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cutting through complexity

SUSTAINABILITY

Green, healthy and productive

The Economics of Ecosystems & Biodiversity (TEEB NL): Green space and health

May 2012

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Foreword

Healthcare and its increasing cost is a serious issue facing our society. In this context it is interesting to see that several studies point to the positive effects of nature on health.

The report Green, healthy and productive, examines the potential costs and benefits of nature for our health, on the basis of two scientific studies. In addition to a case study on Amsterdam the report transposes the results to the Netherlands as a whole. What is remarkable about this study is that as well as identifying savings in healthcare costs, it also sees potential for savings in labour costs.

The potential economic value of biodiversity appeared on the international political agenda in 2007 with the publication of the first in a series of international TEEB studies (the Economics of Ecosystems and Biodiversity).

A number of case studies were carried out to obtain insight into the economic value of biodiversity for the Netherlands. The aim was to provide evidence of the benefits to be gained by investment in and conservation of biodiversity, and to give nature a place in policy development. It seems that nature may hold the answer to some of the problems facing society.

De TEEB study into nature and health forms part of the Dutch TEEB research project commissioned by the Ministry of Economic Affairs, Agriculture and Innovation. Six TEEB studies are being carried out in the Netherlands. In addition to nature and health, they deal with the spatial environment (TEEB physical space), Dutch trade chains, the Dutch private sector, the Dutch Caribbean and TEEB in the City (commissioned by the municipal council of Apeldoorn).

I would like to thank the members of the focus group for their constructive, scientific contribution to this study in recent months and to the Municipality of Amsterdam for funding research which takes a closer look at one aspect of city life. I hope that this study will mark the start of new partnerships to explore and exploit nature's potential to the full.

Annemie Burger
Director-General for Nature and Regional Policy
Ministry of Economic Affairs, Agriculture and Innovation

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Summary

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Summary

Investing in green spaces leads to major health care savings and is conducive to people's well-being

Investing in green spaces particularly in urban areas is rewarding on several fronts. Not only will it make environments more beautiful it also has a beneficial effect on people's health because their sense of well-being is enhanced and they will take more exercise. In this way investments in green spaces will reduce health care costs and absenteeism. The indicative outcome of a first investigation is that for this reason investing in green spaces represents an economic value of hundreds of millions of Euros.

Several scientific studies have shown that a green environment has a positive effect in many areas, including that of people's health. A translation of this effect into terms of economic value, like health care savings, however, is hard to find in the literature, if at all. This report contains a first exercise of this kind on the basis of two case studies into the potential economic benefit of nature. A better understanding of the relationships between a green environment and economic benefit allows for better policy as the focus is not so much on the costs of green spaces, or the costs of health care but on the economic value of an investment.

Many scientists believe that the benefits of a green environment are very clear in two specific areas. First, in the area of depression or anxiety, and second in preventing obesity (relevant to diabetes). In order to map the financial impact of the two an Amsterdam neighbourhood Bos en Lommer was taken as the starting point. On the basis of estimates, scientific ideas and statistics a prognosis was made of the effect of an additional ten percent of green spaces in the area.

The figures speak for themselves. In 2014 with an additional ten percent of green spaces in the area the number of people suffering from depression would go down by 130 and the costs involved in health care and absenteeism would decrease by EUR 800,000. The bandwidth for this exercise however is wide. If health benefits on other disorders like asthma, diabetes, neck and back complaints, and heart disease were included the expected recovery time ranges from 5 to 12 years provided that the development and maintenance of green spaces was contracted at competitive prices on land bought earlier.

Assessing the economic value of a greener environment for a decrease in the number of obese people a number of interim stages were needed. Obviously, more green spaces lead to more exercise: the number of children playing outside is 15% higher in green environments, and the risk of obesity in boys playing outdoors is lower. First, the lower costs involved in health care and absenteeism were calculated. The same could be true for other health effects for which exercise has a positive effect. A tentative up-scaling of the benefits of a green environment to 10 million people shows that benefits could be as high as EUR 400 million. The largest proportion would be due to health care savings as the annual amount of employees reporting sick would be reduced with 50,000.

This is figure is of course an estimate but it is an encouragement to look more closely at the related policy area. Not only to map the effects on the costs of depression and obesity but to look more closely at the whole range of potential health effects of a greener environment. The potential seems to be huge and it could very well be an unexpected (and/or unorthodox) manner to contribute to a better grip on health care costs.

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Introduction

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Introduction

Green, healthy and productive

Background
The international study 'the Economics of Ecosystems and Biodiversity' (TEEB)1 has been valuable in moving our thinking about the economic value of biodiversity and ecosystem services forward. The study does not however provide the information necessary to help governments, businesses, health insurers and other parties in the health care system in the Netherlands to take the next step and be inspired to take account of the economic value of biodiversity and ecosystem services in their policy decisions, business operations or business cases. A TEEB for the Netherlands was required for this and has led a cluster of TEEB studies, including:

'the Economics of Ecosystems and Biodiversity' (TEEB) as source of inspiration

Economic value of green, nature and biodiversity for the reduction of healthcare costs

Cases based on scientific evidence, economic relevance and available data

- Physical space in the Netherlands.
- Dutch Trade Chains.
- Dutch Business sector
- TEEB in the city.
- TEEB in the Caribbean.
- Green, healthy and productive.

The Interministerial Consultations on biodiversity of 28 June 2011 concluded that an exploratory study was needed into the social costs and benefits of green spaces, nature, ecosystems and biodiversity to reduce the rising costs of health care and other related economic effects. We know of studies and examples which indicate that 'green' may have a beneficial effect on health. Monitarising this beneficial effect is still an unexplored territory.

Context of the study
The Ministry of Economic Affairs, Agriculture and Innovation asked KPMG to conduct a study to provide an insight into the economic impact of more green space on healthcare costs.

This report was drawn up exclusively for the Ministry of Economic Affairs, Agriculture and Innovation to determine the current financial and economic value of green space, nature, ecosystems and biodiversity in reducing the rising costs of health care.

This report describes the method used, the two selected cases, the results of the economic effects including assumptions and band widths and a set of conclusions and recommendations for further study. The report also provides a perspective for the Netherlands as a whole and in qualitative terms discusses the measures that cannot be expressed in monetary value.

Preliminary inventory
Prior to this study the Ministry of Economic Affairs, Agriculture and Innovation as the client together with healthcare insurer Menzis made an extensive inventory of scientifically based relationships between nature and health. Health experts were presented with an initial list of 25 potential cases. These cases were assessed against three criteria:

- Scientific evidence.
- Social and economic relevance.
- Feasibility for a calculation exercise.

The inventory offered a large number of leads for a follow-up analysis. We applied strict selection criteria for our study, looking only at cases with the best scientific basis. A large number of other cases also illustrated the supposed relationship between green space, nature and health and certainly contributed to the selection of our business case (see attachment 1 for a list of the potential cases).

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Introduction
Key themes and principles

Key themes

Regarding the relationship between green space and health, the two recurring themes in the literature and focus group discussions are

- depression and anxiety, and
- obesity.

In consultation with the focus group it was decided to base the cases on the literature that had a sound scientific basis and potential for a significant impact on healthcare costs. For practical purposes it was also decided to use Dutch studies using Dutch data. This led to the following basis for calculations in the study:

- depression: 'Morbidity is related to a green living environment[2]'
- excess weight/diabetes: 'Juvenile obesity and a green living environment[3]'

The two cases were calculated for a neighbourhood in Amsterdam. Amsterdam was chosen because it is co-financing the study and is working to develop nature, green areas and biodiversity in the city.

These case studies in Amsterdam are large in scope and use practical calculations to reveal range and uncertainties

The Amsterdam district of Bos en Lommer was chosen in consultation with the municipality of Amsterdam and the Ministry of Economic Affairs, Agriculture and Innovation. The first case concerns the economic effects resulting from creating an additional 10% green space to reduce the prevalence of depression. The second case calculates the economic effects of realising the green space standard in neighbourhoods to reduce diabetes caused by excess weight.

Principles

Key principles of this study are:

The cases are interesting and large in scope (considerable health benefits, large numbers of people, large reduction in numbers of treatments, large increase in productivity, and so on).

The cases can be calculated in terms of visits to the doctor, lower treatment costs, fewer days absenteeism, and so on. The results will be transparent, giving insight into the negative effects, scope of study and uncertainties that contribute to the interpretation.

The definition of green spaces is in line with the 'Morbidity' study based on the national land use register of the Netherlands. An area is defined as 'green' if more than 50% of an area of 25x25 metres is green. In built environments this could be public and private green spaces, for example woods, building sites, business parks, public parks and gardens, sports fields and public allotments.

Morbidity is related to a green living environment

This scientific study by Jolanda Maas (main author, Department of Social Medicine VU University Medical Centre) demonstrates a link between the existence of green space within a radius of 1000 metres of the home and the frequency of visits to a general practitioner, related to 24 diseases. In 15 of the 24 diseases studied, the prevalence was significantly lower if there was more green space. In the case of depression, for average prevalence, 1% additional green space resulted in 1 less patient suffering from depression among 10,000 inhabitants.

Juveniles, excess weight and green space

This scientific study by Sjerp de Vries (main author, Alterra) demonstrates the link between green space near the home and more outdoor play by children. For boys aged between 4 and 12 more green space results in fewer cases of obesity. This effect was not found for girls. The study indicated that boys living in environments above the green standard (at least 75 m2 green space within a radius of 500 metres around the home) play on average 1.5 hours a week longer outside than boys who live in neighbourhoods without the green standard. Combined with a 25% lower chance of excess weight per hour of outdoor play, this quantitative relationship forms the second part of the basis of the case in Bos en Lommer.

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Introduction
Focus group

Focus group with general practitioners, TNO, GGD Amsterdam, Menzis, RIVM, Ministry of Health, Welfare and Sport, MUMC, Raad voor Gezondheid, Dienst Ruimtelijke Ordening Amsterdam.

Focus group
To safeguard the study's intrinsic quality and public relevance, the Ministry of Economic Affairs, Agriculture and Innovation set up a focus group which met three times during the study. At the first meeting the group made recommendations for the design of the study and selection of the two cases. At the second meeting the case studies and the economic valuation methodology were presented. At the third meeting the actual results were presented and explained, as was the motivation, data and resources.

Composition of focus group:

- Mirella Buurman (GP Diemen Zuid health centre, for the LHV)
- Sanne de Vries (TNO)
- Fred Woudenberg (GGD Amsterdam)
- Mieke Ansems (Menzis)
- Frank den Hertog and Lea den Broeder (RIVM)
- Arthur van Iersel and Jack Hutten (Ministry of Health, Welfare and Sport)
- Marco Marcus (MUMC)
- Pieter Vos (Health Counsil)
- Johan van Zoest (Spatial planning, Amsterdam)

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Economic valuation methodology

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Economic valuation methodology
Principles

Principles
The economic value of green spaces, nature, ecosystems and biodiversity in reducing healthcare costs can be assessed in a number of ways. In this study we have chosen to look at the social costs and benefits, placing the emphasis on the costs and benefits that are directly visible in budgets or in the revenue and expenditure accounts of municipal councils, health insurers and employers. We have worked on the basis of the following principles:

- our estimates must be thorough and constructive.
- our valuations are based on information from earlier studies (benefit transfer method).
- we will map the long-term effects (from age of 30 up to a whole life, depending on the case).

From intervention, looking at the relationship between effects and quantifying them to expressing the value of green spaces, nature, ecosystems and biodiversity in monetary terms.

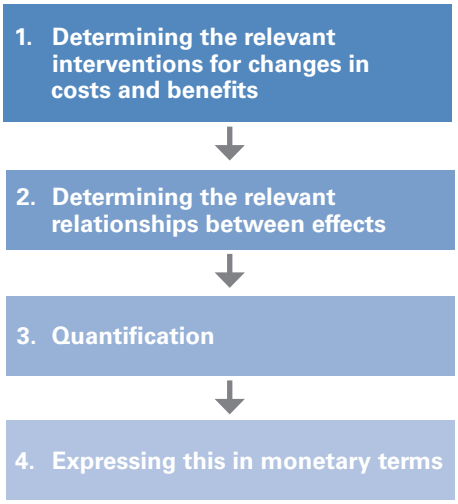
This is based on the following steps:

1. Determining the relevant interventions to change costs and benefits.
The financial and economic value is central and not the intrinsic value of nature, green space, or biodiversity. We will primarily look at the direct utility value of nature, green space, and biodiversity and potential interventions with a positive cost-benefit ratio.

2. Determining the relevant relationships between effects.
Nature, green space, and biodiversity can have an effect on the costs and benefits in health care in several ways. In this study we use the relationships from the two scientific studies referred to earlier:

- In the first case we will look at the intervention 'changing the surface area of green space in a neighbourhood' and its consequences for the number of people falling ill and calling on their GP. Creating more green space in a neighbourhood directly fits in with the scientific relationship found between more green space in living environments and lower prevalence of disease.
- In the second case we will look at the intervention changing the surface area of green space and its accessibility in the vicinity of homes and the change in the number of children taking more exercise as a result. Next we will look at what effect this has on excess weight, and finally, at the chance of these children getting diabetes.

Fig.1: Steps in economic valuation



In this step the underlying mechanisms and assumptions for the different relationships between effects are analysed, such as changes in the prevalence of disease as the result of more green space, the effect of comorbidity (two or more coexisting medical conditions) or alternative interventions like developing various types of extra green space (for instance low and high maintenance nature).

3. Quantification
All the relevant elements in the relationships between effects are quantified (green space in number of hectares, reduction in the number of patients, reduction in absenteeism, etc.). Here the emphasis will always be on the change after the intervention. It is always the number of times it happens and the number of units to which it applies.

4. Expressing this in monetary terms
Finally, we will link amounts of money to the various units (m2 grass, days of absenteeism, health care costs for depression per person per year, etc.).

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Economic valuation methodology
Direct price effects

Focus on direct price effects measure-related and disorder-related

Indirect and non-price effects fall outside the scope of this study

Direct measure-related price effects
Both costs and benefits of the creation and maintenance of more green space are included in the calculation of the price effects. The costs include all the physical measures involved in developing the green space and their annual maintenance. The purchase of land is not part of the calculations as we assume that the additional green space can be developed on land already owned by the municipality of Amsterdam or others. We also assume that this land is not considered suitable for other uses which is why there is no need for land acquisition or for looking at the 'opportunity costs' of the land where nature will be improved or developed. We do not therefore consider the costs of potential alternative use for the land in whatever form, such as housing, shopping centres or offices rather than green space.

Direct disorder-related price effects
The study also quantifies the disorder-related price effects. In both cases these concern the benefits like healthcare savings and lower workplace absenteeism.

Non-priced direct effects
In addition to the price effects of depression/anxiety or excess weight/diabetes, there are effects that in the end positively affect our wellbeing but do not have an economic value expressed in monetary terms. More green space can make people not suffering from depression 'happier' or children that are not overweight can become more physically active. Biodiversity can increase with the creation of more green space in a neighbourhood.

Indirect effects
The proposed measures may have a number of indirect effects but they fall outside the scope of this study. For instance, more green space could affect house prices and happier employees could be more productive.

In this study the non-priced and indirect effects are not translated into money terms. Our aim is not to overestimate the benefits and not to use complex economic models on the basis of various assumptions.

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Fig.2: Economic valuation methodology

	Direct effects		Indirect effects	
	Disorder related	**Measure related**	**Disorder related**	**Measure related**
Price effect (market)	• Healthcare savings (patient numbers, treatment costs) • Less wastage (wages, replacement, re-integration)	• land acquisition, green space creation and maintenance • Change in land value following alternative use land use	• Changes in consumption, investment and saving patterns • Different career choice	• Effects jobs (e.g more work for nurseries) • Sales playground equipment • Change in value of houses / real estate • Savings in maintenance original land use
Non-priced (no market)	• Sense of fitness • Sense of well-being	• Providing shade/ Heat stress • Biodiversity • Collecting rainwater	• Labour productivity • Changing lifestyle	• More attractive living environment • Social security

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Costs

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Costs
Healthcare

This study examines the detailed monetary effects of green space intervention for two disorders – anxiety and depression, and excess weight and diabetes. Possible effects are a reduction in the curative healthcare and labour costs generated by these diseases.

Healthcare costs

For some years healthcare costs have been rising faster than inflation combined with economic growth. In 2010 total healthcare expenditure amounted to EUR 87.6 billion4. It has been a government priority to reverse these rising costs, but in spite of the many efficiency initiatives aimed at direct healthcare costs and healthcare funding and organisation, costs continue to rise, and are expected to continue to do so (see KPMG Plexus Werken aan de Zorg'[5]).

Total cost of psychiatric disorders: EUR 15.9 billion per year, EUR 966 million of which is for depression

In 2010 42.7% of Dutch people were overweight, with 9.8% seriously obese

In 2010 there were an estimated 1 million diabetes patients, resulting in healthcare costs of EUR 1 billion per year

Cost of depression

In 2007 the total costs of psychological disorders in the Netherlands were EUR 15.9 billion, of which EUR 966 million was spent on depression. Most of these costs (EUR 923 million) are for curative measures, against EUR 43 million for preventative measures6. In the period 2003 to 2007 mental healthcare costs showed the greatest increase of all care sectors. This growth was caused solely by the growth in the number of patients.[7]

Healthcare costs of obesity and diabetes

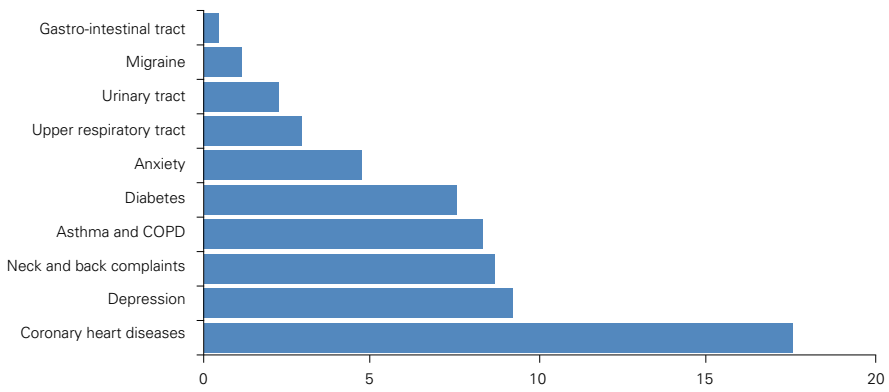
In 2010 42.7% of the Dutch population was overweight. Of these, 31.9% were moderately overweight and 9.8% were seriously overweight.[8] The risk of disease caused by obesity increases in relation to the Body Mass Index or waist circumference. Adults with a BMI greater than 30 have 5 to 12 times greater risk of contracting diabetes mellitus type 2 and a 2 to 4 times greater risk of contracting heart disease or one of several types of cancer than adults of normal weight[9].

In 2010 an estimated 1 million people in the Netherlands suffered from some form of diabetes.[10] In 2007 the healthcare costs of diabetes amounted to more than EUR 1 billion.[11] Due to the ageing population and increased obesity cases of diabetes may double by 2025. This is in spite of the expectation that better treatment of diabetes will lead to fewer or later complications, which would result in a reduction in the total cost.[12]

Total costs of diseases on which nature may have an impact

If we examine the total healthcare costs for all diseases in the Morbidity study showing significantly lower prevalence if people have more access to green areas, we see that depression and diabetes together represent one of the largest costs, with coronary heart disease the most costly by far. The total curative care healthcare costs for these diseases amounts to EUR 6.3 billion a year, based on 2007 figures.

Fig.3: Total healthcare costs for relevant disorders (billion Euros)



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Costs
Labour market

Workplace absenteeism costs EUR 13 billion a year

In the Netherlands 188,000 employees suffer from depression and cost the economy EUR 2.1 billion a year from low productivity and from wastage

Diabetes costs employers EUR 318 million per year

A large part of the cost to the economy of diseases is caused by workplace absenteeism. Although this declined from 10% in the late 1970s to 4.1% in 200913, the total costs are still considerable. On average, a Dutch employee is absent for 7.5 working days a year. A rough estimate shows that this results in an approximate cost of EUR 13 billion a year for all types of health-related absenteeism, (short, long-term, frequent)[14].

Labour costs and depression[15]

Of the active labour force 188,000 employees suffer from depression. The total work-related costs from depression are estimated at EUR 2.1 billion a year, composed of EUR 1.0 billion from absenteeism, EUR 0.7 billion from sickness presenteeism (present, but less productive) and EUR 0.4 billion from wastage.

Labour market costs and diabetes[15]

In the Netherlands 161,000 employees suffer from diabetes. The total labour-related cost of diabetes amounts to EUR 318 million, of which EUR 186 million is from absenteeism, EUR 120 million from sickness presenteeism, and EUR 12 million from wastage. Unlike people suffering from depression, of diabetes patients only 34% experience relatively little impediment during their work and are on average only absent for an extra 5 days.

Fig.4: Annual costs to the labour market of depression and diabetes

	Employees with clinical disorder	Cost of absenteeism	Cost of sickness presenteeism	Costs from wastage	Total
	Number	mln. Euro	mln. Euro	mln. Euro	mln. Euro
Depression	188.000	1000	700	400	2100
Diabetes	161.000	186	120	12	318

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Case 1

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Case 1: 10% additional green space in Bos en Lommer

Positive effect on number of patients suffering from depression

Bos en Lommer is a concrete case for the calculation of the economic effects of 10% more green space on the reduced prevalence of patients suffering from depression

The benefits are the healthcare savings from reduced prevalence of patients suffering from depression and savings in labour costs

Healthcare savings are the result of fewer patients suffering from depression, multiplied by the average healthcare costs per patient

Introduction

In this case we calculate the effects of more green space on healthcare and labour costs in a specific neighbourhood. In consultation with the municipal council of Amsterdam we selected the 'Bos en Lommer' district. In line with the 'Morbidity'-study we opted for the intervention 'creating an additional 10% of green space in residential area' to assess the effects on the prevalence of people suffering from depression living in Bos en Lommer. We then made a cost and benefit analysis, followed by a discussion of the results, and a set of recommendations.

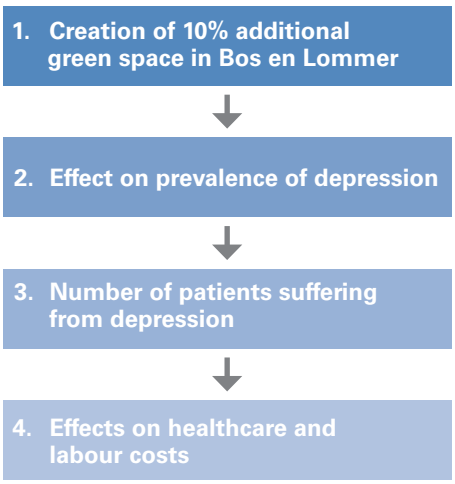
Benefits

The benefits from a lower prevalence of people suffering from depression due to an increase of green space in a neighbourhood are categorised into benefits from healthcare savings and benefits from less disease, reduced labour productivity and wastage.

Health cost savings

In order to determine the total savings in healthcare and labour costs we must be able to determine the difference in the number of patients suffering from depression.

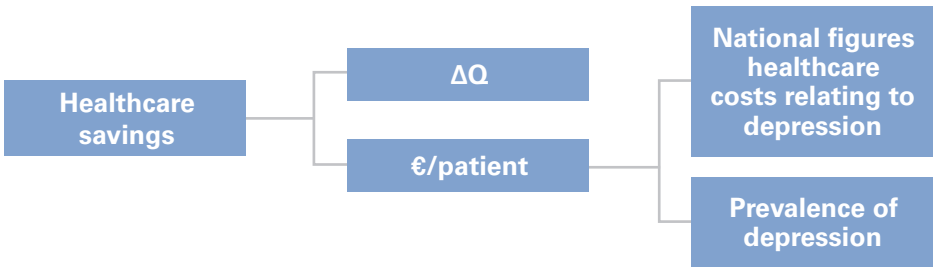
Fig.5: Case 10% additional green space



With the prevalence statistics of the Municipal Health Service in Amsterdam[16] and the inhabitants of the relevant postal code districts[17] we found that in 2014 a 10% increase in green space in Bos en Lommer would reduce the number of people suffering from depression in the age category of 16 years and older by 132. This age category was chosen because there were not enough statistics for children under the age of 16.

The average costs per patient were determined by dividing the total sum of curative costs for depression in the Netherlands in patients over the age of 15 (EUR 915 million) by the number of patients suffering from depression in the Netherlands (542,000) over the age of 15.[18] The average costs per patient then come to EUR 1,687. The assumption is that the prevalence of depression does not change over the period.

Fig.6: Calculation model healthcare savings



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Case 1: 10% additional green space in Bos en Lommer

Reduced healthcare costs and reduced absenteeism

Assuming that average costs of healthcare also apply to the people in Bos en Lommer, total healthcare savings in 2014 would add up to more than EUR 223,000. These savings will slightly increase year by year to EUR 254,000 in 2044.

Labour cost savings

In addition to the benefits produced by healthcare savings, greener living environments also result in labour cost savings from a decline in absenteeism. These labour cost savings can be subdivided into three categories[15]

- Labour cost savings as a result of less absenteeism.
- Labour cost savings as a result of less 'sickness presenteeism'.
- Labour cost savings as a result of less wastage (WIA disability law)

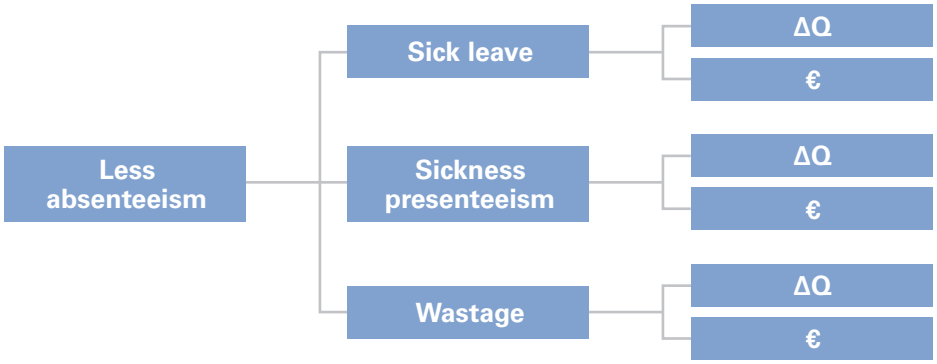
Fig.7: Total savings healthcare in greener living environment (EUR/year)

Difference in the number of patients suffering from depression	132
Average costs of treatment per patient	€ 1,687
Total healthcare savings	**€ 223,000**

Fig.8: Total savings on account of less absenteeism (Euro/year)

Difference number of people suffering from depression aged 16-55	94
Difference number of people suffering from depression aged 55-65	20
Labour force aged 16-55	69%
Labour force aged 55-65	51%
Labour participation	71%
Average number of days absent per patient	22.8
Average costs per day absent	€ 230
Savings on absenteeism	**€ 277,000**

Fig.9: Calculation model labour costs savings



Labour cost savings as a result of less absenteeism

In order to determine the total savings in labour costs as a result of less absenteeism we have estimated the lower number of people suffering from depression in employment. Assuming that the average labour participation in Bos en Lommer is equal to the Amsterdam average (69%[19] the number of people in jobs suffering from depression is reduced by 114, spread over the age categories 16-55 and 56-65. With an average extra 23 days of absenteeism and attendant costs of EUR 230 a day per employee[15] total healthcare savings in 2014 add up to EUR 278,000.

A second category of labour cost savings is less 'sickness presenteeism', which means less productivity from workers who go to work but cannot work at full strength. Assuming that cost ratios in Bos en Lommer are the same as in the rest of the country the savings on sickness presenteeism in Bos en Lommer were estimated at EUR 191,000 in 2014. The third category, that of wastage, to which the same assumptions are applied, will lead to savings of more than EUR 111,000 in 2014.

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Case 1: 10% additional green space in Bos en Lommer

Labour productivity up wastage down

Benefits as a result of lower losses in labour productivity in 2014 EUR 191,000, and as a result of less wastage EUR 111,000 in 2014

Total benefits in 2014 more than EUR 802,000

Total labour costs savings (the benefits) for Bos en Lommer add up to more than EUR 579,000 in 2014. Together with the EUR 223,000 savings in healthcare costs total savings for Bos en Lommer come to EUR 802,000 in 2014, rising to EUR 871,000 in 2044.

Fig.10: Total labour cost savings (EUR/year)

Savings on account of less absenteeism		€ 277,000
NL costs ratio sickness presenteeism/ absenteeism	0,69	
Savings sickness presenteeism		€ 191,000
NL costs ratio wastage/absenteeism	0,40	
Savings in labour costs as a result of wastage		€ 111,000
Total savings labour costs		€ 579,000
Total savings healthcare costs		€ 223,000
Total benefits for Bos en Lommer		**€ 802,000**

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Case 1: 10% additional green space in Bos en Lommer

Costs of the creation of green space

Costs of green space

The costs of creating an additional 10% of green space were subdivided into creation of green space and maintenance of green space. The former are a one-off investment, the latter an annually recurring item.

In order to determine the total costs of green space we have detailed them in a number of units:

- number of m^2 for 10% additional green space.
- Price per m^2 for the creation of green space.
- Price per m^2 per year for the maintenance of green space.

Number of m^2 of required green space

To establish the number of inhabitants and the amount of green space required we used postal code districts to calculate the surface area of Bos en Lommer. In consultation with the municipal council of Amsterdam we selected districts 1055, 1056 and 1061 for this purpose. The total surface area of these three districts adds up to 3.33 km^2, which roughly equals the area of the Bos en Lommer district.

The creation of an additional 10% of green space in Bos en Lommer then comes to 0.33 km^2, or 33 hectares.

Costs of the creation of green space

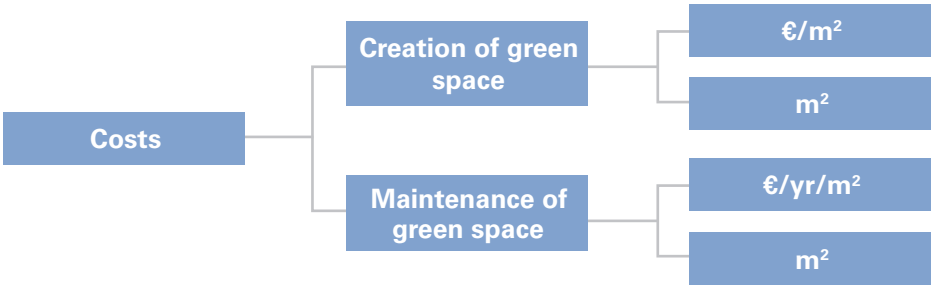
The table below includes a survey of the price estimates provided by the municipal council of Amsterdam21 for the creation of five additional types of green space on the 33 hectares in Bos en Lommer.

On the basis of average estimates the creation of additional green space in

Bos en Lommer equals EUR 40.50 /m^2 , including the placing of 10 benches per hectare.

Alternatively, one could establish 33 hectares of new green space in line with the current green mix in Bos en Lommer. If we use the cost price per green space category from the detailed cost estimate made by BtL Advies for the province of Brabant22 the costs of creating green space including the placing of benches and removal of hard surfaces23 would add up to EUR 15.56 per m^2.

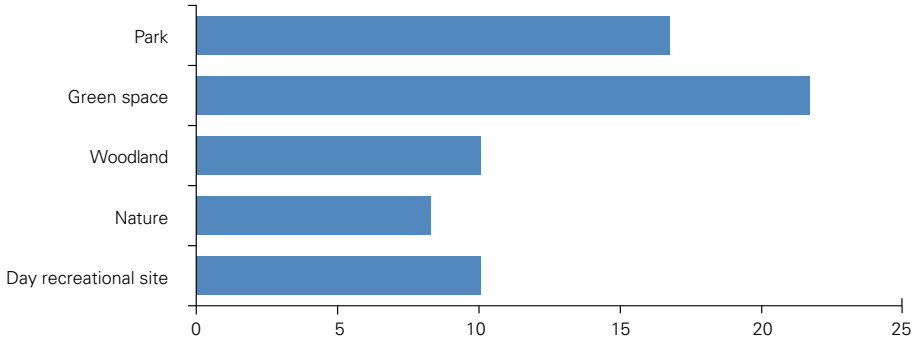
Fig.11: Calculation model costs of green space



Costs of new green space consist of the creation of green space and its maintenance

The costs for the creation of additional green space in Bos en Lommer are estimated at EUR 40.50 /m^2

Fig.12: Costs for the creation of an additional 10% of green space in Bos en Lommer based on average prices for various types of green space in Amsterdam (in EUR m)



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Case 1: 10% additional green space in Bos en Lommer

Costs of green space maintenance

One-off investments for the creation of 33 hectares of green space add up to EUR 13.5 million

Maintenance of an additional 33 hectares of green space equals broadly EUR 1 million a year

Maintenance costs are based on current green mix in Amsterdam West district

The difference between these costs can be explained by the fact that the BtL Advies estimates are based on green space in non-urban areas, a factor which reduces the costs. Also, the price estimates provided by the municipal council of Amsterdam include overheads, whereas the BtL Advies estimates only cover the planting of grass, trees and shrubbery. In addition, the council's estimates are based on a tailored design and development plan incorporating the urban requirements for quality, access and safety.

For these reasons we have chosen the more conservative, expensive option, also because studies have shown that the quality and accessibility of green space are factors contributing to people's health.24 Multiplied by the required surface area of 33 hectares, the one-off investment costs for the creation of this extra green mix add up to EUR 13.5 million.

Green space maintenance costs

To determine the costs for green space maintenance we used the data from the report *Databank Gemeentelijk Groenbeheer Amsterdam*[25]. This report details the surface area and maintenance of the various types of green space in Amsterdam West as illustrated in the figure below. On the basis of these data maintenance costs equal EUR 3.04 /m2. If these estimates are used to calculate the annual maintenance costs of the green space on the additional 33 hectares in the Bos en Lommer district, costs would add up to EUR1,010,000. Here, too, the estimates differ considerably. According to Amsterdam West's own estimates26 current green space maintenance costs in Bos en Lommer average EUR 1.17 /m2, whereas BtL Advies figures come to EUR 0.45/m2.

As BtL Advies figures are based on extensive green space maintenance instead of the intensive maintenance now taking place in the municipality of Amsterdam we did not include these maintenance costs in our calculations. We used the more detailed and substantiated maintenance figures from the *Databank Gemeentelijk Groenbeheer Amsterdam* report as Amsterdam West estimates had not been itemised sufficiently and we did not know on what assumptions they were based to allow proper comparison with the municipality of Amsterdam or BtL Advies estimates.

Fig.13: Green space management costs

Management	Percentage	€/m²
Trees	2%	€ 7.07
Lawn	37%	€ 1.02
Rough grass	24%	€ 0.45
Shrubbery	35%	€ 5.63
Planting beds	2%	€ 18.62
Benches		€ 0.03
Totaal (gemiddeld)	**100%**	**€ 3.04**

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Case 1: 10% additional green space in Bos en Lommer

Results

Results business case 1

On the assumption that all green space investment takes place within one year (2014), and that the number of inhabitants in Bos en Lommer and all other parameters remain constant (like maintenance costs per m2, labour costs per day, annual healthcare costs per patient etc.), we could calculate the total costs and benefits for 2014 and after.

It turns out that the annual green space maintenance costs equal the reduced annual healthcare costs as there are fewer patients suffering from depression. The table below shows the various cost and benefit categories for 2014 and 2015.

Fig.14: Business case results

Year		2014		2015
Healthcare savings	€	223,000	€	224,000
Labour costs savings (less absenteeism)	€	277,000	€	279,000
Labour costs savings (less 'sickness presenteeism')	€	191,000	€	192,000
Labour costs savings (less wastage)	€	111,000	€	112,000
Total benefits	€	802,000	€	807,000
Creation of green space	€	13,500,000	€	0
Green space maintenance	€	1,010,000	€	1,010,000
Total costs	€	14,510,000	€	1,010,000
Balance	**€**	**-13,708,000**	**€**	**-203,000**

Discussion

The outcome of this business case for the creation of an additional 10% green space in Bos en Lommer has produced the following insights:

For this business case we used the highest estimates. If we had used the lower BtL Advies estimates for the creation of green space (EUR 15.56 /m2), and the lower Amsterdam West estimates for green space maintenance (EUR 1.17 /m2/year) we would in the end have an annual positive balance of more than EUR 400,000 and a recovery period of some 12 years.

With lower costs for green space creation or maintenance and including the savings resulting from the reduced prevalence of other diseases susceptible to more green the case could be positive with a recovery period ranging from 5 to 12 years

It should be noted that the prevalence of depression in Bos en Lommer is almost four times the national average. Therefore the healthcare savings on account of reduced depression in this district are relatively high.

If we would have included healthcare savings resulting from the reduced prevalence of other diseases susceptible to more green space assuming these benefits would be equal to those at the national level (see chapter 6) the annual savings of more than EUR 1.5 million could in this case reduce the recovery period to some 5 years. If the prevalence of these other diseases equals the national level (that is, is not higher by a factor 4 as is the case with depression) then the recovery period would go down to 8 years. But these are broad estimates. It would require a closer analysis of the concrete prevalence statistics for these other diseases in Bos en Lommer to gain a better insight.

The Bos en Lommer case is very specific with its high household densities (6,000+/ha) and high green space percentage (29%). The authors of the 'Morbidity' therefore believe Bos en Lommer comes within the calculable domain.

The costs for the creation and maintenance of green space are higher in highly urbanised Amsterdam than in other parts of the country.

The same ratios also apply if the percentages of added green space are smaller (say 1% of additional green space or even less). This is relevant as in Bos en Lommer there is no room to create an additional 10% green space without buying up land. This flexible gauge applies to areas with a 10-90 green space percentage; where for each percentage of extra green the same health benefits can be expected.

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Case 1: 10% additional green space in Bos en Lommer

Discussion and follow-up research

Further study is needed to provide more certainty and establish the precise effects of the composition and design of more green space

An analysis of the business case based on the 15 diseases identified in the Morbidity study would be more accurate at a national level. The results of the source studies would be more suitable for national analysis instead of an area-specific analysis.

In the Bos en Lommer case we used existing figures for our calculations and tried to come to a conservative estimate of the benefits. Alongside the sensitive parameters like the costs of green space creation and maintenance, discussed earlier, there are two more parameters that could have a significant impact on the outcome of our calculations.

Labour cost savings

In our calculations we have assumed that the average income (and so the costs of days lost at work) equals the average income in the Netherlands. In reality incomes in Bos en Lommer are 20% lower than the national average. As we do not know how this would translate in lower labour cost savings we decided to use the average wage costs in the Netherlands.

Amount of additional green space

In this case our calculations are based on the assumption that the surface area units (of 25x25 metres) are fully deployed with green space, a unit also used in the calculation of the morbidity study.

Since areas are already defined as 'green' if 50% of the surface area of 25x25 metres is green this would mean that creating green space in half of the areas would suffice to arrive at a 10% increase of green space in the district.

The outcome of this study presents a rough indication of the economic effects of more green space on healthcare costs.

To provide government decision-makers, healthcare institutes, healthcare insurance companies and employers with more certainty about the actions which could produce maximum results a follow-up study is necessary built around the following questions:

- What additional green space percentage is required for living environments with an existing share of green space to achieve the desired effect?
- What composition should the green space have given a specific living environment to achieve maximum effect?
- What are the costs involved in the creation and maintenance of green space and what are the benefit-cost ratios of the several variants?

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Case 2

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Case 2: More green space, more activity

Positive effects for playing children

In areas where each home has access to at least 75m^2 of green space within a radius of 500 metres, children spend 15% more time playing outside, an average of 1.5 hours a week

This leads to lower prevalence of excess weight in boys between the ages of 6 and 12 years

In Bos en Lommer there are 1715 boys in this age range

In this case we only studied the direct relationship between more green space -> boys playing more -> less excess weight -> less diabetes, in order to determine the costs to public healthcare.

As starting point we used the Alterra 2008 study 'Jeugd, overgewicht en groen' (juveniles, excess weight and green space' by Sjerp de Vries3 and others. This study demonstrates a causal relationship between green space in the living environment and the risk of excess weight in children. It shows that children living in areas that meet the green space standard of at least 75m2 green space per dwelling within a radius of 500 metres, spend almost 15% more time playing outside, that is 1.5 hours a day. A direct relationship between extra outdoor play of 6.5 hours a week and a reduced risk of obesity of 25% was found only in boys, perhaps due to the more active nature of their play.

If we assume that there is a linear relationship between the risk of obesity and the number of hours of outdoor play, boys between 6 and 12 years have a 6% less chance of obesity if there is at least 75m2 green space per dwelling within 500 metres of their home. In that case the prevalence of excess weight declines from the present 13.3% to 12.4%. More accurate figures are not currently known to us or the focus group.

To determine the positive effects on healthcare costs and workplace absenteeism in Bos en Lommer a cohort of boys between the ages of 5 and 12 years, 1715 boys in total, was studied, using the model on the following page.

On the advice of the focus group we based our study on the principle that overweight children become overweight adults and children who are not overweight do not. The prevalence of diabetes is higher in people who are overweight, creating a discrepancy in the projected numbers of people in a specific year. The risk of diabetes is very small during the childhood years, with the risk increasing in later years. The anticipated results will only be achieved after a relatively long term.

Creating green spaces is a relatively easy way of getting children to be more active. Once in place, green spaces require no extra effort to achieve an effect, whereas exercise programmes, for instance, always require a trainer. The creation of green space can however be supported by other projects such as the Gezond gewicht Overvecht healthy weight programme in Utrecht (www.utrechtgezond.nl).

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Fig.15: Benefits of green space for diabetes

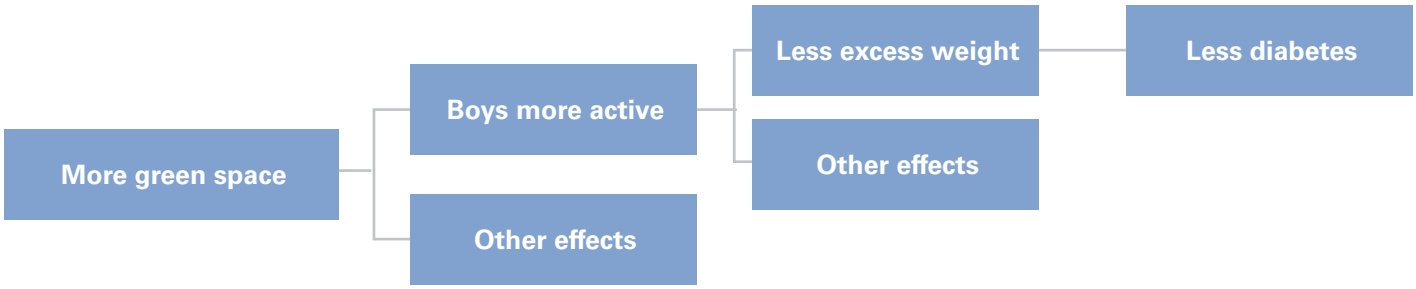
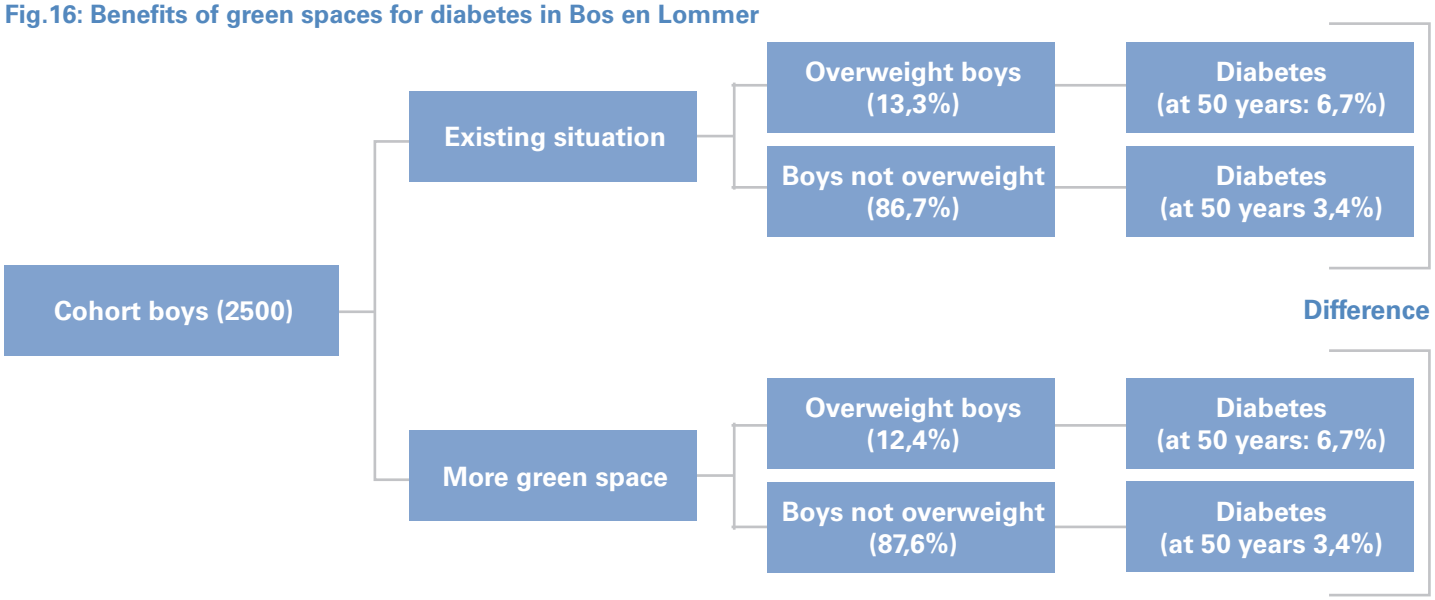


Fig.16: Benefits of green spaces for diabetes in Bos en Lommer



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Case 2: More green space, more activity
More research needed

Fig.17: Health effects of activity

Regular exercise can directly reduce the risk of contracting the following diseases	Regular exercise has a positive effect on these individual factors, indirectly reducing the risk of disease.
Coronary heart diseases	Body weight
Diabetes mellitus type 2	Blood pressure
Stroke	Body fat percentage
Osteoporosis	Bone density
Bowel cancer	Triglyceride count
Breast cancer	Ratio HDL/LDL cholesterol
Falls among the elderly	Glucose intolerance (see diabetes mellitus)
Depression	Insuline intolerance/susceptibility

Benefits

As the diagram on the previous page shows, the effect of green intervention in the prevalence of obesity is minimal: of the 1715 boys aged between 6 and 12 years studied, 19 fewer of them will be overweight. If we transpose the reduction of children who are overweight to the prevention of diabetes, the reduction in the prevalence of diabetes is practically nil. In our calculations we used a prevalence difference for excess weight of 0.7% to determine the difference in prevalence between children who are overweight and children who are not overweight (1,1%).

On the basis of these findings we have calculated the total benefits for the present generation of 5 to 12 year-olds over their whole life span to be approximately EUR 51,000 in a neighbourhood like Bos en Lommer. This would work out at a figure of several hundred euros, to a maximum of 1700 per year, as our calculations show that in 2070 there would be a maximum of 2 fewer diabetes patients. The saving in curative healthcare costs would therefore be relatively small.

The low prevalence difference of 1.1% for diabetes shows that the effect of more green space on diabetes is minimal (2 patients less at age 70)

The labour costs saving would also be relatively small, as the average workplace absenteeism for diabetes patients amounts to 5 extra days, considerably less than the 23 days for depression.

The labour costs resulting from sickness presenteeism and absenteeism due to diabetes represent only a quarter of the costs of workplace absenteeism, so that the total savings on labour costs would be very small.

Costs

Bos en Lommer meets the green standard of at least 75 m^2 green space in a radius of 500 metres from the home. If we follow the causality between green spaces and greater physical activity described in Alterra's report, then Bos and Lommer does not need to make any costs, but neither would there be any effects. The report does show that there is a direct relationship between excess weight and green spaces by means of greater activity.

In addition the Nationaal Kompas28 gives an extensive summary of the direct health effects of physical activity and the indirect effects of physical activity. This clearly shows that the effect on body weight is only one of many effects.

The consequences of excess weight on a person's health can be similarly summarised, showing that excess weight produces more effects than diabetes alone. Cardiovascular disease, certain types of cancer, infertility and even suicide can be attributed to excess weight.[29]

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Case 2: More green space, more activity

Discussion

More research is necessary to determine the total benefits, resulting in better health in children that spend more time in outdoor activity

Discussion

In this case the benefits associated with a lower risk of diabetes do not weigh up against the cost involved. This is partly due to the small number of patients. Even in the years in which the difference in the number of diabetes patients is the greatest, this never rises above 2 patients per year. In addition, Bos en Lommer already meets the green standard. Although it is possible that are effects above the standard, there is no evidence for this.

The directly demonstrable economic value of green space on excess weight and resulting fewer cases of diabetes is minimal. A detailed study of the extent to which other benefits arise from greater physical activity thanks to green space is recommended.

Because of the extent of positive effects gained from greater physical activity, and the demonstrated relationship that boys and girls play outside 15% more in a green living environment, the eventual positive effects of a green living environment on the costs to healthcare may turn out to be more favourable. Which is why further research is necessary.

Fig.18: Diseases and disorders associated with obesity

Diseases and disorders associated with obesity
Diabetes mellitus type 2
Cardiovascular disease
Some types of cancer (throat, pancreas, bowel, gall-bladder, breast (post-menopausal), uterine and kidney)
Gall bladder disorders
Motor system disorders (including arthritis)
Respiratory disorders (reduced lung function, sleep apnea)
Infertility
Depression
Anxiety disorders
Suicide

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Looking at The Netherlands

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Looking at The Netherlands

Total savings in healthcare and labour costs

Results of depression case transposed to the whole of the Netherlands

To determine the effects of extra green space on healthcare costs for the Netherlands as a whole we used the following principles:

The national prevalence figures from the morbidity study were combined with other national data from Statistics Netherlands, RIVM-kostenvanziekte.nl, Nationaal Kompas and a TNO study into labour costs from health absenteeism.

According to the Morbidity study, the effect of more green space on lower prevalence of disease only occurs in areas that are urbanised to a greater or lesser degree, with a total population in the Netherlands of 10.1 million people30. These effects do not occur in heavily urbanised areas and non-urban areas.

The effects on numbers of patients, healthcare costs and labour costs were calculated for each disease which the morbidity study identified as having significantly lower prevalence in areas with more green space.

The effects of comorbidity were not included in the calculations as there was insufficient insight into the extent of comorbidity between the diseases in relation to both healthcare costs and labour costs. It is not possible to carry out these calculations for all clinical pictures, as insufficient data was available. Benefits were calculated for seven diseases.

The first table shows the savings in healthcare costs. In total 10% more green space in the living environment would mean 84,000 fewer patient visits to general practitioners, resulting in a saving of more than EUR 65 million in healthcare.

The reduction in labour costs was calculated by adding the costs of absenteeism, sickness presenteeism and wastage, based on figures from the TNO study into national labour costs from health absenteeism.[15]

Ten per cent more green space in the Netherlands would result in 57,000 fewer patients among the working population, resulting in a total annual reduction in labour costs of

EUR 328 million. The total annual savings in healthcare and labour costs would amount to EUR 394 million.

Fig.19: Total savings in healthcare costs in the Netherlands

Disorder	No of fewer patients	Saving in healthcare costs (€)
Gastro-intestinal tract infections	1.770	1.031.841
Migraine	7.587	480.374
Diabetes	2.529	2.820.041
Asthma and COPD (+ respiratory tract)	27.820	11.548.806
Neck and back complaints	24.026	4.231.571
Depression (+ anxiety)	20.232	43.984.118
Coronary heart disease	506	1.340.682
Total	**84.470**	**65.437.433**

Fig.20: Total savings in labour costs in the Netherlands

Disorder	No of fewer employees	Saving in labour costs (€)
Gastro-intestinal tract infections	1.190	9.838.071
Migraine	5.101	24.431.548
Diabetes	1.700	5.569.397
Asthma and COPD (+ respiratory tract)	18.705	82.358.001
Neck and back complaints	16.154	43.251.794
Depression (+ anxiety)	13.604	161.802.074
Coronary heart disease	340	1.477.177
Total	**56.795**	**328.728.061**

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Looking at The Netherlands

Discussion and apportionment of costs

Due to comorbidity and the use of different data bases, the calculation serves only as an indication

Discussion

The categorisation according to complaint diagnosed by GP may not strictly relate to the healthcare and labour costs. For instance, a patient may be diagnosed with migraine, but treated for a different complaint. This effect, in addition to the considerable comorbidity between these diseases, means that the total costs avoided by the Netherlands serves only as an indication.

In addition to the lessons from the case studies, it is necessary that any investment in extra green space for the Netherlands should be preceded by a study into which locations would prove the most cost effective, involving little or no acquisition costs and relatively cheap creation and maintenance costs.

Apportionment of costs

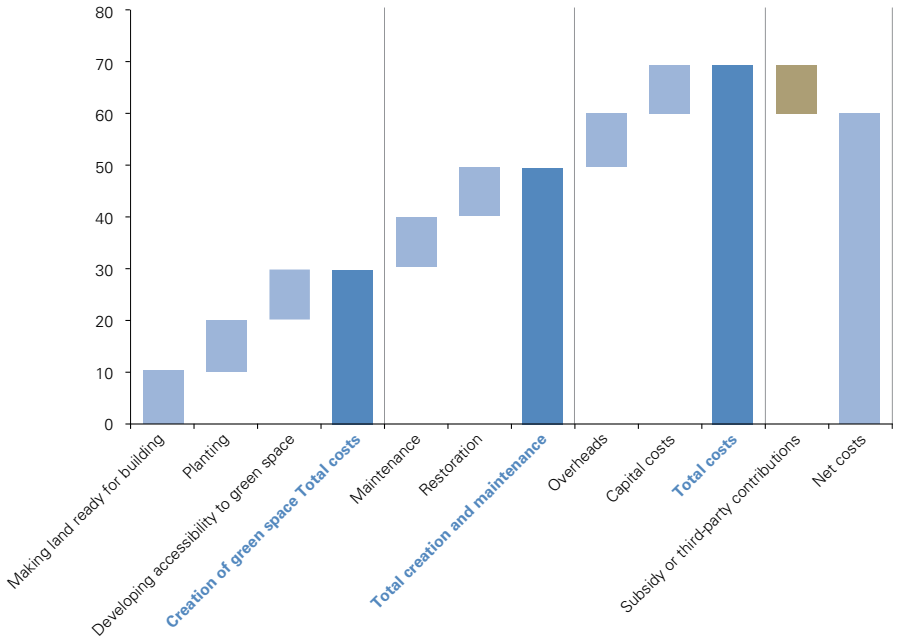
As for many issues facing society, more knowledge is required about the financial and economic value of proposed measures, and how the costs and benefits can be better distributed.

In the Bos en Lommer case, in the traditional approach all costs for the creation and maintenance of extra green space would fall almost entirely to the municipality. The benefits however would be enjoyed elsewhere, in the first place by the healthcare insurance companies and employers.

The chart below shows the different cost components for creation and maintenance of green spaces. The subsidy component and third-party contribution was not included in this study.

The business case for the municipality could be made more positive by undertaking a joint venture with the right parties and mix of public and private green spaces. Municipalities could then for instance encourage private land owners to develop more green spaces, (for instance in business parks and private gardens).

Fig.21: Possible composition of net costs for the creation and maintenance of green space



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Looking at The Netherlands

Long-term follow-up study with control groups

More research necessary into relationship between green space and health and into the specific effects of design and quality of green spaces

Opportunities for creation of extra green space through possible funding between municipalities, healthcare insurers and business

Further action

From the potentially high benefits for healthcare and labour costs shown by our calculations, it is tempting to invest immediately in extra green space in urban areas. However, this study gives a first indication of possible effects, but also contains considerable uncertainties. A follow-up study is necessary to obtain more insight into both the actual benefits and specific costs involved in creating green spaces. In addition, more insight is needed into the effects of other possible intervention apart from the creation and maintenance of green space.

There is still too much uncertainty about the correct quantity, composition, design and physical possibilities for creating green space in existing areas and the accompanying costs of extra green space to achieve a maximum cost-effectiveness impact on people's health.

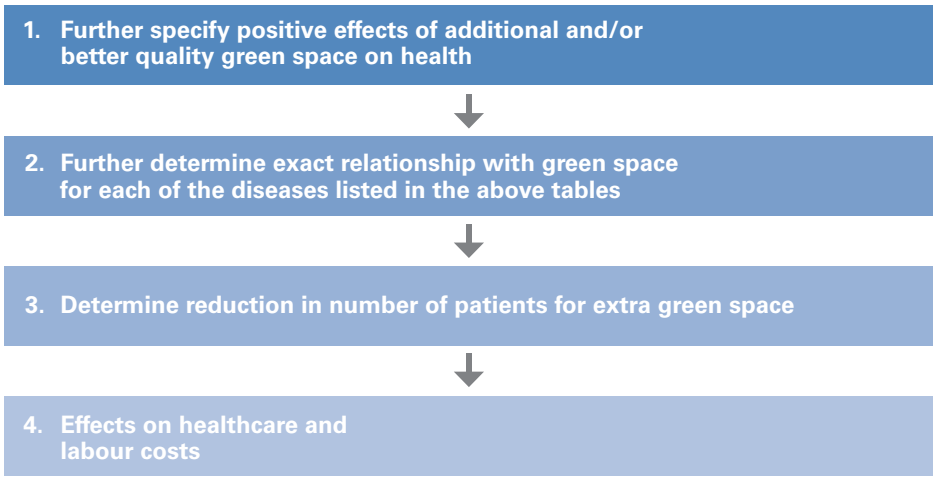
Systematic study

To identify all possible health effects of more green space and of improved design and use potential of existing green spaces, a multi-year study with control groups is needed. The proposed design of such a study, based on the sources studied for this case, is outlined in the figure below.

Research is required in two areas. On the one hand there is much uncertainty about healthcare costs and wastage due to comorbidity. More research is needed to obtain a realistic view of possible savings.

In addition, for the case on excess weight, use is made of a very indirect effect of green space on health. The challenge is to reduce the number of interim steps necessary to calculate a positive effect. In short, what is the character of the causal link between green space and health?

Fig.22: Model systematic study



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Appendix

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Appendix 1

Green, healthy and productive Relevant studies

Vitamine G-project[31]

The Vitamine G research project was carried out by Alterra Wageningen, knowledge institute for the green living environment, and NIVEL, the Netherlands institute for health services research. The study was funded by the Gamma-onderzoek Milieu, Omgeving, Natuur (GaMON) of the Netherlands Organisation for Scientific Research (NWO). For the first time, researchers from the Vitamine G research programme demonstrated, using various methods, that a green environment provides health benefits. They showed that people not only feel healthier, but are actually healthier if there is green space in their neighbourhood. This is probably because green space can reduce stress and improve social contacts. No evidence was found that greater physical activity contributed to this.

JOGG[32]

JOGG (youngsters at a healthy weight) is a local approach where parents, health professionals, businesses, schools and municipalities take action to improve the lifestyle of children. They do this by making healthy eating and physical activity attractive and accessible. The municipalities involved include Amsterdam, The Hague, Utrecht, Rotterdam, Breda and Zwolle.

'Groen Loont'[33]

This 2011 publication by Groene Stad makes a cost and benefit analysis of a green city in terms of health, the environment, safety and the increased value of land and property. Several of the study's claims refer to a total saving on care costs of EUR 1.4 billion as a result of 15% less people overweight or obese. It also claims ten per cent less use of antidepressants and ADHD medication and the greening of hospitals.

Healing environments[34]

In recent years scientific literature has given a strong indication that contact with green spaces is beneficial to the health and welfare of hospital and care-home patients and staff. In its *Ontwerpen met groen voor gezondheid,* research institute Alterra poses that having a view onto green spaces can reduce stress and ease pain and distract people from their cares about disease and death. An increasing number of institutions are transforming themselves into green healing environments.

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Appendix 2

Impression workshop green = free medicine

The draft results of this report were presented at the nature and health workshop: green = free medicine, during the 2012 Dutch Public Health congress on 12 April 2012.

Participants included doctors, researchers, mental health workers, municipalities and insurance providers. Three aspects were highlighted during the workshop:

- The influence of biodiversity and nature on health.
- An explanation of the results of the KPMG study
- Practical experiences of a general practitioner on physical activity in green space.

Main points arising from discussion:

- Jolanda Maas's study is based on correlations and does not demonstrate a causal relationship.
- This study demonstrates that green space is beneficial. Further research resulting from this study into the effects of nature on health would be welcome.
- The question is, what is more effective: making better use of existing green space or developing 10% extra green space?
- In addition to research into the effects of nature on health, greater insight is needed into the type of green space that is most beneficial.
- Involve the residents and the neighbourhood in designing green space.
- The benefits in lower care costs are as expected: new are the great benefits attached to lower workforce wastage.

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Appendix 3
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11	**Cost of diabetes for healthcare**	RIVM kostenvanziekten.nl http://kostenvanziekten.nl/kvz2005/
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22	**Handleiding Biodiversiteit Noord-Brabant**	Measures in order to support the development plan, chapter 3 financial aspects, ratio's originating from BTL Advies (2011)
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25	**Alterra (2010)**	Databank Gemeentelijk Groenbeheer
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27	**Sources for table relationship obese boys and diabetes**	Prevalence from Nationaal Kompas Relationship diabetes and obesity from CA Baan, G Bos, MAM Jacobs-van der Bruggen (2005) Modeling chronic diseases: the diabetes module
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29	**Nationaal Kompas**	(http://www.nationaalkompas.nl/gezondheidsdeterminanten/persoonsgebonden/lichaamsgewicht/wat-zijn-de-mogelijke-gezondheidsgevolgen-van-overgewicht-en-ondergewicht/)
30	**CBS**	inhabitants of urban areas (http://www.cbs.nl/nl-NL/menu/themas/bouwen-wonen/cijfers/default.htm)
31	**Het vitamine G project (Nivel)**	http://www.nivel.nl/projecten/vitamineg/
32	**Jongeren op Gezond Gewicht**	http://www.jongerenopgezondgewicht.nl/home
33	**Groen loont (De groene stad)**	www.degroenestad.nl/Media/download/6961/def_groen_loont.pdf
34	**A. Van den Berg (2006)**	Ontwerpen met groen voor gezondheid

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