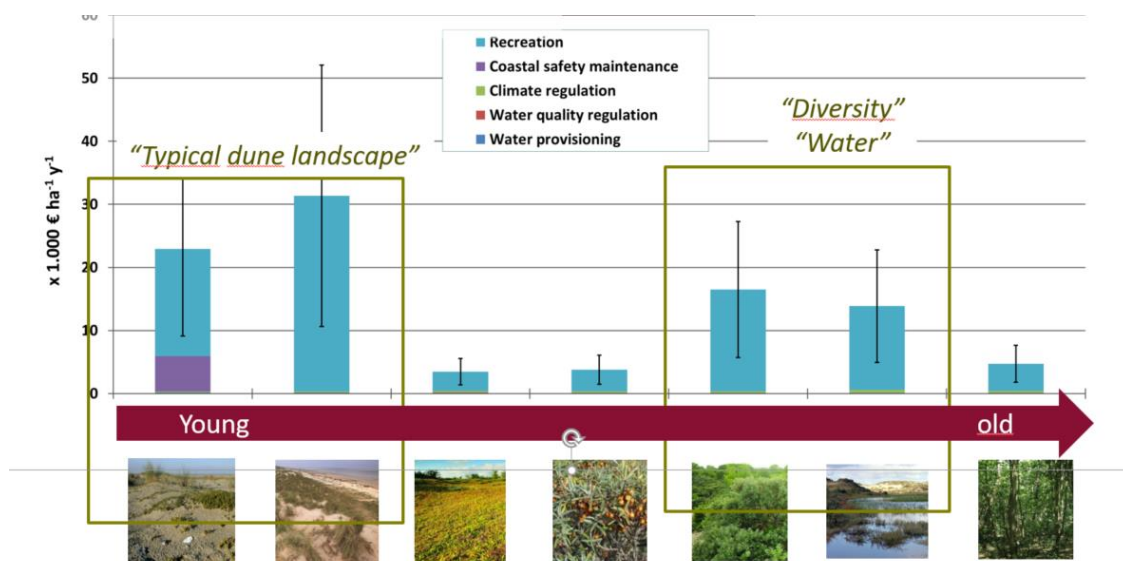
→ Impact on recreation and tourism, amenity and health

These are the important ecosystem services of the area. We discuss them together because the impact on amenity of the environment and impact on public health for local residents are also related to opportunities for recreation (walking, ...) in the area and habitat types. On the other hand, the proximity of habitation and the high number of visits lead to high recreational pressure in and around the area with potential conflicts for preserving biodiversity.

The assessment indicates that the impact of the LIFE + Flandre project on recreation and tourism, amenity and health will be positive:

- Firstly, the management plans pay a lot of attention to combining the recreational functions of the areas with nature conservation objectives. This is reflected, for example, in plans for opening up, construction of hiking trails, etc.
- Secondly, project measures and management plans provide for the restoration of habitat types that are loved by visitors. The survey of holidaymakers already revealed that white dunes and wet dune breakdowns score high with regard to landscape qualities (see chapter 4.3.2).
- This analysis has been confirmed in the context of additional research, in which these preferences have been confirmed based on the photos of habitat types that are uploaded on social media (Van Der Biest, 2017). In general, this also means that holidaymakers and tourists have a preference for more dynamic dune types. This is illustrated in the figure below, which allocates recreational benefits to different habitat types. It is mainly the typical dune landscapes with, for example, white dunes and wet dune breaks that bring diversity and water to the area, which are highly valued.

Figure 19: Ecosystem services of different habitat types



Bron: Van Der Biest, 2018.

Our literature review also underlines the importance of the attractiveness of landscapes for recreation and tourism (De Nocker, 2016). This indicates that naturalness is the first most important characteristic, before infrastructure for accessibility (path) and information.

7.4. CONCLUSIONS RELATED TO THE SOCIO ECONOMIC IMPACTS

7.4.1. THE SOCIO ECONOMIC BENEFITS OF THE NATURAL AREA

The analysis showed that the socio-economic benefits of the area are considerable. It offers important ecosystem services to society with regard to some regulatory services, including flood protection and water filtration, and cultural services related to tourism and recreation.

Although not all services can be quantified and valued, and the uncertainties in methods and data are high, the available information points to major benefits in terms of the value of the regulatory and cultural services provided per hectare. We estimate the value of these services for the total project in the order of magnitude of 20 to 60 million euros per year. These benefits benefit both the local economy and population (amenity and public health, coastal safety, etc.) but are also important supra-local (avoided costs for coastal safety, climate, and air quality,...). In line with the important ecosystem services for recreation and tourism, we estimate the expenditure associated with these at 25 to 130 million euros per year, with an employment effect of 2250 FTE / year, of which 1600 are local FTE / year.

The mechanisms that explain the high value of these services, e.g. proximity to residential areas and tourism, as well as the relatively small size of the area, often cause pressure on the area that may threaten the sustainability of the provision of these services.

7.4.2. THE IMPACTS OF THE LIFE + FLANDRE PROJECT

Due to the nature and size of the project, the analysis indicates that the direct and immediate socio-economic effects of the projects will be small compared to the situation in 2014. On the other hand, we expect the project to have positive long-term effects in order to anchoring the sustainability of the area and the delivery of the related services.

The analysis shows that the Flandre life + has contributed to better protection of the area and its services. This concerns the acquisition of sites, the preparation of management plans, the restoration of habitats that are important for both nature and tourism, the improvement of cross-border understanding and cooperation, the increased awareness of the importance of the area and its potential.

Although the acquisition of land is limited (2.5% of the total area), this is important because it contributes to better, long-term protection and more effective and efficient implementation of management plans.

We also note that the area as a whole has been preserved between 2014 and 2019, while figures from the analysis for NATURA2000 areas in Flanders indicate that there is continuing pressure to turn green destinations into hard destinations (habitation,).

Furthermore, we have no knowledge that the area on the project had major negative consequences for the other economic sectors or activities around the area.

The analysis in 2019 shows the positive long-term effects. Firstly, the survey of the various stakeholders shows that there is increasing support for lasting, cross-border protection and development of the area. Secondly, the analysis shows that the most important ecosystem services (coastal safety, recreation and tourism) will increase due to the measures, either already implemented or part of the management plans. Coastal safety and recreation benefit from more dynamic dunes, and the habitat types that increase (white dunes, wet dune pans) increase the landscape quality for visitors and tourists. On the other hand, deforestation and removal of shrubs leads to less capture of particulate matter and lower public health benefits. We cannot estimate or compare the magnitude of all these effects on ecosystem services.

LITERATURE

Agence de l'eau Artois Picardie (2015). Prélèvements en eau.

Arens S., van Puijvelde S. and Brière C. (2010). Effecten van suppleties op duinontwikkeling. Rapportage geomorfologie. 224p.

Arens S., Mulder J., Slings Q., Geelen L. and Damsma P. (2013). Dynamic dune management, integrating objectives of nature development and coastal safety: Examples from the Netherlands. *Geomorphology* 199, 205-213

Barez (2010). Dossier Grand Site Dunes de Flandres, 2010

Bauwens D. & Claus K. 1996. Verspreiding van amfibieën en reptielen in Vlaanderen. De Wielewaal Natuurvereniging, 196 p.

Beaumont N.J., Jones L., Garbutt A., Hansom J.D. and Toberman M. (2014). The value of carbon sequestration and storage in coastal habitats. *Estuarine, Coastal and Shelf Science* 137, 32-40

Broekx, S., De Nocker, L., Liekens, I., Poelmans, L., Sates, J., Van der Biest, K., Meire, P., Verheyen, K., (2014). Estimate of the Benefits Delivered by the Flemish Natura 2000 Network. Flemish Government Nature and Forestry Agency, p. 217.

Broekx, Steven; Beckx, Carolien; De Smet, Lieven; De Nocker, Leo; Liekens, Inge; Craninx, Michel; Poelmans, Lien; Meire, Patrick; Leone, Michael; Jacobs, Sander; Vrebos, Dirk; Staes, Jan (2019), Globale Socio-Economische Impactanalyse van de uitvoering van het Vlaams Natura 2000-programma : Handleiding.

Calcoen J. & Van Opstaele B. (2005). Uitgebreid bosbeheerplan voor de waterwinning Sint-André. Studie uitgevoerd door ESHER bvba in opdracht van Intercommunale Waterleidingsmaatschappij van Veurne-Ambacht. 140p.

Chevassus-au-Louis B., Salles J., Bielsa S., Richard D., Martin G. and Pujol J. (2009). Economic approach of biodiversity and ecosystem services. Contribution to the public opinion (in French). 378p.

De Nocker, L; Michiels, H; Deutsch, F; Lefebvre, W; Buekers, J; Torfs R. 2010. Actualisering van de externe milieuschadetekosten (algemeen voor Vlaanderen) met betrekking tot luchtverontreiniging en klimaatverandering; Studie uitgevoerd in opdracht van MIRA, Milieurapport Vlaanderen MIRA/2010/03; December 2010; 122 p. , www.milieurapport.be

De Nocker L., Broekx S., Demeyer R., Simoens I., Turkelboom F., Provoost S. & Vanderbiest K. 2015. Evaluatie van de socio-economisch impact van het FLANDRE project op de lokale economie, bevolking en het herstel van de ecosysteemdiensten. Studie uitgevoerd in opdracht van het Agentschap voor Natuur en Bos West-Vlaanderen. VITO & INBO, Mol, 76 p.

Figuroa-Alfaro R. and Tang Z. (2016). Evaluating the aesthetic value of cultural ecosystem services by mapping geo-tagged photographs from social media data on Panoramio and Flickr. *Journal of Environmental Planning and Management*. P. 1-16, doi.org/10.1080/09640568.2016.1151772

Flanders Geographical Information Agency and Province of West-Vlaanderen, 2012. Aerial photographs 2012.

Herr C. & Hens M. (2014). Bodemchemisch onderzoek i.f.v. natuurherstel in de Oostvoorduin te Koksijde en de Oude Hazegraspolder te Knokke. Rapport van het Instituut voor Natuur- en Bosonderzoek R.2014.2059894, Brussel, 23 p.

- Jones M.L.M., Wallace H.L., Norris D., Brittain S.A., Haria S., Jones R.E., Rhind P.M., Reynolds B.R. and Emmett B.A. (2004). Changes in vegetation and soil characteristics in coastal sand dunes along a gradient of atmospheric nitrogen deposition. *Plant Biology* 6, 598-605
- Jooris R., Engelen P., Speybroeck J., Lewylle I., Louette G., Bauwens D. & Maes D. 2013. De amfibieën en reptielen van Vlaanderen. Recente verspreiding en toelichting bij de nieuwe Rode Lijst. Rapport Natuurpunt.Studie 2013/6, Mechelen, 50 p.
- Kooijman A.M. & Smit A. (2001). Grazing as a measure to reduce nutrient availability and plant productivity in acid dune grasslands and pine forests in The Netherlands. *Ecological Engineering* 17, 63-77
- Kooijman A.M., Noordijk H., van Hinsberg A. en Cusell C. (2009). Stikstofdepositie in de duinen een analyse van N-depositie, kritische niveaus, erfenissen uit het verleden en stikstoffefficiëntie in verschillende duinzones. Universiteit Amsterdam. 56 p.
- Koopal A. (2013). Projectplan kustversterking Katwijk. Studie uitgevoerd door Arcadis in opdracht van Hoogheemraadschap van Rijnland. 90p.
- Koks E., de Moel H., Aerts J and Bouwer L. (2014). Effect of spatial adaptation measures on flood risk: study of coastal floods in Belgium. *Regional Environmental Change* 14: 413-425
- Kooijman A.M. and Besse M. (2002). The higher availability of N and P in lime-poor than in lime-rich coastal dunes in the Netherlands. *Journal of Ecology*, 90, 394–403
- Liekens Inge, Van der Biest Katrien, Staes Jan, De Nocker Leo, Aertsens Joris, Broekx Steven (2013). Waardering van ecosysteemdiensten, een handleiding. Studie in opdracht van LNE, afdeling milieu-, natuur- en energiebeleid. Digitale versie december 2014
- Masterplan Kustveiligheid (2012). Gedownload van www.kustveiligheid.be (februari 2015). 90p.
- Mint en Rebel, 2013. Standaardmethodiek voor MKBA van transportinfrastructuurprojecten. Kengetallenboek.
- MIRA (2012). MIRA-T Achtergronddocument vermessing.
- MIRA (2014). Website Milieurapport Vlaanderen <http://www.milieurapport.be/>, gedownload februari 2015.
- MUMM (2015). IDOD database, Integrated and Dynamical Oceanographic Data management. Sedimentparameters 'Bulk Density' en 'Particulate Organic Carbon', Belgisch deel Noordzee, periode 2004-2014
- OMES monitoring data Zeeschelde from 1995. Onderzoek Milieu-effecten Sigmaplan. Multidisciplinaire studie rond het estuariene milieu van de Zeeschelde.
- Oosterlynck P., De Saeger S., Leyssen A., Provoost S., Thomaes A., Vandevoorde B., Wouters J. & Paelinckx D. 2018. Criteria voor de beoordeling van de lokale staat van instandhouding van de Natura 2000 habitattypen in Vlaanderen. Basisinstrumentarium ter bepaling van de mate van instandhouding van habitatlocaties a.d.h.v. indicatoren voor structuur, vegetatieontwikkeling, verstoringsindicatoren en ruimtelijke context. Versie 3.0. Ongepubliceerd rapport van het Instituut voor Natuur- en Bosonderzoek (INBO.R.2018), Brussel, 282 p.
- Packet J.(2014). Blauwdruk Mollusken. In: De Knijf G., Westra T., Onkelinx T., Quataert P. & M. Pollet (red.) Monitoring Natura 2000-soorten en overige soorten prioritair voor het Vlaams beleid. Blauwdrukken soortenmonitoring in Vlaanderen. Rapport Instituut voor Natuur- en Bosonderzoek (INBO), INBO.R.2014.2319355. Brussel, 79-101.

- Provoost S., Feys S., Van Gompel W. en Vercruyssen W. (2011). Evaluatie van het gevoerde beheer en opmaak van een beheerplan voor het VNR De Duinen en Bossen van De Panne. Deel I: Evaluatie van het gevoerde beheer in de deelgebieden Houtsaegerduinen en de Westhoek. Rapporten van het Instituut voor Natuur- en Bosonderzoek 2011 (53), Brussel. 123 p.
- Provoost S., Van Gompel W., Feys S., Vercruyssen W., Packet J., Van Lierop F., Adams Y. & Denys L. (2010). Permanente Inventarisatie van de Natuurreservaten aan de Kust. Eindrapport periode 2007-2010. Rapport van het Instituut voor Natuur en Bosonderzoek R.2010.19, Brussel, 168 p. + bijl.
- Provoost, S.; Hoffmann, M. (1996). Ecosysteemvisie voor de Vlaamse Kust: 1. Ecosysteembeschrijving. Ministerie van de Vlaamse Gemeenschap. Afdeling Natuur: Gent. vi, 375, xxxvii, pp.
- Provoost S., Van Gompel W., Feys S., Vercruyssen W., Packet J., Van Lierop F., Adams Y. & Denys L. 2010. Permanente Inventarisatie van de Natuurreservaten aan de Kust, eindrapport periode 2007-2010. Rapport Instituut voor Natuur- en Bosonderzoek 2010.19, Brussel, 169 p.
- Provoost S., Van Gompel W., Vercruyssen E., Packet J. & Denys L. 2015. Permanente Inventarisatie van de Natuurreservaten aan de Kust, PINK II. Eindrapport periode 2012-2014. Rapporten van het Instituut voor Natuur- en Bosonderzoek 2015 (8890955), Brussel, 176 p.
- Remke E., Brouwer E., Kooijman A., Blindow I. and Roelofs J. (2009). Low Atmospheric Nitrogen Loads Lead to Grass Encroachment in Coastal Dunes, but Only on Acid Soils. *Ecosystems* 12: 1173–1188
- Remke E., Brouwer E., Kooijman A., Blindow I. and Roelofs J. (2009). Low Atmospheric Nitrogen Loads Lead to Grass Encroachment in Coastal Dunes, but Only on Acid Soils. *Ecosystems* Volume: 12 Issue 7
- Rosé F. and Lemauviel S. (2004). Sand dune restoration in North Brittany, France: A 10-year monitoring study. *Restoration Ecology*, Vol 12, No 1, 29-35
- Sen A, Harwood A, Bateman IJ, Munday P, Crowe A, Brander L, Raychaudhuri J, Lovett AA, Provins A, Foden J (2013) Economic assessment of the recreational value of ecosystems in Great Britain. *Environ Resour Econ*. doi:10.1007/s10640-013-9666-7
- Staes J., Van der Biest K., Meire P., Beauchard O., Broekx S., De Nocker L., Liekens I., Poelmans L., Verheyen K. and Panis J. (2014). Chapter 7: Quantification and Valuation of Ecosystem Services provided by the NATURA 2000 Ecological Network in Flanders (Northern Belgium). PhD Dissertation Jan Staes. ISBN 978 90 5718 074 3.
- Steezel H. 2009. Modelleren (en stimuleren) van lange termijn duinontwikkeling. Presentation NCK Days, 28 May 2009, Delft.
- Stive M., de Schipper M., Luijendijk A., Aarninkhof S., van Gelder-Maas C., van Thiel de Vries J., de Vries S., Henriquez M., Marx S. and Ranasinghe R. (2013). A New Alternative to Saving Our Beaches from Sea-Level Rise: The Sand Engine. *Journal of Coastal Research*, 29, 5, 1001–1008
- TEEB (2010). The Economics of Ecosystems and Biodiversity Ecological and Economic Foundations. Edited by Pushpam Kumar. Earthscan, London and Washington
- Temmerman S., Meire P., Bouma T., Herman P., Ysebaert T. and De Vriend H. (2013). Ecosystem-based coastal defence in the face of global change. *Nature* 504, Issue: 7478, pp 79-83
- Temmerman S. and Kirwan M. (2015). Building land with a rising sea. *Science*, V349, I6248, p588-589
- ten Harkel Van Boxel J.H. and Verstraten J.M. (1998). Water and solute fluxes in dry coastal dune grasslands. The effects of grazing and increased nitrogen deposition *Plant and Soil* 202 1-13

- Toerisme Vlaanderen (2012). De vakantieganger in commercieel logies aan de Vlaamse Kust 2011. Deel I: Globaal rapport. Brugge: Westtoer.
- Toerisme Vlaanderen (2016). Toerisme in cijfers 2018. Brussel: Toerisme Vlaanderen.
- Vandenbohede A., Van Houtte E. and Lebbe L. (2009). Sustainable groundwater extraction in coastal areas: a Belgian example. *Environmental Geology* 57:735–747
- Van der Biest K, Verwaest T, Reyns J, Mostaert F (2009). CLIMAR: Section Report 2 – Quantification of secondary effects of climate change to the Belgium coastal zone. Versie 2_0. WL Rapporten, 814_01. Waterbouwkundig Laboratorium: Antwerpen, Belgium (in Dutch)
- Van der Biest K., Vrebos D., Staes J., Boerema A., Bodi M.B., Franssen E. and Meire P. (2015). Evaluation of the accuracy of land-use based ecosystem service assessments for different thematic resolutions. *J. Environ. Manag.*, 156 (2015), pp. 41–51
- Van der Biest Katrien, De Nocker L., Provoost S., Boerema Annelies, Staes Jan, Meire Patrick (2017).- Dune dynamics safeguard ecosystem services, *Ocean and coastal management* - ISSN 0964-5691 - 149(2017), p. 148-158
- Van der Ploeg, S. and R.S. de Groot (2010) The TEEB Valuation Database – a searchable database of 1310 estimates of monetary values of ecosystem services. Foundation for Sustainable Development, Wageningen, the Netherlands
- van Dobben H.F. en van Hinsberg A. (2008). Overzicht van kritische depositiewaarden voor stikstof, toegepast op habitatypes en Natura 2000-gebieden. Alterra, 2008. 78p.
- Vanlerberghe, F.; Vanhoutte, M. (2001). Waterwinning in de duinen: gebruik of misbruik?, in: (2001). *De Grote Rede 2. De Grote Rede: Nieuws over onze Kust en Zee*, 2: pp. 7-8
- Verwaest T., Van der Biest K., Vanpoucke P., Reyns J., Vanderkimpfen P., De Vos L., De Rouck J. and Mertens T. (2009). Coastal flooding risk calculations for the Belgian coast. In: McKee Smith J (ed) *Proceedings of the 31st international conference on coastal engineering 2008*, Hamburg, Germany, 31 August to 5 September 2008, pp 4193–4201
- VLM (2011). Voortgangsrapport betreffende het mestbeleid in Vlaanderen. Mestbank 2011. Vlaamse Landmaatschappij, Brussel. 99 p.
- VLM (2014). Focusgebieden Nitraat - gemeenten van West-Vlaanderen.
- Weekers, K. (2013a). De economische betekenis van toerisme in Vlaanderen. TSA 2010 voor het Vlaamse Gewest (incl. schatting voor het Brusselse Hoofdstedelijke Gewest), in: *SVR - Methoden en technieken, 2013 (1)*. Brussel: Studiedienst van de Vlaamse Regering.
- Weekers, K. (2013b). De economische betekenis van toerisme in Vlaanderen. Teverkstelling in de sector Toerisme in het Vlaamse en Brusselse Hoofdstedelijke Gewest in 2008 en 2010, in: *SVR - Methoden en technieken, 2013 (2)*. Brussel: Studiedienst van de Vlaamse Regering
- Weekers, K. (2017). Het aantal tweede verblijven in Vlaanderen in 2016, Brussel: Studiedienst van de Vlaamse Regering. <http://www.statistiekvlaanderen.be/sites/default/files/atoms/files/aantal-tweede-verblijven-vlaanderen.pdf>
- Weekers, K. (2018). De economische betekenis van toerisme in Vlaanderen. TSA 2016 voor het Vlaamse Gewest (incl. schatting voor het Brusselse Hoofdstedelijke Gewest),
- Westtoer 2015. Statistics visitor center Nature Reserve Westhoek. Personal Communication.
- Westtoer 2015. Daguitstappen 2018.
- WES (2017). Reisgedrag van de Belgen in 2016. Commerciële reizen in Vlaanderen, naar macroproduct. Brugge: WES.

WES (2017). Reisgedrag van de Belgen in 2016. Eindrapport. Brugge: WES.

WES (2017). Reisgedrag van de Belgen in 2016. Tabellenboek. Brugge: WES.

Westtoer (2008). Onderzoek naar gebruikers van vaste standplaatsen op kustcampings 2008. Brugge: Westtoer.

Westtoer (2010). Dagtoerisme aan de kust 2009, een stabiele pijler van het kusttoerisme. Brugge: Westtoer.

Westtoer (2016). Trendrapport Kust 2015. Brugge: Westtoer.

Westtoer (2017). Trendrapport Kust 2016. Brugge: Westtoer

Zwaenepoel A., Van de Genachte G. & Lambrechts J. (2004). Natuur- en bosbeheerplan voor de Oosthoekduinen, het Calmeynbos en de Krakeelduinen (De Panne). Deel 2. IWVA. 123 p.