



# **The Green Well-Being Triangle**

Mediating the relationship between  
green surfaces and well-being through  
neighbourhood satisfaction

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## Abstract

There is increasing evidence on the positive direct relationship between green land use surfaces and well-being. Existing research is mainly focused on neighbourhoods or cities. This paper investigates the relationship between green surfaces of municipalities and well-being of individuals through the use of a mediation model. Using land use data from 393 municipalities in the Netherlands and well-being responses from individuals in these municipalities, mediation analyses are performed. Results show a positive significant relationship between green surfaces and well-being. This relationship is statistically mediated by the level of satisfaction with the neighbourhood. Without this mediator, the relationship between green surfaces and well-being is weakened or in the case of agricultural, recreational and forest surfaces even non-existent. These analyses contribute to further understanding the relationship between green surfaces and well-being, as well as the potential factors influencing that relationship.

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## 1. Introduction

Various physical and mental health benefits are tied to surrounding oneself with nature, whether this comprises of potted office plants or lush forests. People with access to nearby nature or green areas are found to be healthier than other individuals who lack such access (Kaplan & Kaplan, 1989). Proximity to nature can even be replaced by pictures of nature. After showing participants photographs of parks, Hull and Harvey (1989) suggest that people feel different emotions in parks than in urban environments. Sheets and Manzer (1991) added trees to pictures of an urban street, causing participants to report higher levels of positive affect. Galindo and Rodriguez (2000) found that people who considered photographs of landscapes to be more pleasing also gave themselves a higher rating on their mood compared to people looking at less pleasing slides. In addition, Galindo and Rodriguez (2000), Kuo (2015) and Soga, Gaston, and Yamaura (2017), amongst others, have shown that access to a green environment has positive health benefits on illnesses such as obesity, depression and heart deficiencies. Ulrich (1984) even suggested that patients with a nature view have a faster recovery after surgery.

In this research, the relationship between private and public green surfaces and well-being of individuals is examined through the use of a mediator. Hart et al. (2018) found a positive direct correlation between residence in a green neighbourhood and well-being for five big European cities. Cloutier, Larson, and Jambeck (2014) found a positive direct association between self-reported well-being and sustainable green cities in the United States. However, for urban green environments Hadavi (2017) suggests that the relationship with well-being depends greatly on the satisfaction with the quality of it. A similar suggestion is made by Mukherjee et al. (2017), who researched the relationship between park availability and depression in India. They hypothesised that neighbourhood satisfaction could act as a mediator for that relationship. This mediation effect could not be significantly proven, in contrast to research in Belgium by Van Herzele and de Vries (2012). Using the green space monitoring tool, they compared two neighbourhoods which differed in the amount and proximity of green areas. Here, neighbourhood satisfaction provided complete mediation.

The mediation model, or mediating variables, finds its origin in psychology. Mediation analysis aims to find the fundamental processes that underlie human behaviour (MacKinnon & Fairchild, 2009). Most commonly used in the field of psychology is the mediation work by Baron and Kenny (1986), which takes a causal steps approach (MacKinnon et al., 2002). The popularity of this method is shown in the many authors using this mediation method (Nima, Archer, & Garcia, 2012; Tkach & Lyubomirsky, 2006). For the relationship between nature and well-being, the use of mediators as found in literature is relatively new. Despite this, several different mediators have been researched. Howell, Passmore, and Buro (2013) found that one's meaning in life mediated both the relationship between nature connectedness and well-being and the relationship between religiousness and well-being. Interestingly, religion or spirituality itself is a significant mediator for the relationship between nature connectedness and well-being (Kamitsis & Francis, 2013). Feeling related to nature, or nature relatedness, mediates the relationship between environmental education and changes in vitality (Nisbet, Zelenski, & Murphy, 2011). Vitality as used in their research is a central indicator of psychological well-being. Panno et al. (2017) researched the Parco Nord Milano and concluded that visiting urban green spaces is associated with a higher well-being, with ego depletion as a mediator. Ego depletion is a low mental energy,

influencing the self-regulatory resources of an individual. Spending more time in nature based recreation in general has a positive relationship with well-being. This effect is mediated by restorative experiences that are provided by nature (Korpela et al., 2014). In addition, they concluded that the duration of the visit and the amount of social company do not mediate this relationship.

Mediation analyses therefore provide varied results relying also on the study location. The purpose of the present study is to investigate the nature of the relationship between green areas and the well-being of its inhabitants by looking at possible mediators. Following White et al. (2013) and Hart et al. (2018), the current research uses land use data of green areas. Conceptually, green areas are considered at the level of the municipality and include two dimensions. The first is the amount of green areas in the municipality. The second is access to a private or shared garden. Land use data from the Netherlands is used, which is the sixth happiest country in the world according to Helliwell, Layard, and Sachs (2017). For the 122th happiest country, India, Mukherjee et al. (2017) found that neighbourhood satisfaction does not mediate the relationship between park availability and depression. In Belgium, the 17<sup>th</sup> happiest country, satisfaction with the neighbourhood does mediate the relationship between green spaces and well-being (Van Herzele & de Vries, 2012). This Belgian research used a GIS application and looked at two neighbourhoods in one Belgium city.

While the present research also uses neighbourhood satisfaction as a mediator and looks into a country similar to Belgium, this research differentiates herself by using land use data as the independent variable and by expanding the view from several neighbourhoods to all Dutch municipalities. The predication for this research is that individuals living in municipalities with a higher percentage of green surfaces indicate higher levels of well-being. In addition, the prediction is that this association is actually caused by a mediator, namely neighbourhood satisfaction. Finally, several types of green surfaces are explored in relation to well-being and satisfaction with the living environment.

The research is organized as follows. The next section presents various factors influencing well-being. The third chapter introduces the methods of analysis and the dataset. The main results are discussed in the fourth section. The fifth section gives an overview of the strengths and challenges of the research after which the sixth chapter concludes.

## 2. Theoretical framework

### 2.1. The definition of well-being

Most terms surrounding well-being are similar and are often used as each other's synonyms. However, they are in fact different words and interpretations can differ between people, backgrounds and cultures (Carlquist et al., 2017; Fave et al., 2016; Frey, 2008). For social sciences, an exact and researchable definition would be desirable, but is unfortunately not available at the moment (Carlquist et al., 2017). This also causes numerous terms to be used by various researchers, with little clarity on the exact definitions. Several terms that are currently being used in well-being research, amongst others, are quality of life, good life, life-satisfaction, happiness and well-being itself (Carlquist et al., 2017; Veenhoven, 2017).

#### 2.1.1. *Classic distinctions*

To understand these different terms, and the differences between them, two classic distinctions can be used: between objective and subjective and between hedonic and eudaimonic (McMahan & Estes, 2011).

##### 2.1.1.1. *Objective and subjective*

The first classic distinction denotes the method of assessment. Regarding quality of life, objective refers to assessment by an impartial outsider. Subjective on the other hand refers to self-appraisal, often based on implicit and personal criteria (Veenhoven, 2013). A person's own well-being is therefore a subjective measure, whereas a person's well-being is objective when another person measures it. Objective well-being can be seen in terms of the different dimensions surrounding health, development and the factors influencing these. Subjective well-being concerns the own life assessment (Axford, Jodrell, & Hobbs, 2014). It has to be said though, that this distinction does not imply that objective assessments convey absolute truth nor that subjective assessments are vague by definition. Both methods have their own worth and neither are facts nor opinions (Veenhoven, 2013).

##### 2.1.1.2. *Hedonic and eudaimonic*

The above classic distinction refers to methodology, while the following classic distinction is related to philosophy of well-being. A hedonic viewpoint puts greater importance on experiencing pleasure. The goal is to maximize the amount of pleasure, with well-being being the total of these pleasurable moments (Ong, 2009). In its simplest form, it is the number of positive emotions in relation to negative emotions (Carlquist et al., 2017).

An eudaimonic viewpoint holds that even after achieving these pleasures, a person would not necessarily achieve a high level of well-being (Ong, 2009). To achieve this, deeply held values are needed. Eudaimonic well-being is therefore the degree to which a person feels their aspirations or desires are met (Veenhoven, 2015). Ideally, this contributes to the greater good (McMahan & Estes, 2011). That makes this latter form less fleeting than counting one's pleasurable moments. Generally speaking, a hedonic viewpoint is focused on the short term, while an eudaimonic viewpoint looks at the long term (McMahan & Estes, 2011).

##### 2.1.2. *Common terms for well-being*

How do these distinctions relate to currently used terms? This section looks at five popular synonyms, namely utility, quality of life, life satisfaction, happiness and well-being itself.

#### 2.1.2.1. Utility

Where well-being is now used in psychology and economics alike, standard economics started with a focus on utility. In standard economic theory, without the interference of psychology, it is assumed that people consciously and rationally try to maximize their own utility (Frey, 2008). The term utility reflects the observable choices made by individuals (McMahan & Estes, 2011). It can be used as a synonym for well-being, where it indicates the quest for pleasure and therefore a more hedonistic approach (Axford et al., 2014).

#### 2.1.2.2. Quality of life

The definition of quality of life from the World Health Organization is “individuals’ perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns” (WHO, 1995). This closely follows the lines of subjective and eudaimonic thinking. How long and how happily an individual lives, is the most inclusive measure for quality of life according to Veenhoven (2013).

#### 2.1.2.3. Satisfaction with life

Life satisfaction is defined by Veenhoven (2015, p. 212) as “the degree to which a person evaluates the overall quality of his or her present life-as-a-whole positively”. The term indicates a self-evaluating process based on an individual’s own judgements (Diener et al., 1985). Similar to quality of life, this term loosely follows the subjective and eudaimonic line of thinking. Surveys asking about happiness prefer this terminology, often using the formulation of life-satisfaction, for example in the question “how satisfied are you with life as a whole?” (Frey, 2008).

#### 2.1.2.4. Happiness

Morris (2004) sees happiness as a fleeting sensation, where the experience of life being better than before creates an elation that is lost as quickly as it came. Morris’ definition seems more hedonic in nature. Diener (2000) proposes that the amount of time that positive affect is experienced is the key input for being happy. If more pleasant emotions are being experienced than unpleasant emotions, a person is happy. In other words, a hedonic viewpoint. A similar viewpoint is provided by Cloutier et al. (2014), who see happiness as lasting feelings of pleasure where the positive emotions outweigh the negative ones. More eudaimonic in nature is Veenhoven (2014, p. 1037) who defines happiness as “the subjective enjoyment of one’s own life as a whole”.

Happiness is here not the only criterion for, but it is the best available summarizing indicator term (Veenhoven, 2013). Currently though, many researchers seem to prefer a combination of hedonic and eudaimonic attributes when defining happiness. Lyubomirsky (2007, p. 32) for example describes in her book *The How of Happiness* the word happiness as “the experience of joy, contentment, or positive well-being, combined with a sense that one’s life is good, meaningful and worthwhile”.

#### 2.1.2.5. Well-being

Well-being itself is more an umbrella term, with several other terms being a part of it (Fave et al., 2016). When a person evaluates their own life, it is called subjective well-being (SWB). SWB consists of several components: life satisfaction, positive affect and negative affect (Diener et al., 1985). Affect, both negative and positive, is a type of emotion. Generally, good life events are correlated with positive affect whereas less good, or bad, life events correlate with negative affect (Diener, 2000). Diener (2000) argues that people experience SWB by feeling many pleasant and

only a few unpleasant emotions, by engaging in interesting activities and by being satisfied with their lives. This indicates that SWB consists of both hedonic and eudaimonic viewpoints.

#### 2.1.2.6. Well-being in this research

The above definitions they are all being used interchangeably in most publications (Carlquist et al., 2017; Fave et al., 2016). Many definitions differ based on the kind of data used. This research uses survey data, in which individuals rate their life satisfaction on a 1 to 10 scale. As their own judgement is necessary, the method is clearly subjective. A disadvantage of survey data is that it is unclear what the respondents are thinking about while responding to the question. The word life indicates life as a whole, but people could also only take into account the last five year of maybe even five months. It is therefore difficult to determine whether the respondents thought of hedonic or eudaimonic happiness. Because of this, this research deems it safer to use a definition that consists of both aspects.

## 2.2. Factors influencing well-being

With a definition of well-being in place, it is good to acknowledge that well-being is caused by several factors. A distinction is made between environmental, individual and mediating factors.

### 2.2.1. Individual factors influencing well-being

Layard (2005) gives the 'Big Seven', factors which have proven to impact well-being. These factors are income, employment, marital status, social capital, personal freedom and personal values or religion. Other possible influences of well-being found in various research are gender, age, children, education, homeownership and volunteer work. These individual factors are used as control variables in this research.

#### 2.2.1.1. Gender

Men and women are pretty much equally happy (Layard, 2005). Mroczek and Kolarz (1998) in their research also found no difference between male and female that was significant. Rather, the same patterns seem to hold for both genders. Men are more likely to become alcoholics and women are more likely to get depressed though. However, both genders are equally likely to be satisfied with their lives (Myers, 2000). Wood, Rhodes, and Whelan (1989) on the other hand found that woman are happier than men. Although this effect was small, it was significant. A reasoning behind this can be that women are more able to be emotionally responsive and experience more emotions (Diener et al., 1999). In most research however, the gender effect often reduces to nothing, especially when taking other factors into consideration. That leads to the belief that gender is not of great importance when explaining well-being (Dolan, Peasgood, & White, 2008).

#### 2.2.1.2. Age

Well-being is quite stable in a human's life, with several ups and downs but overall not very dependent on a person's age (Layard, 2005). Some studies argue that age does matter and show that well-being reaches the lowest point in middle age, after which it starts to increase again. A study by Blanchflower and Oswald (2008) shows happiness as curvilinear, adopting a U-shape. Specifically for Europeans, they found that well-being minimizes around the mid-40s.

An explanation for this U-shape, and in particular the well-being of the elderly, is difficult. Despite a popular view of people of old age being sad and characterized by loss, evidence points to people becoming happier when becoming older (Carstensen et al., 2011). Explanations for this

can be adaptation to life and the corresponding process of learning from experiences, rewards and punishments. Likewise, people compare themselves to others and in later age learn to count their blessings compared to other people who may have been less fortunate (Blanchflower & Oswald, 2008). In addition, the elderly have invested in meaningful activities causing them to experience emotionally rich moments. They also respond less to daily events compared to younger people, causing them to have a relatively stable emotional response regardless of the event (Carstensen et al., 2011). Other research confirms the evidence on the U-shape and the well-being of older people (Dolan et al., 2008; Frey & Stutzer, 2000; Gerdtham & Johannesson, 2001).

#### 2.2.1.3. Marital status

In general, it seems that single people experience a lower level of well-being than people in a partnership. Being married therefore leads to the highest level of well-being, while getting separated again causes the lowest level (Dolan et al., 2008). The moment of marriage provides a peak in well-being, with an increase the years before and a slow decrease after the marriage. Despite this decrease, people remain happier after marriage than they were four years before their marriage (Layard, 2005). The decision to break up and dissolve a failing marriage, in other words divorcing, decreases well-being in the short run. Over time, well-being rises again and is able to stabilize on a level that was higher than during marriage (Gardner & Oswald, 2006).

Whether cohabitating leads to a similar increase in well-being as marriage does, depends strongly on the stability of the bond. According to Helliwell and Putnam (Helliwell & Putnam, 2004), the effect of being married is stronger than cohabitation. Dolan (Dolan et al., 2008) however found that if people expect to stay together in the long term, the well-being levels are comparable with that of married people.

The idea behind the positive effects of marriage or cohabitation on well-being are based on the exchange of love and comfort. Connected to this is the activity ranking the highest on the well-being scale: sex (Layard, 2005). Couples experience more and a better quality of this act. Sex makes people more satisfied with their life, but people also report a higher life satisfaction if the number of sexual partners in the previous year is one. This indicates a steady partner, which provides both social connection and regular sex (Blanchflower & Oswald, 2004).

#### 2.2.1.4. Children

Children provide new parents with positive and negative novelties. These can be deepened social ties and a greater feeling of adulthood. At the same time, an increase of housework occurs as well as a strain on the relationship between the parents (Margolis & Myrskylä, 2011). Whether having children makes a person more happy, is therefore not always easy to say. It depends on the household, as Frey and Stutzer (2000) found that couples without children experience higher levels of well-being than people who are single, a single parent or living in a collective household. Depending on a person's philosophy, a child could increase someone's well-being significantly. People who see children as good for the society are more inclined to report higher levels of well-being when having children of their own than people with different views. This is also dependent on the society and the culture (Cranney, 2017).

Time also influences the well-being level surrounding children. In general, having a child leads to a spike in well-being, which lasts for approximately two years before the parents return to their initial level of well-being (Layard, 2005). At the same time, new parents experience higher distress than their childless counterparts. Young children provide for the biggest financial and emotional



costs, which can explain this (Margolis & Myrskylä, 2011). The effect of having children on self-reported well-being might therefore be small, as the various smaller effects might cancel each other out.

#### 2.2.1.5. Income

Up to a point, money can buy a higher level of well-being. Higher income makes people more satisfied on the short term, but over an entire life cycle, well-being takes on an average value with little variation (Frey, 2008). The extremely impoverished can buy well-being with money, as being able to gather the basic needs such as food and shelter will improve subject well-being. After these basic needs are met, an increase in income has less effect (E. Diener et al., 1999).

Research by Gardner and Oswald (2007) shows that people who experience a sudden increase in income without performing the work, such as winning the lottery, do report higher levels of well-being in the short term. People get used to this new status though. An increase of income induces well-being, but after a certain amount of time, this newness wears off, leaving the individual at the same level as before – although with a higher income. This phenomenon is called adaptation (E. Diener et al., 1999). To correct for these effects a natural log of income is normally used in well-being research, seen in Gardner and Oswald (2007), Frey, Luechinger, and Stutzer (2009) and Lucas et al. (2004), amongst others. With this log of income, it is expected that a positive relationship exists between income and well-being.

#### 2.2.1.6. Education

Layard (2005) shows a small effect of education on well-being. This is primarily because education works indirectly, as a higher education impacts a person's employment, income and social status, which all influence well-being (Kim, 2018). The study by Hartog and Oosterbeek (1998) on Dutch adults shows that a higher level of education does not produce the highest well-being. A reasoning why higher education doesn't make people more satisfied with life is that those people are more ambitious, causing higher aspirations which are difficult to attain thus causing a lower level of well-being. A new theory is that people are willing to trade well-being in order to get upward in life, or that they complete education to get a higher social status (Nikolaev, 2016).

Other research does find a connection between education and well-being. Frey and Stutzer (2000) argue that people with a higher education also report higher levels of well-being. Gerdtham and Johannesson (2001) show that people finishing university report significantly higher levels of life satisfaction than people who have finished a lower education degree. Another study, using longitudinal data with three measures of well-being, discovered that people with a higher education are more prone to reporting higher levels of well-being. This positive effect is increasing, although at a decreasing pace (Nikolaev, 2016). An explanation can be that education provides people with more extensive social networks and a bigger involvement with the world, this leads to a higher level of well-being (Chen, 2012). Education is obviously closely linked to other factors, such as personality traits, income and health. This makes education an indirect effect, but one that can still be useful to explain well-being to a smaller extent (Dolan et al., 2008).

#### 2.2.1.7. Employment

Although income and employment are linked, simply the fact of being employed has a positive influence on well-being. It provides people with a feeling of contributing to society, leading to a meaning to life (Layard, 2005). In contrast, unemployment has a negative effect on well-being. Although people in general adapt pretty quickly to new circumstances, most people never return

to their initial levels of well-being after the unemployment period. Rather, the negative impact of unemployment keeps influencing an individual's well-being level (Dolan et al., 2008). Unemployment reduces self-respect and social work relationships, consequentially reducing well-being (Layard, 2005). Employment is therefore expected to have a significant effect on well-being.

#### 2.2.1.8. Personal values

Regarding a philosophy of life, religion is a strong method to find comfort in life events. Research shows that, on average, religious people report higher subjective well-being, indicating some sort of link (Abdel-Khalek, 2006; Hackney & Sanders, 2003; Layard, 2005; Tkach & Lyubomirsky, 2006). Explanations for this can be that faith enables and increases social support. During negative events, this and hope are especially important. Religion provides hope, a sense of meaning and purpose, enabling people to report more joy in the wake after the event (Myers, 2000; Tkach & Lyubomirsky, 2006). Also, being religious generally leads to a healthy life style with, on average, less smoking and drinking. This healthy life style can, in turn, make people happier as well (Myers, 2000).

Stavrova, Fetchenhauer, and Schlösser (2013) suggest that while religious people report higher levels of well-being, this effect is higher in religious countries where negative attitude towards non-religious people are dominant. This is because religious people get a higher level of social recognition. Dolan et al. (2008) add to this, mentioning that the strength of the causality differs from country to country.

#### 2.2.1.9. Personal freedom

In the Netherlands personal freedom and peace are taken for granted, just as in other countries in the West. Looking at other countries, it shows that this element of personal freedom is important in feeling happy. In countries where there is violence, instability, corruption and inefficiency of the system, people report lower levels of self-reported well-being (Layard, 2005). Frey and Stutzer (2000) argue that direct democracy has a positive effect on well-being. Simply having more possibilities to participate in the political process makes people happier. This is seen in countries where differences in levels of democracy exist. Such as in Switzerland where in some canton regions citizens have more rights to demand referendums. The people there report a higher level of well-being (Layard, 2005). In countries where such differences within the nation do not exist, such as the Netherlands, it seems difficult to measure and control for this effect of freedom.

#### 2.2.1.10. Homeownership

Housing in itself provides many factors possibly contributing to well-being: a platform to interact with others, a safeguard for the future and feelings of freedom, independence, pride, security and privacy (E. A. Morris, 2018). Owning one's housing seems to add another layer to this. Guven and Sørensen (2012) show that ownership of a house and well-being are positively correlated for residents in the United States. Ruprah (2010) found the same result for Latin-America. Closer to the Netherlands, in Germany, Zumbro (2012) found that a significant relationship exists between homeownership and life satisfaction.

Owning a home could be an indication of a higher level of wealth, especially when compared to the alternative of renting a home (MacKerron & Mourato, 2009). Another explanation for the higher level of well-being can be the improvement of self-esteem, as the purchase of a house is seen as an important life goal, or a sign of adulthood, for most people (Rohe, Van Zandt, &



McCarthy, 2013). Purchasing a house also causes the belief that a person is in command of his or her own life, with a renewed sense of autonomy. After all, he or she can make decisions regarding the house individually, without having to be subject to a landlord (Ruprah, 2010). However, this also means that homeowners are fully responsible for repairs and maintenance of the house. Owning a home also decreases flexibility, causing people to be tied to a location, even when house prices drop or job opportunities are dwindling (Ruprah, 2010). It is expected that the gains surpass the losses in this respect and that owning a home has a positive relationship with well-being.

#### 2.2.1.11. Social capital

Social determinants are often seen as critical for well-being. A big part of this is trust, where people have the feeling they can trust their friends, family, neighbours and the rest of their social capital (Layard, 2005). Social capital, in essence an intangible concept, has been defined by Rodríguez-Pose and Von Berlepsch (2014) as including trust, norms, sanctions, informal and formal information channels. A person's social capital is therefore the total of social networks and corresponding feelings he has.

Social capital in general is strongly correlated with well-being, although different networks have different strengths in the correlation with well-being (Helliwell & Putnam, 2004). Helliwell and Putnam (2004) found that frequent interaction with friends is more important than with family and neighbours. Contact with family is slightly more important than with neighbours though. Sandstrom and Dunn (2014) found that even weak ties contribute in a positive way to well-being. These weak ties are the social interactions with people on the skirts of somebody's social networks, for example the informal banter with the cashier in the supermarket or the quick chat with the person always walking his dog in your neighbourhood. These small interactions provide information across different networks and brighten up a person's day.

It appears it doesn't matter who we socialize with: as long as they are acquaintances or more (Sandstrom & Dunn, 2014). Only socializing with the boss is regarded as even less well-being inducing than spending time alone (Layard, 2005). As a person's social capital is, in a certain manner, dependent on his or her own feelings about the networks he or she is in, it seems that a subjective measure for social contact can already show a positive relationship with well-being.

#### 2.2.1.12. Volunteer work

Volunteering differs from paid employment by being, first of all, unpaid and second, by focusing in most cases on bettering the community (Thoits & Hewitt, 2001). Volunteer work is not only performing unpaid services to others in need, but also activism in politics or in boards of communities. The majority of the research investigates formal volunteering, which is in or for the community. This type of volunteering seems to enhance well-being. At the same time, people who have higher levels of well-being invest more time in volunteering (Thoits & Hewitt, 2001). This effect is even stronger when looking at religious volunteering. While religious volunteering has a greater effect, all volunteering makes an impact on well-being (Borgonovi, 2008).

Evidence gathered by Dolan et al. (2008) shows no relationship between volunteering and well-being. They found that for older people, volunteering does provide a sense of meaning, but does not significantly increase well-being. Musick and Wilson (2003) found that in regard to tackling depression, mainly the elderly benefit from volunteering. For other age groups, the effect is not significant. Especially with volunteering, the matter of causality is hard to define. It can also

be that people with higher well-being volunteer more often and it is therefore questionable whether volunteering in itself increases well-being. As most research agrees that volunteering increases a sense of meaning, it might have a positive relationship with well-being as well.

### 2.2.2. Environmental factors

A relevant factor associated with well-being is the environment. This varies from the location itself, the urbanity but also the quantity of green surfaces. The impact of green is divided in two factors in this research: green surfaces and access to gardens.

#### 2.2.2.1. Nature

Research on nature and well-being widely shows the existence of a positive and significant effect of interacting with, living nearby or looking at nature. McFarland (2017) found that workers in offices with windows or real plants have a more positive view of their work, their job and their quality of life. Another finding from an 8-week intervention study amongst office workers showed that self-reported emotional health improved in the lunchtime nature walking group, but not in the built environment walking or control group (Brown et al., 2014). Access to walkable green spaces positively influenced the longevity of urban senior citizens' lives in Tokyo (Takano, Nakamura, & Watanabe, 2002).

Specific for cities are the rapidly occurring heat stress episodes. Green areas can alleviate these, significantly improving the well-being of the visitors (Lafortezza et al., 2009). In addition, green urban areas have the potential of mitigating air pollution, although this performance depends greatly on the proportion of vegetation cover (Whitford, Ennos, & Handley, 2001). The presence of trees and other vegetation can also positively influence the amount of biodiversity. In turn, rich biodiversity affects self-reported well-being in natural urban and peri-urban areas (Carrus et al., 2015).

Despite the various significant results, not every neighbourhood, city or country benefits from green areas. Saw, Lim, and Carrasco (2015) for example found no significant relationship between green space or the proximity to green spaces and well-being. The existing relationships were positive, but not significant. This contradicts the other studies. On the other hand, Saw's study takes place in Singapore whereas most of the previous studies took place in Europe. Those regions more often than not have a temperate climate, while Singapore has a tropical climate. As green spaces can help to feel cooler than in urban spaces, people in Europe might have a more positive view towards green than people in Singapore, where people mainly rely on indoor air-conditioning (Saw et al., 2015).

#### 2.2.2.2. Gardens

Another potential 'green' variable is access to a private garden. This provides an additional nearby green space as well as the opportunity to interact directly with nature. Gardening reduces stress, lowers obesity rates and can have a positive impact on heart diseases (Soga et al., 2017). In addition, gardening can lead to a sense of accomplishment, as owning a garden and consequently gardening in it provides a commitment with the outdoor environment instead of just a casual experience (Kaplan, 1973). Indirectly, gardening can encourage people to start physical exercise, which contributes to health improvements (Soga et al., 2017).

Access to a shared garden adds the social element to these benefits, as this enables people to participate in gardening in a social environment (Kaplan, 1973). Common or shared gardens are

mainly designed for this purpose as well (Kullberg, 2016). Access to a garden in this way improves not only physical health but also psychological and social health (Soga et al., 2017).

#### 2.2.2.3. Urbanity of municipality

Big cities have countless benefits: from agglomeration advantages for production and employment, to more consumer choices. On the other hand, cities are more expensive and are the breeding place for crime, traffic congestion, pollution, social isolation and diseases (Hoogerbrugge & Burger, 2017). Research shows that for the European capitals, people report significantly lower levels of well-being than people living outside of that capital (Piper, 2015). Big cities more often than not have a disproportional high amount of poor, homeless, migrants and singles, all of which are, on average, less satisfied with their lives (Hoogerbrugge & Burger, 2017).

For Europe as a whole, research finds a negative correlation between living in a capital and well-being. However, it can still be that less satisfied people venture to capital cities, rather than capital cities making people less satisfied with their lives (Piper, 2015). They are unsatisfied with the possibilities in the place they used to live and decide to try their luck in a new location. This causes a big city to have more people who report lower levels of well-being than for example a village in the countryside (Hoogerbrugge & Burger, 2017). This is also shown in the Netherlands, where municipalities in rural areas are reported to have the happiest inhabitants while bigger cities score lower on this factor (Marlet & Van Woerkens, 2017).

#### 2.2.3. Mediating factors

##### 2.2.3.1. Satisfaction with the neighbourhood

Sirgy and Cornwell (2002) proposed that neighbourhood satisfaction consists of social, economic and physical features. This last category, consisting of the landscape, crowding, noise, proximity of facilities, upkeep of homes and gardens and the quality of the environment, most closely resembles the focus of green areas in this research. The physical features of a neighbourhood influence well-being significantly, but the greatest impact is made when all three features are used to measure neighbourhood satisfaction (Russ-Eft, 1979; Sirgy & Cornwell, 2002).

Satisfaction with the neighbourhood itself can be predicted with physical green measures as well. Ellis, Lee, and Kweon (2006) suggested that nearby trees are an important factor for neighbourhood satisfaction. Hur, Nasar, and Chun (2010) found vegetation rate to be an indirect predictor of neighbourhood satisfaction and a direct predictor of satisfaction with presence of trees. Lovejoy, Handy, and Mokhtarian (2010) found yards and big trees to have no significant contribution though. Simply being able to view natural elements from a window also contributes to neighbourhood satisfaction (Kaplan, 2001). Zhang et al. (2017) found that access to and use of green spaces is significantly and positively related to neighbourhood satisfaction in Groningen. In addition, they found that this satisfaction is higher when residents perceive these green spaces as high in quality, therefore indirectly influencing well-being.

Other research on determinants of neighbourhood satisfaction suggests that population density significantly and negatively predicts satisfaction with the neighbourhood (Lee & Guest, 1983). Howley, Scott, and Redmond (2009) proposed that this factor in itself is not the source of dissatisfaction, but rather other factors related with high density such as noise, lack of safety, traffic and lack of community. Highly correlated with neighbourhood satisfaction is satisfaction with other attributes, such as with schools, public services, community involvement and perceived safety (Lovejoy et al., 2010; Permentier, Bolt, & van Ham, 2011). It is acknowledged in

most research that neighbourhood satisfaction is caused by a diverse array of factors, depending on the location and the personal preferences of the population living there (Hur & Morrow-Jones, 2008).

#### 2.2.3.2. Health

Good health, subjectively measured, positively influences well-being according to Gerdtham and Johannesson (2001) in their research on the relationship between several socio-economic values and well-being. Bad health on the other hand has negative influence on well-being, as it might be interfering with a person's capability to reach his or her goals (E. Diener et al., 1999). As people are remarkably capable of overcoming physical limitations, a health score doesn't always reflect the actual health. Subjective health relies heavily on personality and comparison with others (E. Diener et al., 1999). However, chronic pain or a mental illness are more difficult to overcome and will influence well-being more significantly (Dolan et al., 2008; Layard, 2005).

### 3. Methodology

Existing literature shows increasing evidence of a relationship between green surfaces and well-being. Various research has looked into the potential of mediators to influence this relationship, using satisfaction with the neighbourhood, satisfaction with the quality of green, relatedness to nature and spirituality (Hadavi, 2017; Kamitsis & Francis, 2013; Nisbet et al., 2011; Van Herzele & de Vries, 2012).

This research differentiates herself from this existing research by using land use data as an indicator for green surfaces. In addition, this country uses the entire country of the Netherlands as a case study, whereas most research looks at a specific neighbourhood or a city. Other research using land use data often compares even bigger areas, such as various countries within Europe (Hart et al., 2018). This chapter outlines the used analyses and data for the research.

#### 3.1. Analyses

Statistical analyses were performed using Stata 10 Intercooled (StataCorp, 2007) and SPSS version 23. Well-being is in all cases the dependent variable. To estimate the initial associations between this dependent variable and the other variables, an ordinary least squares (OLS) regression was performed in stages. In model 1, the individual-level control variables and access to gardens was used. Model 2 added the green surfaces to this and model 3 added the area-level variables. Well-being was measured through the WoON2015 surveys at the individual level while the green surfaces were measured on the level of the municipality. The OLS regression was run in Stata 10 Intercooled, where the command *robust* was added to account for this difference in measuring level.

##### 3.1.1. Mediation model

Mediation analyses were carried out using the SPSS PROCESS macro (Hayes, 2017) with a 95% confidence interval based on 1,000 bootstrap samples. The accuracy of the mediation effect was evaluated with the traditional method suggested by Baron and Kenny (1986). If the confidence interval does not contain zero, the indirect effect can be considered statistically significant (Tan, Krishnan, & Lee, 2017).

Multiple mediation models were analysed. Figure 1 shows the basic model for the mediation analysis with well-being as the dependent variable, surface as the independent variable and satisfaction with the living environment as the mediator. In this figure, path c captures the total effect of and surface on well-being. Path a shows the effect of land use surface on satisfaction with the living environment, while path b shows the effect of satisfaction with the living environment on well-being. Path c' captures the direct effect of land use surface on well-being. This last path is calculated by controlling for path b. The mediated effect then works through paths a and b together (Oshio, 2017).

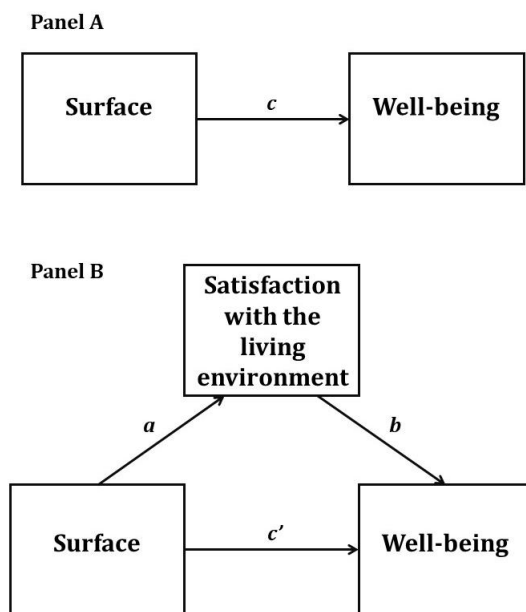


Figure 1. Mediation model, adapted from Preacher and Hayes (2004)

This mediated effect can also be denoted as  $a*b$ , or  $ab$  for short. The relationship between the pasts is denoted by  $c'+ab=c$ . The significance of the mediating effect is tested by calculating the 95% confidence interval through bootstrapping. The proportion of the mediated effect in the total effect is calculated by  $ab/c$  (Oshio, 2017). These results were inspected with the following four ordered steps (Baron & Kenny, 1986).

1. X should predict Y (c-path should be significant)
2. X should predict M (a-path should be significant)
3. M should predict Y (b-path should be significant)
4. X should no longer predict Y, or is lessened in predicting Y (c'-path should not be significant and c-path should exceed c'-path)

For each of the seven land use surfaces individually, the mediation model was performed with first satisfaction with the living environment as a mediator and second with health as a mediator. This same approach was taken for access to a garden, which the distinction between shared and private gardens. Finally, these analyses were repeated with satisfaction with the region as a mediator to calculate the sensitivity.

## 3.2. Data

### 3.2.1. Well-being index

Well-being data originates from the well-being question in the WoON2015 (BZK/CBS), a grand scale survey executed in 2014 and 2015 and commissioned by the Dutch Ministry of Home Affairs. A sample of households received a survey on living habits, housing and the living area. This research used data on the municipality level. In total, 62.668 respondents answered this by giving a score between 1 and 10 for their satisfaction with life.

Related to well-being is the satisfaction with the neighbourhood, which is used as a mediator. A question on satisfaction with the living environment was used for this, answerable on a 5-point scale, ranging from completely unsatisfied to very satisfied (BZK/CBS). Zhang et al. (2017) used a similar survey question to measure neighbourhood satisfaction in their research. Again, 62.668 respondents answered this question.

### 3.2.2. Green surfaces

The Dutch Central Bureau for Statistics (CBS) provided information on land use per municipality. The land use is divided in several categories, namely transport, built-up area, semi built-up area, recreation, agriculture, woodland and nature, inland water and tidal water. Following Annerstedt Van Den Bosch et al. (2016) green surfaces in this research are defined as land that is covered, either partly or completely, with vegetation. Specific numbers on the level of coverage for the Netherlands were not known, therefore land uses that are commonly known to be covered with

vegetation were included for the current research. The definition of green space can also easily differ per culture or region (White et al., 2013). As this research took place solely in the Netherlands, this risk was deemed insignificant. This reasoning led to the inclusion of six types of land use out of the CBS categories. The land uses and the corresponding examples can be found in table 1.

For all six of the land usages in table 1 it can be argued that these locations have additional attributes, in terms of providing leisure, social connectedness or food. However, as this research was primarily interested in investigating the effect of green surface on well-being, these points were left out of the main analysis. Water, both inland and tidal, were excluded. It can be argued that water, also called blue surface, is also nature and should therefore be included. However, the positive health benefits are smaller and following Annerstedt Van Den Bosch et al. (2016), it was not included in this research.

Including specifically urban green spaces, such as street trees, proved difficult for this study and is therefore excluded. Included in the model is a variable denoting the urbanity of the neighbourhood, which can give some insight into the amount of green in the specific neighbourhood. The CBS gives the land use in hectare, which is an absolute number. For this research, these absolute numbers were recalculated into relative ones. The green surfaces therefore became a percentage of the total surface of the municipality. The model used these six land uses, as well as a seventh variable namely total green surface, which is the sum of the six. The land uses per municipality were connected to the corresponding individuals through the municipality code, which was also found in the WoON2015.



*Table 1. Green land usages in the model*

Variable name	CBS category	Land use	Examples of land use
Park surface (%)	Recreation	Park and public garden	Locations classified as parks, lawns, playing fields, sunbathing fields, shrubs, water ponds, flowerbeds and greenbelts.
Sport surface (%)	Recreation	Sport grounds	Land used for sport fields, swimming pools, sports halls, motor cross areas, associated parking areas, and forests if those are part of the sports area. While swimming pools and sport halls provide little green surface, sport fields do. For this reason the variable is included in the model.
Community garden surface (%)	Recreation	Allotment garden	Locations in use for non-commercial cultivation, such as allotment gardens, school gardens and the associated parking.
Recreational surface (%)	Recreation	Holiday recreation	Locations that are used for long term recreation, such as campsites for both camping and caravan, holiday parks, youth hostels and areas with recreational houses. These locations typically provide a lot of green surface, with the exception of the youth hostel.
Agricultural surface (%)	Agriculture	Other agricultural usage	Greenhouses are excluded from this variable. Agriculture in this model encompasses pastures, fields and orchards. A lot of the land is therefore grassland.
Forest surface (%)	Woodland and nature	Woodland and nature total	Locations classified as woodland or other nature areas.
Green surface (%)	-	-	Sum of the six land use surfaces specified above.

*Categories, land use and examples retrieved from CBS (2017)*

### 3.2.3. Gardens

Information on possession of or access to gardens was found in the WoON2015. Two questions were available on possession or access to a garden:

- Does your housing have a private garden, patio or court yard?
- Does your housing have a shared garden?

If respondents answered the first question with garden, it was counted as possession of a private garden. If respondents answered the second question with yes, it was counted as access to a shared garden. If both dummy variables are answered with no, the respondent does not have possession of or access to a garden.

The term shared garden is used in this research to indicate a garden nearby or surrounded by housing which is shared by the inhabitants of those buildings. It is therefore not to be confused with community gardens, which indicate shared gardens for the purpose of socializing or growing vegetables and which can be visited by various people, independent of their living location.

### 3.2.4. Individual-level attributes

Table 2 shows additional individual-level attributes, their origin and the expected impact on well-being. Explanations as to why that specific variable was chosen in this research are given below.



Employment, religion, participation in volunteer work, gender and homeownership are all included in the WoON2015 and were used in this research as dummy variables. This was also the case for whether the respondent has children, something they have also mentioned in their responses in the WoON2015. For marriage, this research looked at whether a person indicated that he or she has a partner. Whether this is by marriage, cohabitation or other is not specified in the WoON2015. The final dummy was the higher education dummy, which indicates whether a respondent has completed a high level of education, in the Netherlands either hbo or wo. A variable for personal freedom was not included in this research as all respondents lived in the Netherlands and the amount of personal freedom was expected to be equal over all respondents.

In the WoON2015, access to social capital was ranked by each respondent on a scale from 1 to 5, ranging from not satisfied at all to very satisfied. The values 4 and 5 were used to indicate a high, or good, level of social capital. The other values indicated a low level. A similar approach was taken for health, where in the WoON2015 each respondent rated his or her health on a scale from 1 to 5, from very bad to very good. The values 4 and 5 were seen as good health in this research, while the rest corresponded to bad health. Psychological, or mental, health was not measured in the WoON2015 and was therefore not added to this model.

Age is given both as the age and as a square of the age. No measures on individual income were available for the respondents, but household income was considered to be the next best thing. Specifically, spendable household income from the WoON2015 was chosen to give the best estimate of how much money a person is accustomed to receiving and consequently spending. To be able to take the log, only nonnegative spendable household incomes were taken into consideration.

*Table 2. Control variables in the model*

Variable	Type of factor	Scale	Expected effect
Gender <sup>a</sup>	Gender	1=male, 2=female	+/-
Age	Age	Continuous	0
Age (square)	Age	Continuous	0
Partner <sup>a</sup>	Marital status	0=no, 1=yes	++
Child <sup>a</sup>	Child	0=no, 1=yes	+
Health <sup>a</sup>	Health	0=bad, 1=good	+
Income (log)	Income	Continuous	++
Higher education <sup>a</sup>	Education	0=no, 1=yes	0
Work <sup>a</sup>	Employment	0=no, 1=yes	++
Religion <sup>a</sup>	Personal values	0=no, 1=yes	+
-	Personal freedom	-	none
Homeownership <sup>a</sup>	Homeowner or renting	0=rent, 1=own	
Satisfaction with social capital <sup>a</sup>	Social capital	0=no, 1=yes	+
Volunteer work <sup>a</sup>	Volunteer work	0=no, 1=yes	+
Population density	Urbanity of municipality	Continuous	-
Province	Location		0
Center village (living environment) <sup>a</sup>	Type of neighbourhood	0=no, 1=yes	+
Green urban (living environment) <sup>a</sup>	Type of neighbourhood	0=no, 1=yes	+
Outside center (living environment) <sup>a</sup>	Type of neighbourhood	0=no, 1=yes	-
Center urban (living environment) <sup>a</sup>	Type of neighbourhood	0=no, 1=yes	-
Year WoON2015 <sup>a</sup>	Year	0=2014, 1=2015	0

a. Binary, other variables are continuous

*All control variables are from the WoON2015 (BZK 2016), except for PopDen which was calculated with municipality surfaces and population from the CBS (2017).*

*0=no effect, -= negative effect, +/-can be both, +=positive effect, ++=very positive effect*

### 3.2.5. Area-level attributes

In addition to the above traditionally used covariates, this research also used area-level attributes which indicated key demographic and socioeconomic conditions, such as population density and urbanity.

Population density was calculated by dividing the total population per municipality by the surface of that municipality. The population and surface numbers were gathered from the CBS (2017). Another measure for the urbanity of the municipality was found in the WoON2015, which asked the respondents in what kind of living environment they live. This led to the creation of dummy variables to indicate whether this is a rural, center-village, green urban, outside center or center urban area. Apart from the urbanity, simply the province itself might also have an influence on well-being, or can account for some differences. To correct for these, I also included the twelve different provinces. Finally, differences in the year the WoON2015 survey was taken might be the cause of some differences in well-being. Although named the WoON2015 survey, these questionnaires were processed in both 2014 and 2015.

### 3.2.6. Descriptive statistics

Table 3 summarizes the above and shows the means and standard deviation of these variables. Normality of the variables was assumed if the absolute values of skewness and kurtosis did not exceed two and seven, following Kim (2018). Dummy variables cannot be tested for normality due to the binary nature. At first glance the dummy variable of satisfaction with social capital seemed negatively skewed. The underlying original data shows that this was not an extreme case though. Probably, people are reasonably satisfied with their social capital, causing more people to respond with a high level of satisfaction. This can also be seen for well-being, which is negatively skewed as well, but within the allowable boundaries.

Surfaces of community gardens seemed skewed to the right, implying that a majority of the values are below the mean. This was also the case for recreational and forest surfaces. These surfaces accounted for small percentages of the total land surface, with a few municipalities being outliers.

For gardens, 38.863 of the 55.095 respondents indicated that they have access to a private garden. That is 70.5%, which was roughly the same as the percentage of houses in the Netherlands having a private garden according to Kullberg (2016).

*Table 3. Descriptive analysis of model variables*

	N	Mean	Std. Deviation	Skewness	Kurtosis
Well-being	62668	7.75	1.036	-1.110	4.607
Satisfaction with current living environment	62668	4.06	0.830	-1.074	1.665
Satisfaction with the region	62668	4.16	0.667	-0.781	1.964
Garden (shared) <sup>a</sup>	55095	0.08	0.277	3.006	7.038
Garden (private) <sup>a</sup>	55095	0.71	0.456	-0.901	-1.188
Total green surface (%)	62355	54.92	22.892	-0.056	-1.230
Park surface (%)	62355	2.82	3.044	1.570	3.149
Sport surface (%)	62355	2.10	1.603	1.007	0.998
Community garden surface (%)	62355	0.33	0.448	2.360	6.577
Recreational surface (%)	62355	0.42	0.493	2.006	5.412
Agricultural surface (%)	62355	38.90	24.433	0.172	-1.291
Forest surface (%)	62355	10.36	11.667	2.003	4.133
Gender <sup>a</sup>	62668	0.47	0.499	0.103	-1.989
Age	62668	49.12	18.872	0.082	-0.973
Age (square)	62668	2768.86	1917.000	0.671	-0.300
Partner <sup>a</sup>	62668	0.52	0.500	-0.074	-1.995
Child <sup>a</sup>	62668	0.28	0.451	0.955	-1.087
Health (ordinal)	62668	3.79	1.079	-1.613	3.321
Health <sup>a</sup>	60445	0.78	0.413	-1.365	-0.138
Income (log)	62458	4.51	0.272	-0.834	4.574
Higher education <sup>a</sup>	61578	0.31	0.463	0.810	-1.344
Work <sup>a</sup>	62668	0.59	0.492	-0.371	-1.862
Religion <sup>a</sup>	62668	0.49	0.500	0.022	-2.000

(table continues on the next page)

	N	Mean	Std. Deviation	Skewness	Kurtosis
Homeownership <sup>a</sup>	55225	0.62	0.486	-0.477	-1.772
Satisfaction with social capital (ordinal)	62411	4.27	0.670	-0.799	1.348
Satisfaction with social capital <sup>a</sup>	62411	0.91	0.285	-2.880	6.293
Volunteer work <sup>a</sup>	62668	0.38	0.486	0.477	-1.773
Province	62668	7.97	2.653	-0.719	-0.010
Population Density	62385	1462.81	1417.645	1.073	0.166
G4 (big 4 municipalities) <sup>a</sup>	62668	0.12	0.330	2.278	3.188
Center village (living environment) <sup>a</sup>	62668	0.39	0.489	0.434	-1.812
Green urban (living environment) <sup>a</sup>	62668	0.11	0.317	2.446	3.982
Outside center (living environment) <sup>a</sup>	62668	0.32	0.467	0.770	-1.408
Center urban (living environment) <sup>a</sup>	62668	0.11	0.312	2.507	4.284
Valid N (listwise)	51286				

a. Binary, other variables are continuous  
Corrected for the WoON2015 survey year.

## 4. Results

### 4.1. Multilevel regression

First, to test whether the results conform to previous well-being research, a linear regression was performed containing the socio demographic individual variables. These were: income (log), age, age (square), work, volunteer work, higher education, partner, children, satisfaction with social capital, health, gender, homeownership and the year the WoON2015 survey was held. The majority of these attributes showed an association with well-being that corresponds with existing literature on this topic.

Second, a hierarchical regression was performed to indicate the effect of the various green variables. Model 1 in table 3 shows the association between access to a garden and well-being, controlled for the individual-level variables. Consistent with the predictions, residents with access to a garden report significantly higher values of well-being. This effect is stronger for access to a private garden ( $p < 0.001$ ) in comparison to a shared garden ( $p < 0.1$ ).

Consistent with the predictions was also the significant relationship between community garden surfaces and well-being as shown in model 2 in table 4 ( $p < 0.001$ ). Surprisingly, park surfaces showed a negative relationship with well-being ( $p < 0.001$ ). Contrary to the expectations, no significant relationships existed between the other land surfaces and well-being. These effects held after addition of the area-level attributes in model 3, although the significance of access to a shared garden fluctuates. Contrary to the prediction, the area-level attributes themselves showed no significant relationship with well-being.

The relationship between total green surface and well-being had to be analysed separately to avoid overlap. Green surface showed a coefficient of 0.001 ( $p < 0.01$ ) when controlled for the individual-level attributes. Adding access to gardens, similar to model 2 in table 4, lowered this coefficient to 0.00035 ( $p < 0.05$ ). Finally, adding the area-level attributes in the final model lowered the coefficient to 0.000, where it was no longer significant.

Table 4. OLS regression– social-demographic, green and area attributes

	Model 1		Model 2		Model 3	
	Coef.	SE, robust	Coef.	SE, robust	Coef.	SE, robust
Constant	6.100***	0.089	6.114***	0.091	6.123***	0.094
Garden (shared) <sup>a</sup>	0.031*	0.016	0.032**	0.016	0.032*	0.016
Garden (private) <sup>a</sup>	0.053***	0.011	0.051***	0.011	0.051***	0.011
Park surface (%)			-0.014***	0.003	-0.012**	0.003
Sport surface (%)			-0.003	0.005	0.005	0.005
Community garden surface (%)			0.085***	0.016	0.076***	0.017
Recreational surface (%)			-0.001	0.009	-0.002	0.009
Agricultural surface (%)			0.000	0.000	0.000	0.000
Forest surface (%)			0.000	0.000	0.000	0.000
Population density					0.000	0.000
G4 municipalities <sup>a</sup>					0.015	0.018
Center village (living environment) <sup>a</sup>					-0.013	0.018
Green urban (living environment) <sup>a</sup>					-0.003	0.021
Outside center (living environment) <sup>a</sup>					0.014	0.019
Center urban (living environment) <sup>a</sup>					0.016	0.022
R <sup>2</sup>	0.1548		0.1557		0.1558	

a. Binary, other variables are continuous

\*\*\* p<0.001, \*\* p<0.05, \*p<0.1

Dependent variable: well-being

Controlled for socio-demographic individual variables: income (log), age, age (square), work, volunteer work, higher education, partner, children, satisfaction with social capital, health, gender, homeownership and the year the WoON2015 survey was held.

Tested for multicollinearity. Except for age and age (square), which are both control variables, all variables have VIF values well below 10.

## 4.2. Mediation models

Hayes's (2017) SPSS macro PROCESS (model 4) with a 95% confidence interval (CI) based on 1.000 bootstrap samples was used to research the indirect effects of green surfaces and gardens on well-being through satisfaction with the living environment and health. Figure 1 visualizes these results for community garden surface, which shows a significant direct relationship with satisfaction with the living environment ( $c=0.0321$ ,  $p<0.001$ ). Adding satisfaction with the living environment as a mediator weakened this direct relationship ( $c'=0.0257$ ,  $p<0.1$ ). The relationship between community garden surface and this mediator was significant ( $a=0.0376$ ,  $p<0.001$ ), as well as the relationship between the mediator and well-being ( $b=0.1710$ ,  $p<0.001$ ). Further support for the existence of a significant mediation effect is the confidence interval, which did not include zero (95% CI=0.0017 to 0.0109).

Although stated as such by Baron and Kenny (1986), the first step, indicating the c-path, does not need to be significant in order for the mediation to hold. An explanation for this can be that the c-path shows the relationship between green surfaces and well-being without influence of a mediator. In the next stages, this mediator is added, potentially causing the relationship to

become significant. This could result in a significant result for the c'-path (Hayes, 2009). This assumption for step 1 was therefore loosened in this research.

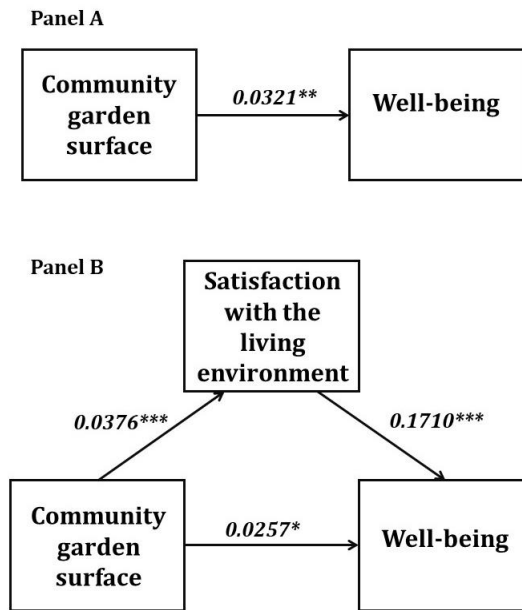


Figure 2. Mediation model 1, satisfaction with the living environment as the mediator for the relationship between green surfaces and well-being

\*\*\*p<0.001, \*\*p<0.05, \*p<0.1

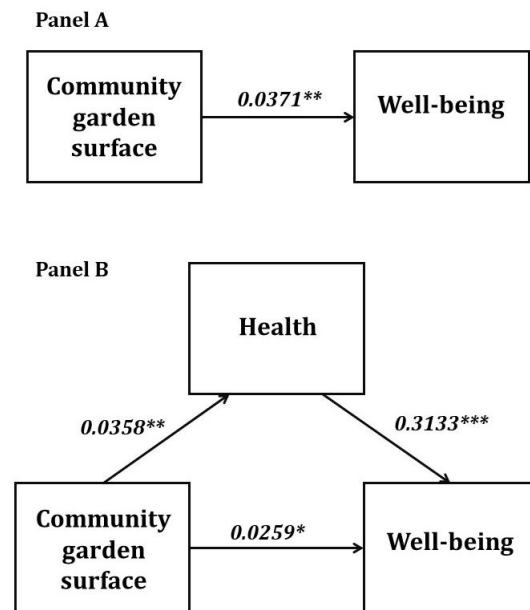


Figure 3. Mediation model 2, health as the mediator for the relationship between green surfaces and well-being

\*\*\*p<0.001, \*\*p<0.05, \*p<0.1

Using this reasoning for all surfaces in table 5, total green surface and sport surface were not significant as both confidence intervals included zero. Land use of parks, which showed a significant direct relationship with well-being in the OLS regression, showed a significantly weaker direct relationship with well-being after addition of the mediator, thus proving the mediation effect. Land use of recreation, agriculture and forest did not show a significant direct relationship with well-being in the OLS regression. These surfaces did show a significant direct relationship after the mediator was added (p<0.001), this mediator in turn showed a positive relationship with well-being (b=0.1710, p<0.001).

Table 5. Estimated direct and mediated effects of green surfaces with satisfaction with the living environment

	Park surface	Sport surface	Com. garden surface	Recr. surface	Agric. surface	Forest surface	Total green surface
a	-0.0088***	0.005	0.0376***	0.0432***	0.0001***	0.0017***	0.0021**
b	0.1709***	0.1710***	0.1710***	0.1710***	0.1710***	0.1710***	0.1709***
c'	-0.0026	0.002	0.0257*	0.0019	0	0.0001	0.0001
c	-0.0042*	0.0029	0.0321**	0.0093	0.0002	0.0004	0.0005*
Confidence intervals	[0.0022, 0.0048]	[-0.0005, 0.0022]	[0.0017, 0.0109]	[0.005, 0.0105]	[0.0001, 0.0003]	[0.0002, 0.0004]	[-0.0005, 0.0005]

\*\*\*p<0.001, \*\*p<0.05, \*p<0.1

Replacing satisfaction with the living environment with health as the mediator leads to only one land surface displaying a significant mediation effect, namely community gardens. As visualized

in figure 3, community garden surface was significantly directly associated with well-being ( $c=0.0371$ ,  $p<0.05$ ). Adding the mediator weakened this direct relationship ( $c'=0.0259$ ,  $p<0.05$ ), indicating a significant mediation effect. This was further suggested by the significant relationship between community garden surface and health ( $a=0.0358$ ,  $p<0.05$ ) and the significant relationship between health and well-being ( $b=0.3133$ ,  $p<0.001$ ). Finally, the confidence interval for this mediated effect did not include zero (95% CI=0.0001 to 0.0215), indicating a statistically significant mediation effect. Community garden surface was the only land use where health is a significant mediator as it was the only land use surface with a significant relationship with health. This requirement did not hold for the other land uses, as visible in table 6. In addition, these other land uses included zero in their confidence intervals, ruling out the possibility of a mediation effect as well.

Table 6. Estimated direct and mediated effects of green surfaces with health

	Park surface	Sport surface	Com. garden surface	Recr. surface	Agric. surface	Forest surface	Total green surface
a	-0.0041	0.0034	0.0358**	0.0118	0.0002	0.0001	0.0002
b	0.3133***	0.3133***	0.3133***	0.3133***	0.3133***	0.3133***	0.3133***
c'	-0.0045*	0.0008	0.0259*	0.0073	0.0004	0.0002	0.0005**
c	-0.0058**	0.0019	0.0371**	0.011	0.0004*	0.0003	0.0006**
Confidence intervals	[-0.0029, 0.0005]	[-0.0019, 0.0039]	[0.001, 0.0215]	[-0.002, 0.0091]	[-0.0001, 0.0002]	[0.0003, 0.0004]	[-0.0001, 0.0002]

\*\*\* $p<0.001$ , \*\* $p<0.05$ , \* $p<0.1$

Finally, access to gardens was used as a variable. Visualized in figure 4, private gardens were significantly directly associated with well-being,  $c=0.0444$ ,  $p<0.001$ . Adding the mediator

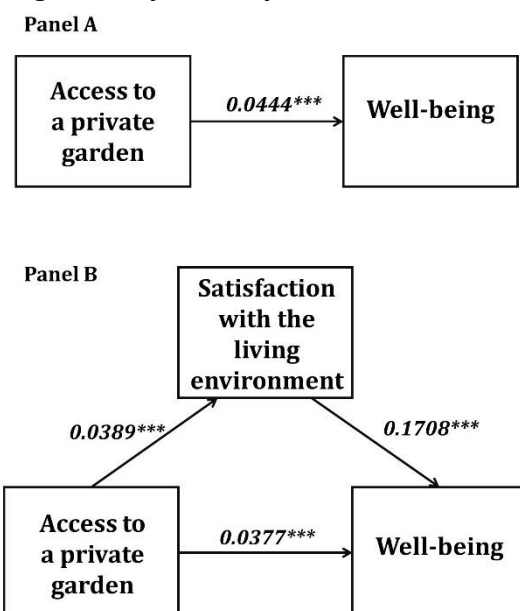


Figure 4. Mediation model 3, satisfaction with the living environment as the mediator for the relationship between access to gardens and well-being  
\*\*\* $p<0.001$

weakened this direct relationship, although it stayed significant ( $c'=0.0377$ ,  $p<0.001$ ). As the relationship between access to a private garden and satisfaction with the living environment was significant as well ( $a=0.0389$ ,  $p<0.001$ ), the mediation effect was significantly present.

Access to shared gardens did not show a significant direct relationship with well-being ( $c=0.0164$ ). Through a mediator, this effect was present as both the relationship between access to a shared garden and the mediator ( $a=0.0632$ ,  $p<0.001$ ) and the relationship between the mediator and well-being ( $b=0.1711$ ,  $p<0.001$ ) proved to be significant. This is visible in table 7.

The same analysis was repeated for access to gardens with health as a mediator. No significant relationship existed between either one of the garden accesses and health. The mediation effect is therefore not present for these variables.



*Table 7. Estimated direct and mediated effects of gardens with satisfaction with the living environment*

Mediator	Satisfaction with living environment		Health	
	Private	Shared	Private	Shared
Garden access				
a	0.0389***	0.0632***	0.016	-0.0199
b	0.1708***	0.1711***	0.3133***	0.3134***
c'	0.0377***	0.0056	0.0423***	0.0084
c	0.0444***	0.0164	0.0473***	0.0022
Confidence intervals	[0.0032, 0.0099]	[0.0062, 0.0151]	[-0.0027, 0.0134]	[-0.0174, 0.0045]

\*\*\*p<0.001

## 5. Discussion

The results showed the existence of a significant direct relationship between well-being and several green indicators. These direct relationships became weaker after adding the mediator, indicating that the mediator was able to explain a part of the relationship. For the other green factors, a significant direct relationship with well-being was not visible. After adding the mediator, these direct relationships also became significant, suggesting the presence of a mediation effect. This effect was especially provided when using satisfaction with the living environment as the mediator. This suggests that the relationship between green surfaces and well-being is not as straightforward as otherwise assumed (Hart et al., 2018; White et al., 2013), but rather that other factors influence this relationship. This research suggests that an important influencer is a person's satisfaction with the living environment. Before this claim can be made stronger, further research is encouraged as this research has some limitations. These, as well as some strengths and other remarks, are shared in the upcoming chapter.

### 5.1. Land use surfaces

The findings suggested a negative relationship between parks and well-being, even after mediators were added. This result is similar to research by Jim and Chen (2006) who concluded that people prefer green areas with natural features that remind of rural areas, with great emphasis on the aesthetics. De Groot and van den Born (2003) suggested that most people prefer wild landscapes where the greatness and forces of nature can be experienced. A preference for these types of nature was also indicated by Jacobs (2001). However, most urban parks in the Netherlands do not have these aesthetics but rather follow a strict plan with tight lines, tiled paths and neatly mowed grass. Dutch parks might therefore not fall in the preferred category of nature for some people. Because of this man-made design, parks require more frequent human management compared to natural green areas. This brings the potential of negative impacts, such as fear of vandalism and crime as nature areas can provide an easy access for burglars (Jim & Chen, 2006). Garretsen and Marlet (2017) also found this counter-intuitive effect of parks in the Netherlands, using housing prices to research the attraction of Dutch cities. They suggested that endogeneity clouds the results, as cities growing in popularity and size create an incentive to build more parks, rather than parks being the initial driver to make cities popular.

Sport areas and total green surface remained insignificant through the entire research. Sport areas as defined by the Central Bureau for Statistics (2017) include various sport related land uses. Some of these are green, such as football fields or grassy sport fields, but others comprise of built-up areas, such as indoor swimming pools, sport halls and parking places. In addition, sport facilities are known to attract negative externalities such as crowds, air pollution, traffic and noise pollution (Tu, 2005).

For community gardens, the additional significant mediation effect was probably caused by its various other benefits, rather than the green aspect. Community gardens provide the opportunity for leisure activities, which can help relieve stress (Deelstra & Girardet, 2000). As community gardens are social places, they also provide opportunities to meet others and strengthen social bonds (Ackerman et al., 2014). Another possibility is that municipalities with

higher percentages of community garden surfaces experience a stronger sense of community, enabling more social ties and decreasing criminality (Battersby & Marshak, 2013).

Korpela et al. (2014) suggested that nature based recreation has a positive and significant relationship with well-being. This effect was not visible in the results of the direct regression in the current research. The effect that emerged after adding the mediator might be attributed to the terminology of recreational areas. This research looked at long-term recreation, composed of campsites, holiday parks, youth hostels and areas with recreational houses (Central Bureau for Statistics, 2017). Potentially, not the green aspect of these areas, but rather the leisure aspect generated a positive relationship with well-being. Mafrolla and D'Amico (2016) found that tourism-related spending has a positive impact on well-being, which supports this notion.

The insignificant results of forest surfaces were surprising, as forests are the ultimate green areas. No other research was found where a similar result was shown. Possibly, an explanation can be found in the topography of the Netherlands. Although a densely populated country, the majority of the land is covered with green areas, mainly agriculture but also recreational, natural and forest terrain (Compendium voor de Leefomgeving, 2016). This was also visible in the descriptive statistics, where agricultural surface has a mean of 38.9% (standard error 24.4%) and forest surface of 10.4% (standard error 11.7%). Although these are high percentages, they are accompanied by high standard errors, indicating great differences across the nation. Potentially, this watered down the effect of green surfaces on well-being until neighbourhood satisfaction was added as a mediator. However, since both forest and agriculture are not located within the neighbourhood for most residents, this mediation effect most likely has other causes as well which can be further researched.

Of the six total land uses, only community gardens showed significant results in each model. Three of the six land uses became significant after adding a mediator and one land use was never significant. Unsurprising, the total green surface also showed no significant results in this research, as it was comprised of the other land uses.

The results showed on the one hand that relationships between land use surfaces or access to gardens and well-being that were significant through direct regressions became weaker after adding a mediator. This indicates that the mediator explained a part of the relationship. On the other hand, relationships between land use surfaces or access to gardens and well-being that were not significant through direct regressions became significant after addition of a mediator. Especially the mediator satisfaction with the living environment provided these effects, suggesting that the relationship between green surfaces and well-being is not as straightforward as otherwise assumed, but rather that other factors influence this relationship.

## 5.2. Access to gardens and well-being

This research included access to or possession of a private or shared garden. Gardens of other people might also influence well-being of an individual, as this provides additional green areas. The impact of nearby neighbours' gardens on well-being was not taken into consideration in this research. However, it is acknowledged that by excluding this, the results in this research lack completeness.

An assumption in this research is that gardens provide green areas. In the Netherlands however, the percentage of green in gardens dropped from 46% in 2002 to 39% in 2011 (Kullberg,

2016). Gardens become easier to maintain when they are 'made grey', indicating tiling the area. This research made no distinction between the type of vegetation, or lack of it, in gardens. The assumption that all gardens are green areas may therefore be a limitation of this research. Within this assumption, the size of the gardens was not taken into consideration either. This research partially corrected for this through individual income. Access to a private garden has a positive significant relationship with income, whereas income to a shared garden has a negative significant relationship.

### 5.3. Mediators

This research used neighbourhood satisfaction and satisfaction with the living environment as each other's proxy. Depending on the interpretation of the respondents, these two terms might mean the same. However, the WoON2015 provides no additional information about the dimensions of the satisfaction with the living environment, the answers were therefore subject to the respondent's own interpretation. Satisfaction with the living environment in general had a positive relationship with well-being, similar to research on satisfaction with the neighbourhood (Van Herzele & de Vries, 2012; Zhang et al., 2017). This substantiates the choice for this mediator.

Another interesting mediator was the self-reported health of the respondent. As expected, community garden surface was the only variable where health proved to be significant mediator. Gardening provides physical activity, access to fresh food and an increased intake of vegetables and fruit (Church, Mitchell, Ravenscroft, & Stapleton, 2014; Wakefield, Yeudall, Taron, Reynolds, & Skinner, 2007). Although nature areas in general have additional health benefits, it can be argued that this direct effect is less strong for the other land uses, therefore not proving a significant mediation effect.

### 5.4. Limitations and recommendations

Generally speaking, well-being results might be biased through the selection mechanism. Through this mechanism, people who already report higher levels of well-being move to greener living areas. De Vries et al. (2003) proposed that green areas attract wealthier and healthier people in the Netherlands. This may cause municipalities with high percentages of green areas to be inhabited by people with higher well-being. Even if there is no relationship between green areas and well-being. Additional research is recommended to ensure whether causation is taking place. The effect of surroundings and activities on well-being or health does not have to be immediate either, as some time can be needed before any impact can be noticed. De Vries et al. (2003) excluded some respondents from the analyses because of this reason. A recommendation for additional research would therefore be to integrate time differences into the research, for example by excluding respondents who have only lived in their present location for a short amount of time.

Research shows a genetic predisposition to well-being, or rather to a specific level of well-being (Lyubomirsky, 2001). Research on twins has shown that differences in subjective well-being between people are for 30% to 50% accountable to their genetic differences (Haworth et al., 2016). The rest is explained by external or environmental differences (Bartels, 2015; Haworth et al., 2016). Genes are therefore important in determining and explaining individuals' well-being levels. Apart from genes, well-being is also explained by personal preferences. It is likely that some

people appreciate nature more and therefore would gain more well-being from living nearby nature areas. The relationship between green areas and well-being would therefore be stronger for these people than for people with a lower appreciation of nature. Information on both of these personal elements was not available for this research and was therefore not included. Future research is recommended to include a question on personal appreciation of nature. For the current research, an assumption can be made about the preferences of people. Van den Born et al. (2001) showed that in the Netherlands 70% to 90% of the population recognizes the importance of nature. This indicates high chances that a person living near nature actually appreciates nature, although additional research should be done to back this claim.

Using land use data, all green areas were measured as the percentage of the total municipality. The mean for forest surface was approximately 10% of the municipality surface. However, this number does not indicate that each individual directly benefits from this nearby green surface. An individual might be located too far to directly view the green surfaces and lack the resources to visit the green surface. Using municipality averages therefore removes individual distances to green surfaces. Indirectly, as green spaces are accessible to all, it can be argued that individuals benefit from the positive externalities that a green area has somewhere in the region (White et al., 2013). A person who does not frequently visit the local community garden might still enjoy the social cohesion in the neighbourhood that is caused by it. Hadavi (2017) showed that being aware of nearby green spaces is already associated with well-being and that actual use of a green space is not essential for this. This research can make no claims about this, as information about green spaces was only available on the municipality level. If available, proximity to green areas can be used in addition to the surfaces of these areas. Garretsen and Marlet (2017) used a weight depending on the travel time to and the weight of a green area. This approach is recommended for further research where, in comparison to this research, data on green provision on the micro level is available. GIS applications are then recommended, as also performed by Van Herzele and de Vries (2012), Zhang et al. (2017) and Annerstedt Van Den Bosch et al. (2016).

Conventionally in regression models, independence of observations is assumed (Church et al., 2014). This assumption does not hold in this research, as both individual and municipality level data are used. The main statistical problem with this is the potential for individuals within the same municipality to be more similar to each other than to the individuals in another municipality (Williams, 2000). This presence of multilevel data leads to the problem of nested or clustered data. To control for this, the regression was run in Stata 10 intercooled, where the robust command was added to the regression. This robust command is used when the data is contaminated with influential observations, which is the case in this research due to the different measuring levels. The robust regression weighs the observations differently based on how they behave within the sample (UCLA, 2018). Although this alleviates the issue of nested data somewhat, it can be argued that other methods solve this problem better. The mixed command in Stata is used for linear multilevel models and already includes robust and cluster standard errors (Albright & Marinova, 2015). For future research or a repetition of this research this command is therefore recommended for the direct regression. For the mediation analyses, the different measuring levels were not taken into full consideration as this was not possible through the used PROCESS macro. A possibility to include this is to use the MLmed macro, which is designed to simplify the fitting of multilevel mediation models (Rockwood & Hayes, 2017).

Also for the mediation analyses, the bootstrapping technique was used. Commonly used for mediation analyses is the mediation work by Baron and Kenny (1986). This traditional causal-step method has some disadvantages, such as having a low ability to detect mediated effects. This ability does increase when the amount of data subjects increases as well, as is the case in the present research (MacKinnon & Fairchild, 2009). Most importantly, a critical step in the Baron and Kenny method is that the relation between X and Y, also known as the direct c-path, has to be significant overall. MacKinnon and Fairchild (2009) argued that this statistical test is subject to error and a failure for an overall significant effect therefore does not exclude the possibility of mediation. Because of these critical views, other methods are used in various research, such as bootstrapping. Oshio (2017) researched the level of social capital that is the most relevant for well-being by combining this method with the traditional method. Tan et al. (2017) looked at the mediating effect of self-esteem in the relationship between extraversion and well-being by using a SPSS macro supplied by Hayes (2017) called PROCESS. The current research used this PROCESS macro as well, which relies on bootstrapping. Most research recommends creating a minimal of 5,000 subsamples (Dardas & Ahmad, 2015; Tan et al., 2017). This research used only 1,000 due to technical restrictions. This might lead to loss of power, as there is less room to allow for the randomness needed (Davidon & MacKinnon, 2001). Further research is recommended to perform the analyses with at least 5,000 bootstrap subsamples.

## 6. Conclusion

This research aimed to further explain the indirect relationship between green surfaces and well-being through a case study in the Netherlands. In summary, satisfaction with the living environment mediates the relationship between nature areas and well-being in the Netherlands. Community gardens, parks and access to private gardens, which already had a significant direct relationship with well-being, showed a weaker direct relationship after the addition of a mediator. Agricultural surfaces, recreational surfaces, forests and access to a shared garden all resulted in a significant direct relationship with well-being after addition of satisfaction with the living environment as a mediator, while this significant relationship was lacking in the direct regression.

Unexpected although corresponding with other research are parks in the Netherlands, which showed a negative significant relationship with well-being. This provides policy makers and land planners with new insights for future land use planning. Policy makers could opt for implementation of activity oriented public community gardens instead of additional public parks, in order to benefit from relationship community gardens have with well-being. Architects could opt to design private gardens for housing rather than shared gardens, as the first showed a stronger significant relationship with well-being.

This research provided initial results of the relationship between nature areas and well-being with satisfaction with the living environment and health as mediators. Land use data was used, which is widely available. Significant results were found, which adhere to the expectations formulated from literature. This indicates that land use data, despite being flawed by generalization and lack of detail, can be used to calculate a general insight in well-being relationships. Policy makers and land use planners can use this information to confidently estimate the relationship between land use and well-being in a specific region with easily accessible and therefore cheaper information. If results appear to be significant, more resources can be used to research the region in more detail. Hopefully, this lowers the threshold to incorporate well-being into decisions regarding land use planning in regions.

These findings therefore complement other research in this area. Others are encouraged to strengthen these arguments through future research and strengthen their position to include well-being strategies in land use planning and policies. From potted plants to lush forests, a little may go a long way in the relationship with well-being.

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## Appendix A. OLS regression

Table 8 shows the full correlation coefficients from the basic OLS regression. These were shown stepwise in three different models in paragraph 4.1 Multilevel regression.

*Table 8. Correlation coefficients from the basic OLS regression in Stata*

	Coefficient	Robust standard error	t
Constant	5.2376***	0.0955	54.84
SatisLivingEnv	0.1292***	0.0058	22.18
SatisRegion	0.1513***	0.0071	21.34
Logincome	0.1510***	0.0207	7.31
Age	-0.0229***	0.0015	-14.88
Age_Sq	0.0003***	0.0000	16.68
Work <sup>a</sup>	0.1008***	0.0118	8.54
VolWork <sup>a</sup>	0.0679***	0.0079	8.63
Dum_education <sup>a</sup>	0.0414***	0.0084	4.93
Partner <sup>a</sup>	0.2180***	0.0101	21.60
Child <sup>a</sup>	-0.0334**	0.0097	-3.44
Dum_SatSocCap <sup>a</sup>	0.6425***	0.0170	37.87
Dum_Health <sup>a</sup>	0.4750***	0.0108	43.99
Religion <sup>a</sup>	0.0130	0.0081	1.61
Gender <sup>a</sup>	-0.0609***	0.0078	-7.84
Home <sup>a</sup>	0.0278**	0.0103	2.70
Garden_shared <sup>a</sup>	0.0186	0.0158	1.17
Garden_private <sup>a</sup>	0.0415***	0.0113	3.68
PercParkSurface	-0.0084**	0.0033	-2.52
PercSportSurface	0.0014	0.0053	0.27
PercComGardSurface	0.0615***	0.0167	3.69
PercRecrSurface	-0.0143	0.0088	-1.63
PercAgrSurface	-0.0004*	0.0003	-1.70
PercForestSurface	-0.0005	0.0004	-1.11
DumCenter-village <sup>a</sup>	-0.0099	0.0177	-0.56
DumGreen-urban <sup>a</sup>	-0.0030	0.0207	-0.15
DumOutside center <sup>a</sup>	-0.0003	0.0190	-0.02
DumCenter-urban <sup>a</sup>	-0.0006	0.0213	-0.03
Province	-0.0001	0.0015	-0.07
G4_big <sup>a</sup>	0.0191	0.0173	1.10
PopDen	0.0000	0.0000	-0.95
Dum_yearW <sup>a</sup>	0.0169**	0.0076	2.22

a. Binary, other variables are continuous

\*\*\* p<0.001, \*\* p<0.05, \*p<0.1

Dependent variable: well-being

Tested for multicollinearity. Except for age and age (square) all variables have VIF values well below 10.

## Appendix B. Additional mediation analyses

Table 9 shows the results of the sensitivity analysis with satisfaction with the region as a mediator. Interestingly, community gardens no longer showed a mediation effect as no significant relationship existed between community garden surface and satisfaction with the region (path a). Park surface, recreational surface, agricultural surface, forest surface and total green surface all showed a significant relationship with satisfaction with the region (path a). In addition, none of their confidence intervals included zero, causing the mediation effect to be significantly present.

*Table 9. Estimated direct and mediated effects of green surfaces with satisfaction with the region*

	Park surface	Sport surface	Com. garden surface	Recr. surface	Agric. surface	Forest surface	Total green surface
a	-0.0158***	0.0006	-0.0121	0.0851***	0.0008***	0.0031***	0.0026***
b	0.2056***	0.207***	0.2058***	0.2061***	0.2057***	0.2059***	0.2058***
c'	-0.0009	0.0028	0.0346**	-0.0083	0	-0.0002	-0.0001
c	-0.0042*	0.0029	0.0321**	0.0093	0.0002	0.0004	0.0005***
Confidence intervals	[-0.0042, -0.0027]	[-0.0012, 0.0015]	[-0.007, 0.0017]	[0.0156, 0.0213]	[0.0001, 0.0002]	[0.0006, 0.0008]	[0.0005, 0.0007]

\*\*\*p<0.001, \*\*p<0.05, \*p<0.1

The results of the mediation analysis of satisfaction with the region on the relationship between private and shared access to gardens and well-being is shown in table 10. Here, similar to the main results, mediation occurred for access to private gardens but not for access to shared gardens.

*Table 10. Estimated direct and mediated effects of gardens with satisfaction with the region*

	Satisfaction with the region	
	Private	Shared
a	0.0166**	0.0154
b	0.206***	0.2062***
c'	0.041***	0.0132
c	0.0444***	0.0164
Confidence intervals	[0.0003, 0.0066]	[-0.0011, 0.0077]

\*\*\*p<0.001, \*\*p<0.05