Amsterdam University College

Interdisciplinary Capstone

Fighting the Paradox of the Compact City

An examination of the externalities involved with urban densification projects and a case study of Haven-Stad

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Preface

Before you lies the thesis that has been written to fulfil the graduation requirements of my Liberal Arts and Sciences bachelor degree at Amsterdam University College (AUC). I was engaged in conducting an extensive literature review and writing this thesis from the beginning of February till the end of May 2018. The topic of this research was formulated with the help of my supervisor, Eric Koomen. I would like to thank my supervisor for his support and feedback, which has helped me improve my thesis considerably throughout the whole writing process. Furthermore, I would like to thank Miriam Ram from the CRa (College van Rijksadviseurs) for the interesting talk and providing me with an extensive set of sources. Finally, I want to thank Herman Morrsink for taking the time to read through my thesis and for his suggestions for improvement.

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Abstract

Population growth and increased rates of urbanization both lead to pressures on cities. To accommodate the large influx of people and to remain sustainable, cities should adopt to new urban growth strategies. One urban development strategy that has received attention in current planning and policy practices as an alternative to urban expansion is urban densification. However, an overview of the costs and benefits of the external effects involved with such compact city developments is lacking in current literature. This research investigates what external costs and benefits are in general associated with urban densification as compared to urban expansion and to what extent these externalities are quantifiable in monetary terms by performing a literature review. An overview of the externalities associated with urban densification is provided and linked to a case study of the Haven-Stad area in Amsterdam to determine the usability of the overview. It is found that it is often very case specific what external effects arise to what extent, making it difficult to identify an optimal urban development strategy. Therefore, urban planners and policy makers are urged to extensively investigate the case specific context to determine the preferred development strategy.

Keywords: compact cities, externalities, Haven-Stad, urbanization, urban densification

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1. Introduction

Over the past decades, the global population has been increasing rapidly (Koziatek & Dragićević, 2016). According to data of the CBS (Statistical Office in the Netherlands) (2018), this trend of population growth has likewise been visible in The Netherlands (see Figure 1). As a result, The Netherlands have grown from a country with a population density of roughly 309 inhabitants per km^2 in 1950 to a country with a density of approximately 507 inhabitants per km^2 in 2017 (CBS, 2017). Moreover, the Dutch population is expected to grow until at least 2030 (CPB & PBL, 2015; CBS, 2016). Consequently, The Netherlands are currently (and will remain) among the most densely populated countries worldwide (World Bank, n.d.).

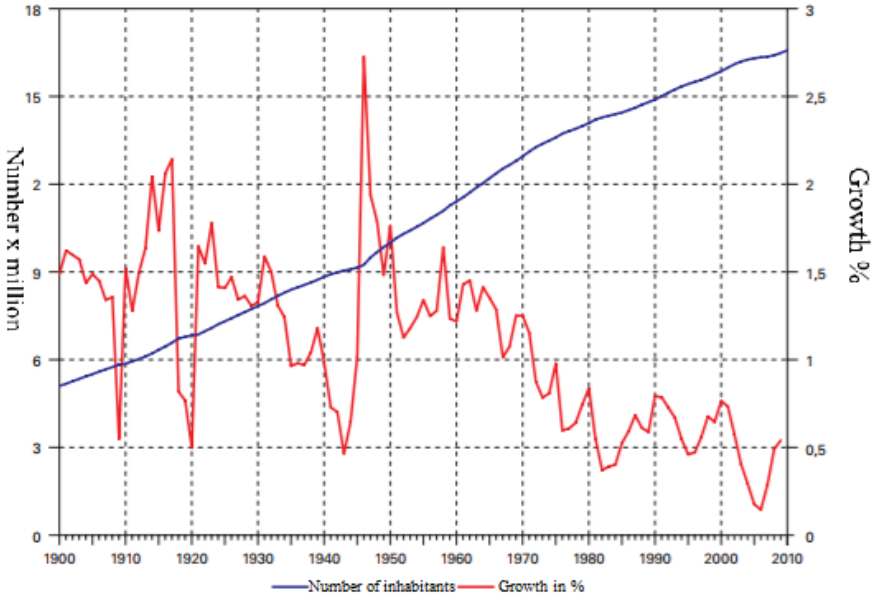

Figure 1: Population and population growth in The Netherlands in the period 1900-2010 (Ekamper, 2010)

In line with the expanding population size, the total area of urban land in The Netherlands has increased (PBL Netherlands Environmental Assessment Agency, n.d.). However, there is a disproportionate relationship visible between population growth and urban expansion, which is caused by, among other things, a reduction in the average number of people per household (Hilderink, Den Otter & De Jong, 2012). Due to the increased demand for housing space and the greater focus on sustainable development, "urban planners and developers [are urged] to consider alternative urban growth strategies, such as vertical and compact development" (Hofstad, 2012; Koziatek & Dragićević, 2016, pp. 349; Lobaccaro & Frontini, 2014). This urban densification approach is supposed to avoid the perceived undesirable consequences of urban sprawl (e.g. ineffective land-use) (Dieleman & Wegener, 2004; Haaland & Van den Bosch, 2015).

Lin and Yang (2005) found that high-density urban patterns, and therefore urban densification, positively affect economic sustainability. Additionally, compact city design generally leads to an average reduction of the total number of auto trips (and consequently to a reduction of emissions) (Bento, Cropper, Mobarak & Vinha, 2005; Kenworthy & Laube, 1996; Mahriyar & Rho, 2014). However, several scholars found that even though urban densification often creates benefits on the large scale, there can be considerable negative effects on the small scale (De Roo, 2000; De Vries, 2016; Melia et al., 2011). Melia et al. (2011) suggest that there exists a so-called paradox of intensification. This paradox of intensification entails that "[an increased population density will], under 'normal' circumstances reduce overall vehicle use, but increase [the total amount of cars used] in the intensified areas" (Melia et al., 2011, pp. 52). This means that even though the total number of cars used decreases since people are less likely to use their car as compared to people living in less dense areas, the total number of cars within the densified area still increases. Likewise, Steemers (2000) writes about the paradox of the compact city, meaning that local environmental problems arise due to high urban densities, which counterbalances the benefits that are gained in terms of transport and space efficiencies. Furthermore, Lin and Yang (2005, pp. 365) state that high-density urban forms and urban intensification "negatively affect the […] social sustainability".

The previously named effects that arise after the realisation of an inner-city project are often (unexpected) externalities (Melia, Parkhust, & Barton, 2011; Ecorys, 2005). It is of great importance to incorporate these external effects in decision-making and planning processes, since their associated costs need to be accounted for (Ecorys, 2005). And whereas there exists quite some research on the positive and negative externalities associated with urban densification, a concise overview that provides insight in the optimal urban development strategy that planners and policy-makers could incorporate is currently lacking. Therefore, this research will compose such an overview, containing the externalities involved with urban densification as compared to urban expansion. In order to compose this overview, it will be attempted to answer the following research questions:

1. What are the external costs and benefits that are in general associated with urban densification as compared to urban expansion?
2. To what extent are these externalities quantifiable in monetary terms?

In the context of this research, densification entails the construction of new residential units within the existing city structure and urban expansion (also known as sprawl) the

addition of housing units with relatively low densities in the urban fringe. The neighbourhoods that arise due to urban sprawl are generally associated with relatively large single-family suburban lots, whereas compact city design is mostly associated with multi-family housing (Ewing & Rong, 2008; Glaeser & Kahn, 2003). Therefore, it is presumed in this research that neighbourhoods in densified areas contain smaller multi-family housing units as compared to attached or detached single-family houses in urban sprawl areas.

To determine the usability of the overview, a case study of one inner-city development project will be used. Currently, there are substantial pressures on the housing market in the Randstad (especially in Amsterdam) and it is expected that due to population growth, these pressures will intensify (CBS, 2016; Gemeente Amsterdam, 2017a). Furthermore, different development plans (expansion and densification) are present in the Amsterdam region (CRa, 2017). Therefore, the Amsterdam Metropolitan Area (AMA) makes a good area to define a case study for this research. The development of the so-called Haven-Stad, a large scale inner-city transformation project where between 40.000-70.000 houses and 45.000-58.000 jobs will be realised before 2040 is chosen as case study (Gemeente Amsterdam, 2017b).

2. Methodology

This research will be organized in a stepwise manner, consisting of three main parts; Firstly, it will be established what externalities arise from urban densification projects in comparison to urban expansions. This will be done by analysing a select group of influential and large Dutch reports on the process of urban densification and the associated effects. It is chosen to analyse Dutch reports since these provide relevant information about the Dutch context, making it applicable to a case study in Amsterdam. These reports will be chosen based on their publishing date (2005 or later) and the publisher (only government agencies, and large and well-known research institutes). Additionally, international academic sources will be reviewed to ascertain that no important external effects have been missed. This will be done by systematically scanning the first five pages (fifty sources) of the online literature database of the University of Amsterdam (UvA) based on the key words "urban densification" and "externalities". Thereafter, the different externalities that arise will be explained in Chapter 3 in more detail based on the found international literature, the Dutch reports, and additional sources found in the UvA database. Subsequently, it will be tried to quantify these externalities based on existing literature and the Dutch reports and it will be determined for each external effect what urban development strategy is optimal.

The second part of this research focuses on the Amsterdam Metropolitan Area (AMA) and its possible housing development strategies. It will be determined whether the provided overview of externalities associated with urban densification is sound by comparing it to the effects in Haven-Stad of urban restructuring processes. For the analysis of the Haven-Stad case study, data on the different criteria is gathered by reviewing planning reports and by making use of the open geodatabase of the municipality of Amsterdam. These datafiles are combined in ArcGIS, where an estimation of the size/quantity is made for several external effects. Ultimately, the application of the overview to a case study will determine whether it is a useful tool and whether alterations/extensions should be made to the overview. Hopefully, this will enable planners and policy makers to incorporate the knowledge on externalities in future urban development projects.

3. The relative impact of urban development strategies: densification versus expansion

There are two main urban growth strategies present: urban densification and urban expansion. This chapter explores the externalities that arise from urban densification projects as compared to urban expansion projects.

3.1 Overview

Table 1 provides an overview of the externalities involved in urban densification projects that have been identified by nine influential Dutch research reports.

	CPB (2010)	Ecorys (2005)	EIB (2011)	SEO (2011)	RIGO (2012)	CPB (2013)	Decisio & EIB (2015)	PBL (2016a)	SEO (2006)
Local urban green space	X	X	X	X	X	X	X	X	X
Regional green space	X	X	X	X	X	X	X		
Congestion		X	X	X	X		X		X
Traffic safety		X					X		X
Environmental damage caused by traffic (emissions and noise)		X	X	X	X		X		X
Neighbourhood quality and "edge" effects	X	X	X	X			X	X	X
Knowledge spillovers	X					X			
Quality and variety of (public) amenities	X	X	X	X	X			X	X
Provision of recreational amenities		X			X	X	X		
Social cohesion							X		X
Safety/criminality		X		X	X		X		X
Segregation							X	X	X

Table 1: Overview of the externalities involved in urban densification projects as discussed in different influential Dutch reports

The effect of urban densification on the Urban Heat Island (UHI) and energy use is not discussed in any of the reviewed Dutch reports but has received attention in current literature (Clark, 2013; Ewing & Rong, 2008; Holden, 2004; Ko, 2013; Stone & Rodgers, 2001) and is therefore included in section 3.2.7. Some of the reports focus on urban densification as compared to an urban expansion reference scenario, others focus on urban expansion as compared to the past situation. In the following chapters, the external effects that arise due to urban densification will be described in relation to the urban expansion reference scenario.

3.2 The externalities involved with urban densification

3.2.1 Local urban green space

The impacts of urban densification on the presence of local urban green is being discussed in all reviewed Dutch reports (Table 1). It has been found that different urban densification development strategies can either have a positive or a negative impacts on the presence of green space. The densification of existing neighbourhoods often results in the development of valued open and/or green space into residential blocks. A research in Sydney by Lin, Meyers & Barnett (2015) found that increasing dwelling density in suburbs has led to a decrease in the amount of tree cover. It has also been found that there is a predominantly negative relationship visible between overall green space and the presence and density of terraced housing and blocks of flats in Sheffield (UK) (Davies et al., 2008). Oppositely, there mostly exists a positive correlation between overall green space and semi-detached housing, which is often the housing type present in urban expansion areas (Davies et al., 2008). In the case of brownfield development (abandoned land previously used for industry), urban densification could have a positive impact on the presence of green space (De Sousa, 2006).

3.2.2 Regional green space

Urban densification results in keeping valuable open space outside the city intact that would otherwise, in the case of urban expansion, have been developed into a residential area (CPB, 2010; SEO, 2011). It is expected that The Netherlands will most probably suffer great losses in terms of agricultural land due to urban expansion (Nilsson et al., 2014). In line with this, it was found that residential expansion in The Netherlands between 2000 and 2010 was in particular at the expense of agricultural land and available building lots (Broitman & Koomen, 2015). However, other types of land use, such as nature and recreation, were also transformed into residential areas, which results in urban expansion often having a negative influence on the present green infrastructure (GI) (Broitman & Koomen, 2015; Glaeser & Kahn, 2003; Maes et al., 2014).

3.2.3 Congestion, traffic safety, and environmental damage caused by traffic

There is also a large emphasis on the impact of urban densification on traffic (and the associated effects) in the reviewed Dutch reports. The externalities associated with an increase in the amount of motorized vehicles are noise pollution, congestion, and more atmospheric pollutants and combustion gases, such as nitrogen oxides (NOx, NO and NO2), small particulate matter (PM10), carbon oxides (CO and CO2), and ozone (O3) (Atkinson et al., 2009; EIB, 2011; Yeh, 2010). According to Clark (2013, pp. 413), an increase in population density in an area in the city's core is associated with a "modest gain in energy efficiency in the urban transport sector and [accordingly a] modest decrease in its carbon emissions". Furthermore, Decisio and EIB (2015) indicate that in an area with high address density, a relative large proportion of the residents travels by public transport or moped/bike as compared to an area with low address density. Also, the percentage of people travelling by car is lower in a densified area as compared to one with low address density (Decisio & EIB, 2015). Moreover, it was found that in Beijing urban sprawl "tends to increase the need for long-distance commuting to the central urban area" (Zhao, Lü & De Roo, 2010, pp. 2467). This is in line with the findings of Glaeser and Kahn (2003), who showed that urban sprawl is often highly correlated with car use. Additionally, it was highlighted by Burton (2001) that an emphasis on public transport, cycling and walking as means of transport exists in densified areas as an alternative to the car. Furthermore, an increase in traffic movements (total number of journeys and the length of the journey) results in general in a decrease in traffic safety and an increase in car-related air and noise pollution (Decisio & EIB, 2015; Glaeser & Kahn, 2003). These findings suggest that urban densification is a more desirable development strategy than urban expansion in terms of transport mode. However, Ferreira and Batey (2011, pp. 231) found that even though the percentage of people taking the car decreases, urban densification often leads to a total increase in travel movements. This total increase is, among other things, explained by the increased number of “available opportunities provided by agglomeration effects” and the increased number of people living in the area. As a result, urban densification projects are often still associated with more road congestion in the densified area than is the case with urban expansion (Clark, 2013; Ferreira & Batey, 2011; Melia et al., 2011).

3.2.4 Neighbourhood quality and “edge” effects

More than half of the reviewed Dutch reports discusses the effects of urban densification on the quality of the densified neighbourhood itself and the effects on the neighbourhoods adjacent to the densified area. Part of the neighbourhood quality is related to

the emissions produced by traffic, however this topic will be excluded from this section since it has been discussed in the section 3.2.3. Furthermore, neighbourhood quality is related to other sources of pollution, such as the nuisance, bad smell and/or noise that is produced by a former or current inner-city industrial or commercial site (CPB, 2010; EIB, 2011; SEO, 2011; Vermeer & Vermeulen, 2012). Changing a polluting area into a cleaner residential area could improve the area considerably. Additionally, improving an area that causes nuisance to the surrounding area will result in decreased external costs in the neighbourhoods adjacent to this area (Ecorys, 2005). In the case of urban expansion, these external benefits would not arise in the short term since the inner-city area will most probably remain in its polluting state for a while. When comparing urban densification to urban expansion, it can be concluded that expansion would not result in improvements to the areas that would otherwise have been densified. Moreover, urban expansion would result in a degraded quality of the neighbourhoods adjacent to the expanded area (Ecorys, 2005).

However, sometimes it is not a former industrial or commercial site, but a residential or green area that is transformed/densified. According to SEO (2011), restructuring a residential area will most probably result in an increase in the amount of owner-occupied housing. Knol (2005) found that inhabitants of owner-occupied properties feel more responsible for their house and their surroundings, which results in more attractive neighbourhoods. Hence, it is expected that urban densification projects lead to, when it coincides with an increase in home owner ship, better quality neighbourhoods as compared to the neighbourhood before densification. However, it is expected that urban sprawl neighbourhoods are also mostly associated with a high level of owner-occupied residential units since single family houses are mostly privately-owned (US Energy Information Administration, 2015). Therefore, it is difficult to find the optimal urban development strategy in terms of the neighbourhood quality category.

3.2.5 Knowledge spillovers and amenities

Another external effect that arises from relatively high densities and has been discussed by two of the reviewed Dutch reports is that of knowledge spillovers (CPB, 2010; CPB, 2013). Knowledge spillovers entail the exchange of ideas and it has been found that these (innovative) ideas easily circulate through spatially concentrated communities (CPB, 2010; CPB, 2013; Glaeser, 2008; Tordoir, 2015). In line with this, Carlino, Chatterjee and Hunt (2006) showed that employment is positively correlated with the per capita invention rate, suggesting that high urban densities result in increased productivity. This is confirmed by

Lin and Yang (2006), who found that companies indeed experience higher productivity in more dense urban environments. Urban sprawl on the other hand is associated with a reduction of urban agglomeration economies since these less dense areas are generally less productive (Glaeser & Kahn, 2003).

The increased productivity that is associated with dense areas and a larger demand due to the increase in the number of people result in an attraction of more companies to the densified area. Moreover, not only the number of companies increases, also public amenities are being reinforced. Though, agglomeration advantages are not only an effect of urban densification, they also often arise as a result of urban expansion (SEO, 2011). Ecorys (2005) found for example that when looking at neighbourhood facilities, relatively modern and large shops could arise in the urban fringe due to urban expansion. However, when comparing urban densification to urban expansion, urban densification is found to be the preferred strategy in terms of quantity and quality of (public) amenities since these are still mostly agglomerated in the city centre since demand is largest there (Arifwidodo , 2012; RIGO, 2012; SEO, 2011).

3.2.6 Social cohesion, security, criminality, and segregation

More than half of the reviewed Dutch reports focus on the impacts of urban densification on (perceived) safety and criminality. Burton (2001), and Lin and Yang (2006) found that urban densification often increases crime rates and hence decreases the sense of security, suggesting that the urban expansion strategy is optimal in terms of security. Furthermore, the effect of urban densification on social cohesion has been discussed in current literature. It has been found that social interaction and group participation within a neighbourhood decrease at high urban densities (Bramley et al., 2009). Additionally, Lin and Yang (2005) found that high-density urban forms result in a worse social environment than is the case in low-density areas. These findings suggest that neighbourhoods with relatively low density in the urban fringe provide a more desirable social climate than densified neighbourhoods.

Another external effect that is associated with urban densification is that of social segregation. According to Clark (2013, pp. 413), urban densification is often associated with a "diminished housing affordability", which contributes to the displacement of poorer people (Burton, 2001; Lin & Yang, 2006). Accordingly, Rosol (2015) states that urban renewal (and therefore also urban densification) often causes 're-urbanization' of the middle-classes in the inner city, resulting in the displacement of the former (often poorer) households. However,

Glaeser and Kahn (2003) found that mostly affluent people settle in suburban neighbourhoods that arise from sprawl, suggesting that social segregation also arises due to urban expansion processes. This was confirmed by SEO (2011), who stated that in The Netherlands, newly constructed neighbourhoods in the urban fringe have resulted in a larger segregation of households with low incomes and non-Western descent.

3.2.7 Urban heat island effect and energy use

None of the reviewed Dutch reports discusses the effect of urban densification or urban expansion on the Urban Heat Island (UHI), a phenomenon that is characterized by higher temperatures in the city as compared to surrounding rural areas (Mohajerani, Bakaric & Jeffrey-Bailey, 2017). The materials used in urban design often have a relatively low albedo as compared to, for example, vegetation (Koomen & Diogo, 2015). As a result, more heat is absorbed in urbanised areas and urbanisation leads to an intensification of the UHI (Ewing & Rong, 2008). In the case of urban expansion, the UHI is intensified substantially since the cooling effect of shading and evapotranspiration is eliminated by removing trees, shrubs, and groundcover (Ewing & Rong, 2008; Stone & Rodgers, 2001). Additionally, urban sprawl limits "the ability for wind and turbulence to dissipate heat in the core of the urban zone", also leading to an intensification of the UHI (Koomen & Diogo, 2015, pp. 288). In the case of urban densification of an already existing residential area, the UHI is strengthened due to an increased building density (Pearsall, 2017). However, when a brownfield is transformed and more green space is added, it could be the case that the UHI is reduced.

The UHI effect results in higher temperatures, which increases energy demand intended for cooling during the summer, while the energy demand for heating decreases during the winter (Ewing & Rong, 2008). It is assumed in this research that the influence of the UHI effect on the overall seasonal energy demand is approximately zero since winters in The Netherlands are mild and summers are cool. However, this is very case specific and different climates (e.g. climates in which the summer is much longer than the winter) experience the influence of the UHI effect on energy use differently. Furthermore, Holden (2004) found that in general, houses in high density areas have a lower energy use since the houses are often smaller than the houses in sprawled areas. This is also in line with the findings of Ewing and Rong (2008), who found that residents of sprawling areas mostly live in detached houses that are often bigger than the houses of their counterparts living in the inner-city, which results in a higher energy use per household.

4. Quantifying the externalities

As mentioned before, it is of great importance to incorporate external effects in decision-making and planning processes (Ecorys, 2005). This chapter identifies whether the externalities are costs or benefits and tries to quantify them for different urban development scenarios.

4.1 Local urban green space and regional green space

The presence of open urban spaces in the form of parks or public gardens has identified as being important for the wellbeing of urban dwellers (Rouwendal & Van der Straaten, 2008). Not only do urban green spaces increase the overall wellbeing through providing a clean environment and room for recreational activities, they also support biodiversity (Arnberger, 2012). Not surprisingly, Rouwendal and Van der Straaten (2008) found that the proximity (within a 500 meters radius) of parks and public gardens has a positive effect on property values (increase of 2-9%). Furthermore, in an extensive research of the Dutch housing market, it was found that the proximity of a park within a 50 meter radius in the city adds 25 euro per square meter living area (Visser & Van Dam, 2006). These studies suggest that the influence of open green space has an effect on housing values on a rather small scale (Dekkers & Koomen, 2013; Rouwendal & Van der Straaten, 2008). Furthermore, Dekkers and Koomen (2013) found that especially the presence of water bodies has a positive effect on property values.

The presence of open green space outside the city boundaries also has a value associated with it. Luttik (2000) found that having a view on open space bordering a residential area can increase the value of a house by 6 to 12 percent (this also applies to an urban park next to a residential area). Furthermore, regional features (such as woods, lakes and a diversity of landscape types) could add between 6 to 12 percent extra value to houses in the region (Luttik, 2000). According to Decisio and EIB (2015), the costs due to the loss of recreational possibilities of a certain green area is approximately 200 euros per added housing unit. These costs are explained by the value people attribute to the possibility of going there, knowing that the area exists, and knowing that it will be preserved (bequest value) (Decisio & EIB, 2015). Dekkers and Koomen (2013) on the other hand found inconclusive evidence for this price impact of regional open space at the local level.

In the case of this research, the question arises whether the transformation of the existing city structure into a more densely-built area with probably less (and more crowded)

green space results in higher costs than the transformation of open space outside the city boundaries. In other words, what is valued more: inner-city green or outer-city green? It is of course case specific which development strategy has the most benefits associated with it, making it difficult to exactly quantify both city green and green outside the city. However, assumptions can be made and in a study performed by Ecorys (2005) it was found that the value of open space outside the city is valued less than green within the city per square meter. This suggests that an inner-city transformation in an area containing green fields would (most probably) have more associated societal costs than urban expansion. However, if the densified area used to be a brownfield without any green, urban densification could have less associated societal costs than urban expansion since no green space is lost. This hypothesis is confirmed by a research performed by EIB (2011), in which it was found that the transformation of a green field would decrease the value per housing unit as compared to the alternative by 8.500 euros (see Table 2). The transformation of a brown field on the other hand does not have any societal costs associated with it when looking at green and open space (EIB, 2011). It might be the case that even value is added due to the addition of green space in this new neighbourhood. However, Arnberger (2012) rightfully pointed out that the societal benefits of urban green space could be lost due to overcrowding. Therefore, when looking at recreational opportunities, urban expansion is the preferred urban development strategy (Ecorys, 2005).

€/housing unit	Urban Densification (transformation of an existing neighbourhood)	Urban Expansion	Urban Densification (brownfield development)
Costs open space and urban green	8500	5200	0

Table 2: Societal costs associated with a loss in the amount of available green/open space per housing unit in different urban development scenarios (EIB, 2011)

4.2 Congestion, traffic safety, and environmental damage caused by traffic

Degraded air quality or an increase in noise pollution, congestion, and/or traffic related accidents will result in a change in housing value within the associated area (SEO, 2006). Mizutani, Suzuki and Sakai (2011) found that there exists a nonlinear relationship between the social costs of vehicular transport and population density in Japan, in which the total costs decrease with an increasing population density. Furthermore, Mizutani et al. (2011) highlighted that the public transport sector tends to slightly decrease the social costs associated with urban vehicular transport and it was stated that compact cities are optimal when looking at traffic use and the associated effects due to the larger focus on public

transport. This statement is in line with the findings of Decisio and EIB (2015), who found that urban densification has 1600 euros per newly developed housing unit less societal costs than urban expansion when looking at traffic related effects (see table 3). Additionally, SEO (2011) found that urban densification leads to 682 euros per year less societal costs as compared to urban expansion per newly developed housing unit per year (see table 4). This is in line with the findings of the research of Ecorys (2005), in which it was found that urban densification is the preferred scenario in terms of congestion and environmental effects. Even though there exists a difference between the different studies in terms of the exact external costs and benefits associated with traffic impact, it is agreed upon that urban densification incurs lower societal costs than urban densification.

€/unit	Densification	Expansion	Difference
External costs due to congestion	2550	2730	180
Costs due to accidents	7730	8620	890
Costs due to emissions	4600	5020	420
Costs due to noise pollution	1030	1140	110
Total external costs related to car traffic	**15910**	**17510**	**1600**

Table 3: Costs associated with car use per newly developed housing unit in different urban development scenarios (Decisio & EIB, 2015)

€/year	Densification	Expansion	Difference
External costs congestion within the city	91	79	-12
External costs congestion on the highway	219	571	352
External costs due to accidents and emissions	159	555	257
Total external costs related to car traffic	**469**	**1066**	**597**

Table 4: Costs associated with car use per newly developed housing unit per year in different urban development scenarios (SEO, 2011)

4.3 Neighbourhood quality and "edge" effects

Rouwendal and Van der Straaten (2008) concluded that the proximity of an industrial area decreases the value of houses, which was also confirmed by De Vor and De Groot (2011). Consequently, changing such an industrial area into a residential area (ideally with green space) increases surrounding housing values. It was estimated that houses located within a 250 metres radius of an industrial site would have a 14.9% lower value than

comparable houses located more than 2 km further away from such a site (De Vor & De Groot, 2011). In the case of urban densification, land at the urban fringe is preserved and quality of the neighbourhoods adjacent to the green areas surrounding the city will not be degraded (Vermeer & Vermeulen, 2012). According to Ecorys (2005), there is a cost difference of 64 million between urban densification and expansion, in which urban densification is the best option. This is in line with the findings of Decisio and EIB (2015), who found that the effect of nuisance, recreation and the environment causes a benefit of 4.000 euros per housing unit for urban densification and a cost of 2.400 euros per housing unit for urban expansion. The effect urban development has on the view was already included in the section on open space and green space, leading to a smaller difference in costs between the two strategies for this research than was found by Decisio and EIB (2015). Also, it is expected that the restructuring and densification of an existing neighbourhood has slightly less associated benefits than the transformation of a brownfield. However, urban densification is still considered to be the preferred strategy in terms of neighbourhood quality and the external effects experienced by adjacent neighbourhoods.

4.4 Knowledge spillovers and amenities

As was discussed in section 3.2.6, urban densification often results in the displacement of poorer people and a re-urbanization of the more affluent middle-classes, who are often higher-educated. Chang, Wang and Liu (2016, pp. 214) found that "the monetary value of spillover effects indicates that a 1 percent increase in the percentage of higher-educated employees in a city will raise the value-added per plant by [approximately 13.000 euros]". However, urban expansion development projects also attract higher-educated people so the difference in external benefits will be lower than this 13.000 euros per plant. Though, urban densification results in a higher concentration of people, leading to a higher degree of knowledge spillovers than is the case with urban expansion.

Furthermore, the labour pool in an area increases due to urban densification, making matching costs between companies and future employees lower (labour market pooling) (Echeverri-Carroll & Ayala, 2010). SEO (2011) found that this improved labour market pooling in combination with an increased productivity and product variety leads to relatively more advantages in the case of urban densification as compared to urban expansion. Also, SEO (2011) found that the advantages associated with the quality and variety of amenities is highest for the densification alternative. Ecorys (2005) and RIGO (2012) found it is too difficult to quantify the diversity and quality of (public) amenities. However, it was found that

urban expansions lead to the negative effect of increased travel costs to reach metropolitan amenities since the demand for such amenities is only high enough in relatively dense urban areas (CPB, 2010; Ecorys, 2005; SEO, 2011). Hence, it is assumed that urban densification is the preferred development strategy in terms of knowledge spillovers, and quantity, quality and reachability of (public) amenities.

4.5 Social cohesion, security, criminality, and segregation

The social safety of an area has a big influence on the neighbourhood quality, and consequently on the housing values (SEO, 2006). According to Ecorys (2005), the feeling of unsafety cannot be quantified exactly for both development scenarios. However, it was concluded that approximately 29% of the people living in a neighbourhood in the city centre experience feelings of unsafety. For an area in the urban fringe, this feeling of unsafety is only reported for approximately 12% of the inhabitants (Ecorys, 2005). This suggests that the urban expansion strategy is desirable in terms of safety/security. This assumption is confirmed by Bramley, Dempdey, Power, Brown and Watkins (2009), who found that lower urban densities often have a more positive effect on safety. The degree of social cohesion and social segregation is especially hard to quantify and therefore left out of this research. It is recommended to further explore the exact effects of urban densification and urban expansion on both social cohesion and segregation.

4.6 Urban heat island effect and energy use

According to Stone, Hess and Frumkin (2010), the number of extreme heat events has increased in large US cities with a higher rate of increase in sprawling metropolitan regions as compared to compact metropolitan regions. This implies that the urban expansion development strategy intensifies the UHI more than the urban densification approach. This assumption is supported by the research of Pearsall (2017) of which the results are shown in Table 5. As is shown in this table, the maximum average surface temperature reached is highest for industrial and commercial lots. Transforming such areas into high density residential areas would actually be beneficial in terms of UHI (decrease of a few degrees). However, densifying an already existing residential area would lead to an increase in the UHI. Urban expansion on the other hand would intensify the UHI more when comparing the mean temperature of park/open space and that of a residential area. Hence, the urban densification development strategy is preferred over the urban expansion strategy in terms of the UHI effect.

	Mean (°C)	Min (°C)	Max (°C)
Residential – High Density	28.9	21.7	36.7
Residential – Low Density	27.7	20.8	35.7
Commercial Business and Professional	30.4	22.4	40.2
Industrial	29.7	14.8	45.6
Park/Open Space	24.0	20.6	34.2

Table 5: Average surface temperature by different land use type in Philadelphia, Pennsylvania (Pearsall, 2017).

The effect of different urban development strategies on energy use is dependent on the type of housing that will be built. Table 6 provides an overview with amount of British thermal unit (Btu, 1 Btu = 1055 Joules) used per housing type. Given that urban densification projects are typically associated with more multifamily housing than single-family housing, it can be concluded that urban densification is the preferred strategy in terms of energy use (Ewing & Rong, 2008).

Housing Unit Type	Per Household (million Btu)	Per Household Members (million Btu)
Single Family:	103.6	37.7
Detached	105.7	38.0
Attached	81.3	33.0
Multifamily:	55.8	27.2
Two to four units	76.1	32.8
Five or more units	46.3	24.0
Mobile homes	67.9	25.8

Table 6: Residential energy consumption in 2009 per housing type (Ko, 2013)

4.8 Overview

Table 7 provides an overview of the previously named externalities and whether they have more benefits/less associated societal costs in the case of urban densification or urban expansion. The pluses and minuses are filled in for different types of urban densification as compared to an urban expansion scenario. When there are no effects, when the effects are the same for urban densification and expansion, or when the effects are too hard to quantify due to different findings in recent research, the cell is given the value 0.

	Urban Densification (transformation of an existing neighbourhood)	Urban Densification (greenfield development)	Urban Densification (brownfield development)
Local urban green space	-	--	0/+
Regional green space	+	+	+
Congestion	+	+	+
Traffic safety	+	+	+
Environmental damage caused by traffic (emissions and noise)	+	+	+
Neighbourhood quality and “edge” effects	+	0	++
Knowledge spillovers	+	+	+
Quality and variety of (public) amenities	+	+	+
Provision of recreational amenities	-	--	-
Social cohesion	0	0	0
Safety/criminality	-	-	-
Segregation	0	0	0
Urban heat island	+	0	++
Energy use	+	+	+

Table 7: Overview of the named externalities associated with urban densification in current literature and whether they are optimal in case of urban densification or urban expansion

5. Housing development strategies for the Amsterdam Metropolitan Area

This chapter will focus on the Amsterdam Metropolitan Area (AMA) and its current and expected housing trends, with a focus on Haven-Stad as case study.

5.1 Amsterdam Metropolitan Area (AMA)

The AMA is a collaboration between 33 municipalities of the provinces Noord-Holland and Flevoland and is often referred to as the "North Wing" of the Randstad, a densely populated urbanized area in the western part of the Netherlands (Metropoolregio Amsterdam, n.d.). As can be seen from Figure 2, the region stretches from Lelystad to Haarlem and it also includes the cities Amsterdam and Almere. The AMA is a region that has received more attention over the last decades. At first the focus was mostly on Amsterdam as a monocentric city (Janssen-Jansen, 2011). However, in the 1960s and 1970s a population shift occurred due to the trend of suburbanization, relocating people from Amsterdam to surrounding municipalities (e.g. Purmerend and the Haarlemmermeer) (PBL, 2016b). Consequently, the focus shifted from Amsterdam as a monocentric city to Amsterdam in a regional context: the Amsterdam Metropolitan Area (Janssen-Jansen, 2011).

Figure 2: Amsterdam Metropolitan Area (Rijksoverheid, n.d.).

5.1.1 Current situation

According to the municipality of Amsterdam (2017a) and Jonkman and Janssen-Jansen (2015), there is a housing shortage in the city of Amsterdam (mostly in the area enclosed by the A10 ring road). On top of that, the city experienced rapid economic growth in the last years, also in comparison to the rest of the country and other European cities

(Gemeente Amsterdam, 2017a). Accordingly, Amsterdam is not only attracting many people from within the Netherlands, but also many international employees (Gemeente Amsterdam, 2017a). These trends have caused an enormous increase in property values (see Figure 3) and has led to difficulties in finding proper and affordable housing (Gemeente Amsterdam, 2017a). As a response, Amsterdam's total housing stock has increased each year since 2013 (Gemeente Amsterdam, 2017c). This trend of building stock increase has also been visible in the rest of the AMA. According to data of the Municipality of Amsterdam (2017c), the housing stock has increased by more than 3% in the region (37.600 houses) in 4 years' time.

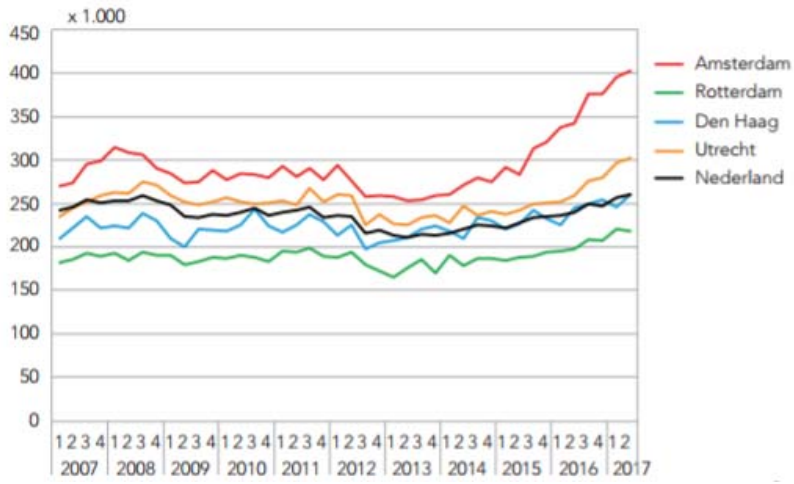

Figure 3: Average selling price of existing owner-occupied properties, quarterly 2007-2017 (Gemeente Amsterdam, 2017a).

5.1.2 Expected trends

According to the CPB and PBL (2015), the total number of inhabitants in the Randstad will increase in both high-growth and low-growth scenarios (in terms of population) till at least 2030, as can be seen in Figure 4. The population growth in the AMA is mostly caused by a large influx of young people from other parts of The Netherlands (who are likely to get children) and international knowledge workers (Gemeente Amsterdam, 2017a; Metropoolregio Amsterdam, 2017). To cope with this population increase, the spatial-economic agenda 2016-2020 aims at, among other things, the realisation of 250.000 new houses before 2040 (Metropoolregio Amsterdam, 2017). This means that an average of approximately 11.000 houses must be built per year over a period of 23 years, which is a bit more than the average that has been built over the last 4 years. However, space has become scarce and the large demand asks for proper future spatial coordination and development (Metropoolregio Amsterdam, n.d.).

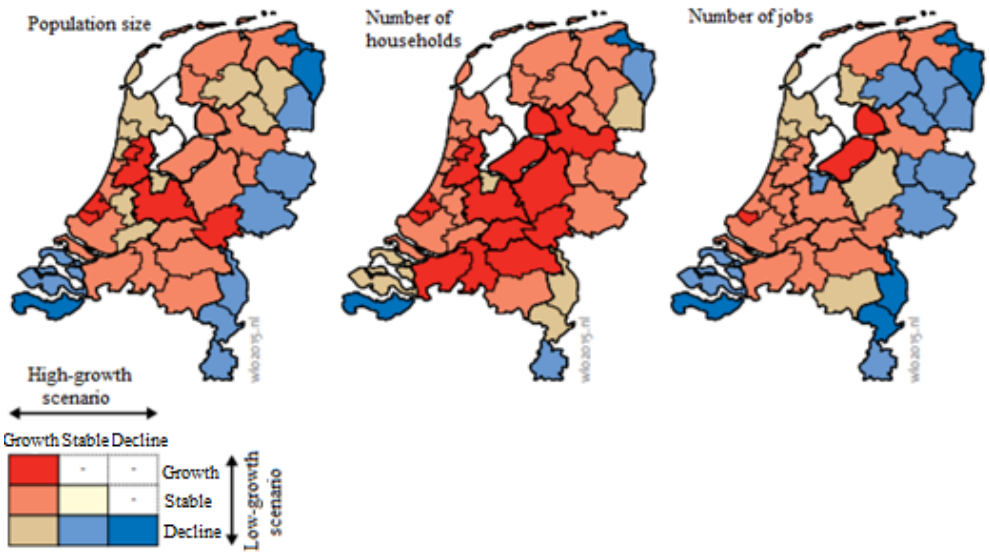

Figure 4: Change in population size, number of households and number of jobs per population growth scenario (high-growth vs low-growth) in the Netherlands (CPB & BPL, 2015).

5.1.3 Housing development strategies

The expected population growth in the AMA calls for more housing developments in the Amsterdam region. As a result, the building and living program for the AMA for 2018 focuses on different housing development approaches in different sub-regions (Metropoolregio Amsterdam, 2017). In the Zaanstreek-Waterland region for example, the focus will be on densification of existing urbanized areas (Metropoolregio Amsterdam, 2017). For the Zuid-Kennemerland and IJmond region on the other hand, there will be a large focus on the potential of non-urbanized areas to become urbanized (Metropoolregio Amsterdam, 2017). Figure 5 provides a map with all housing development plans and their status in 2017 as compiled by The Board of Government Advisors (CRa), the province of South-Holland and RIGO. The figure shows that there are proposed inner-city housing development projects (e.g. in Amsterdam and Purmerend), as well as large-scale urban expansion projects (e.g. around Almere).

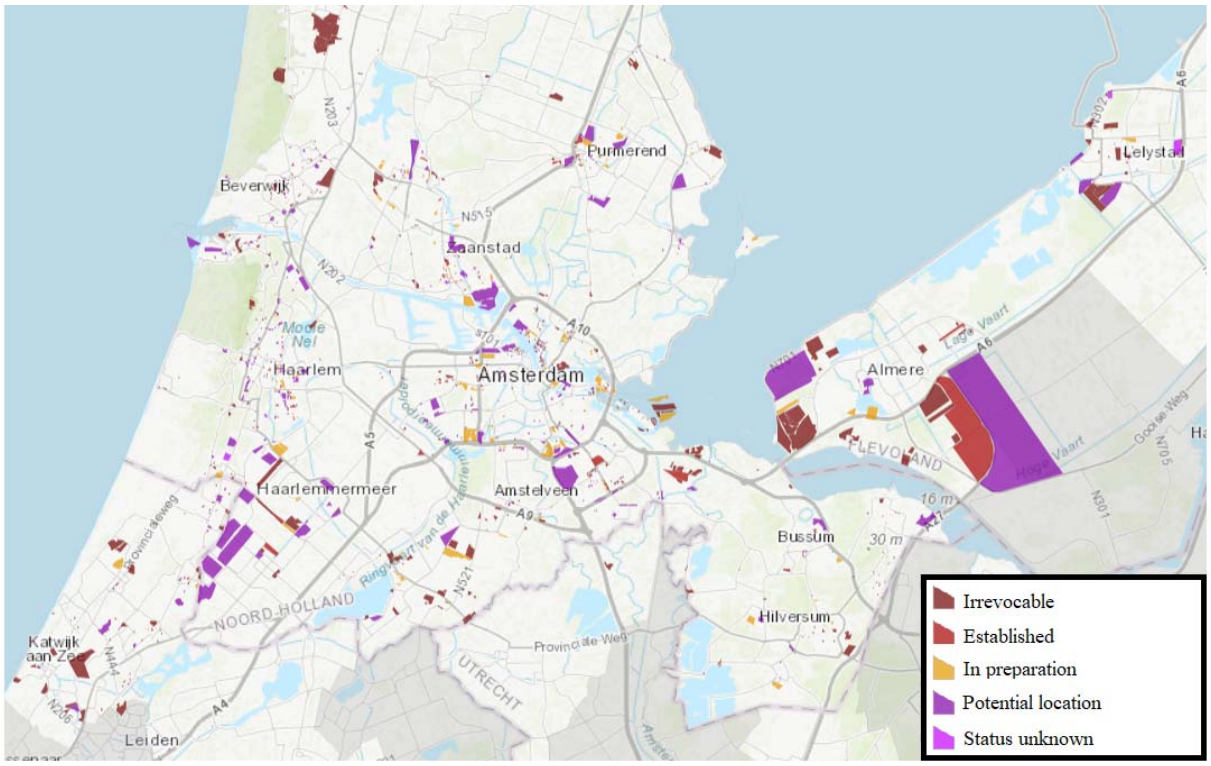

Figure 5*:* Overview of building plans for the Amsterdam Metropolitan Region showing both urban densification and expansion projects. (CRa, Province of South-Holland & RIGO, 2017).

5.2 Haven-Stad

As case study, the development of the so-called Haven-Stad, a large scale inner-city transformation project is chosen (see Figure 6). The development of Haven-Stad is one of the many proposed building plans within the AMA as can be seen in Figure 5 (note however that the Haven-Stad developments are marginal in this image). Currently, two different scenarios have been designed; The first scenario involves the addition of about 40.000 houses and 45.000 jobs within the existing city structure (low scenario). The second scenario entails the addition of 70.000 houses and 58.000 jobs within the existing city (high scenario) (Gemeente Amsterdam, 2017b). The building process has already started a few years ago and the Houthavens neighbourhood has been transformed and densified for a large part. Other neighbourhoods (such as Sloterdijk, and the Spaarndammer and Zeehelden neighbourhood) have not yet been developed but will be in the near future. The overview of externalities associated with urban densification presented in the previous chapter is compared to the processes present in the Haven-Stad area in the next section to determine its accuracy and applicability (see Table 8 for the data used in ArcMap).

Figure 6: Haven-Stad plan area located in the city of Amsterdam (Gemeente Amsterdam, 2017b).

	Publisher	Year	Scale	Type	Purpose	Accuracy
Land Use	Municipality of Amsterdam	2016	Amsterdam	Shapefile	Retrieve land use types of different areas	-
Case Study Area	Created by author .	2018	Neighbourhood in Amsterdam	Shapefile	Specify case study area	0-5 m
Noise From Industry	Municipality of Amsterdam	2017	Amsterdam	Shapefile	Retrieve noise pollution due to industry	-

Table 8: Data used in ArcMap with corresponding characteristics

5.3 Findings Haven-Stad Compared to the Externalities Overview

According to a report written by the municipality of Amsterdam (2017a), the total area of Haven-Stad is approximately 650 hectares (ha) (water excluded). However, own calculations of the total area in ArcMap (portrayed in Figure 7) resulted in an area of approximately 1000 ha (water excluded). No exact explanation could be found for the large deviation between reported area size and calculated area size. However, when water and traffic related land uses were excluded, a total area of approximately 732 ha was found in ArcMap. It could be that traffic related land uses were also not included in the calculations of the total area of Haven-Stad by the municipality of Amsterdam. Since the quantification of specific area types was done by using ArcMap, the own calculated area size was used.

Green Space

In the Haven-Stad area, approximately 2 ha of open and green space is currently present (rural area, recreational area (often green space), and wood and nature) (see Figure 7). According to the development strategy, there is a large focus on providing green space with a good quality to the inhabitants of Haven-Stad. However, when looking at the future projections for green and open space, there will only be about 1.8 ha present (0.2 ha less than

in the current scenario due to extra housing units as can be seen in Figure 8). The current valuation of green space in the Haven-Stad area is low, especially for the Houthavens neighbourhood (5,9 out of 10), which supports the expectation that areas undergoing densification have poorer quality green space (Gemeente Amsterdam, 2017d). Ideally, an overview containing the externalities associated with urban densification would include the costs associated with an absolute loss in urban green space due to the proposed developments as compared to the costs of prevented loss of green outside the city boundaries.

Environmental damage caused by traffic (emissions and noise), congestion, and traffic safety

There is a great focus on providing new public transport connections and hubs in the Haven-Stad area (Gemeente Amsterdam, 2017b). Therefore, it is assumed that the overview containing the external effects that arise from densification also holds for the environmental damage caused by traffic and the traffic safety categories. However, congestion might be worse than expected due to the limited expansion space of the road network in the area (Gemeente Amsterdam, 2017b). These limited opportunities for road expansion highlight that the effects associated with urban development are very case specific and that it is difficult to make generalised assumptions.

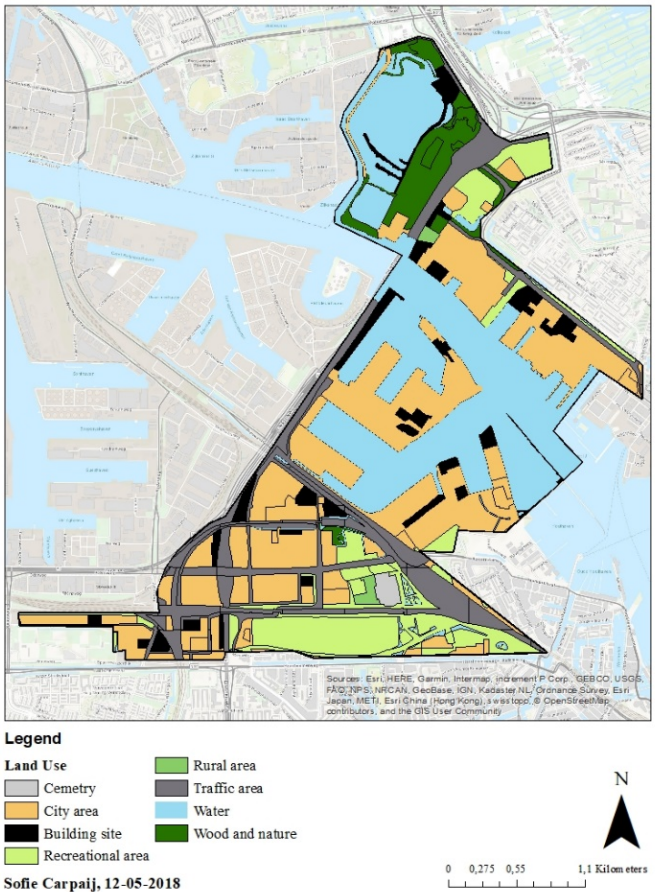

Figure 7: Current land use types in the area where Haven-Stad will be developed.

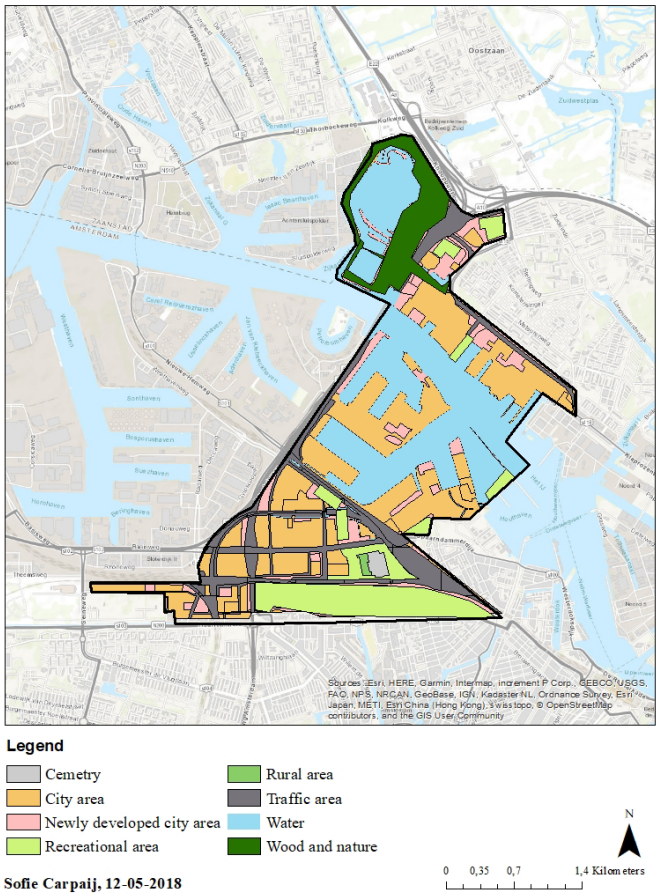

Figure 8: Changes in green and open space due to the Haven-Stad development.

Neighbourhood quality and "edge" effects

Currently, the inhabitants of the future Haven-Stad area value their neighbourhood quite low as compared to inhabitants of surrounding areas (Gemeente Amsterdam, 2017d; Gemeente Amsterdam, 2017g). Furthermore, a lot of decay is experienced in the commercial Sloterdijk area, which will be developed into a mixed use area with working and housing opportunities (Gemeente Amsterdam, 2017e). This in combination with the transformation of the other industrial sites that cause noise pollution (see Figure 9) will most probably result in an improved neighbourhood quality (Gemeente Amsterdam, 2018b). This suggests that urban densification could improve the neighbourhood quality considerably and that neighbourhoods adjacent to the area could also experience positive effects due to the transformation. This is in line with the expected effects in the externalities overview.

Furthermore, the level of decay and nuisance experienced in the densified Houthavens neighbourhood is substantially lower than in the other neighbourhoods present in the Haven-Stad area (Gemeente Amsterdam, 2017d; Gemeente Amsterdam, 2017f; Gemeente Amsterdam, 2017g). This in combination with the ratio of corporately owned housing (high in the neighbourhoods that did not undergo densification yet) and private rental (high in the

Houthavens) suggests that urban restructuring projects are indeed beneficial to the developed area. Though, urban expansions are also associated with privately-owned housing, making this societal benefit less explicit (US Energy Information Administration, 2015).

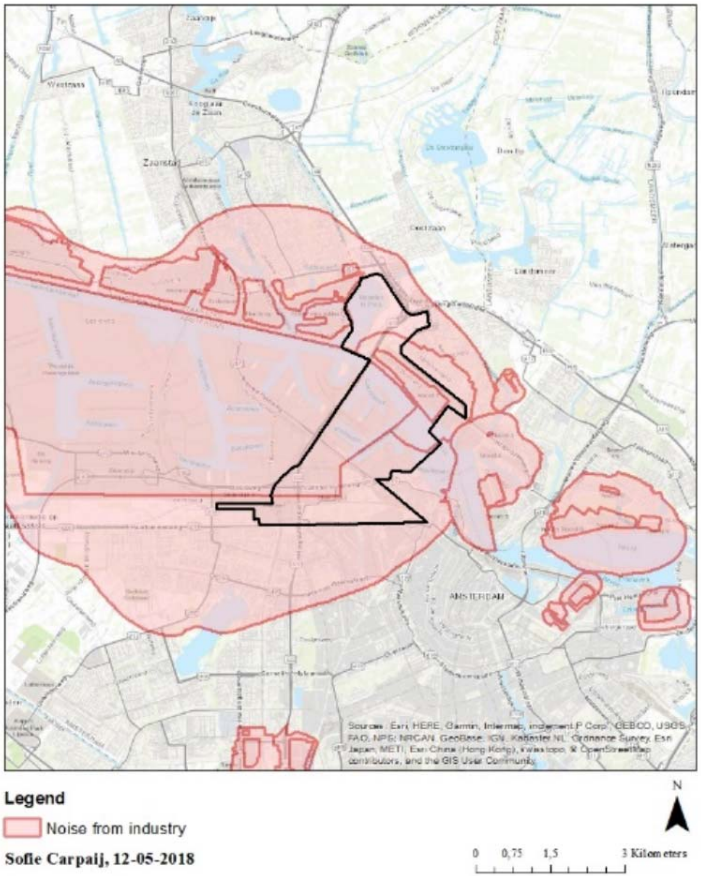

Figure 9: Areas in Amsterdam where noise is experienced due to the present industries

Urban heat island

The urban heat island change in the area is too difficult to quantify and beyond the scope of this research. To find an approximation of the change in UHI it is recommended to perform an extensive regression analysis between different land use characteristics within the city and its surroundings, and the corresponding temperature. Subsequently, the relationship between these land use variables and the UHI can be found for that specific area and an estimation in UHI change due to the urban transformation can be made.

Energy use

The future amount of energy used in an area is extremely hard to quantify because it is dependent on the types of houses that will be built. As is written in the development strategy of Haven-Stad, mostly high-rise will be built since there is no space available for suburban low-rise (Gemeente Amsterdam, 2017b). The same amount of houses in an urban expansion development project would most probably result in more energy use due to the difference in

housing type. Therefore, it is expected in terms of energy use that the densification approach is preferred, which in line with the expectations included in the overview.

Social cohesion and segregation

In most of the neighbourhoods that are currently present in the future Haven-Stad area, there are low levels of participation (Gemeente Amsterdam, 2017f). In the Houthavens however, there is relative high neighbourhood involvement (Gemeente Amsterdam, 2017d). This suggests that urban densification could result in a higher level of social cohesion, which is in contrast with the findings of the first part of this research. Tuindorp Oostzaan however, a neighbourhood with relatively low density adjacent to the Haven-Stad area, experiences high levels of involvement among residents (Gemeente Amsterdam, 2017g). Furthermore, the socio-economic status is found to be relatively high in the Houthavens neighbourhood (Gemeente Amsterdam, 2017d), indicating that urban densification might indeed result in a re-urbanization of the middle-classes. However, the exact influence of urban densification as compared to urban expansion on the level of segregation could not be found. This highlights the difficulty of quantifying the level of social cohesion segregation and more research on these topics should be done to obtain a better overview of the effects associated with urban densification.

Safety/criminality

The feeling of unsafety in the Spaarndammer and Zeehelden neighbourhood is around 26%, which comes close to the found 29% in the first part of this research (the percentage of people living in a neighbourhood in the city centre experiencing unsafety). The feeling of unsafety found in the Tuindorp Oostzaan neighbourhood, which is located in the urban fringe, is much higher (34%) and contradicts the finding in the first part of this research (only 12%). However, the Tuindorp Oostzaan neighbourhood is relatively old and urban expansion might result in lower feelings of unsafety. More research is needed into the effects of urban densification on the level of safety in a specific area.

Knowledge spillovers

Haven-Stad is a large scale inner-city project that will spatially combine residential units with commercial units. It is highlighted in the development report that the current knowledge economy requires interaction and proximity of employees. In the planning process of Haven-Stad it is definitely taken into account that knowledge spillovers occur as a result of the high spatial concentration of skilful people. This suggests that right connections were

found in the first part of this research. However, the exact effect of urban densification on knowledge spillovers has not been found in the case of Haven-Stad.

Quality and variety of (public) amenities

Currently, most people in the neighbourhoods in the Haven-Stad area are dissatisfied with the available amenities (Gemeente Amsterdam, 2017d; Gemeente Amsterdam, 2017f; Gemeente Amsterdam, 2017g), which also holds for the residents of the Houthavens neighbourhood (Gemeente Amsterdam, 2017d). This finding contradicts the findings of the first part of this research , in which it was expected that the quality and variety of (public) amenities will be higher for densified areas. However, it might be the case that the amenities will improve after a few years.

Provision of recreational amenities

Due to the increased demand for living space, part of the area used for recreational purposes will be transformed into city area. It is in line with the findings of the first part of this research that urban densification results in a decrease in the provision of recreational amenities.

6. Discussion and conclusion

This study presented a concise overview of the externalities involved with urban densification as compared to urban expansion. According to this overview, urban densification is the optimal urban development strategy when considering most external effects. However, there are various options for urban restructuring (e.g. high-rise, compact low-rise, or brownfield/green field developments), making the optimal development strategy variable. Based on the findings in this research, it is recommended in most urban development practices to densify areas with a focus on providing enough urban green space (suitable for recreation). Additionally, there should be a focus on reducing crime levels by e.g. creating well-targeted programmes and a proactive attitude within the community to activate inhabitant's involvement, which could also lead to increased social cohesion. In terms of segregation, it is recommended to include social housing as well as privately-owned properties in the area to allow for mixed neighbourhoods. If there is no room for urban densification, it is recommended to include multi-family residential units in the expansion project, to ensure relatively low energy use. Also, it is suggested to use a dense expansion approach, such that the extra land required for the expansion remains low.

A limitation of this research is the restricted availability of scientific literature to describe some of the external effects. It is recommended to especially perform more research on the effects of urban densification on social cohesion, segregation, safety and criminality, and knowledge spillovers. This can be done by performing a statistical analysis based on variables including information on urban density, crime rates, inhabitant participation, socio-economic status, and local productivity. Moreover, it is adviced to do more research on the exact societal costs associated with an absolute loss in urban green space in comparison to a preserved loss of green outside the city boundaries. Additionally, the analysis of the Haven-Stad case study area in comparison to the found externalities and associated quantities highlighted the need for case specific research. Urban planners and policy makers are therefore recommended to extensively analyse the processes associated with the individual effects included in the overview in their specific planning context to find the optimal development strategy.

Furthermore, the densification of existing residential areas often results in the displacement of the poorer inhabitants. For the areas where densification will take place and the adjacent neighbourhoods, mostly positive effects arise in terms of amenities and company revenues. However, the displaced people settle in other (probably poor) neighbourhoods,

optionally intensifying problems that are already present there and increasing regional and social inequalities (Davison & Lee, 2009). The negative external effects that could arise in these other neighbourhoods are not included in this research since it is too difficult to exactly predict the behaviour of the displaced dwellers. Therefore, an underestimation of the negative effects that arise due to urban densification is present and further research concerning the effects on other neighbourhoods is required.

Finally, it is recommended to extend the research by choosing several more case study areas of both urban expansion and urban densification projects. Ideally, some of the case study areas that have undergone densification several years ago are analysed in order to determine long-term effects more precisely. Additionally, a larger number of case studies possibly enables to identify general trends that could not be identified through this research.

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