ACCESSIBILITY IMPACTS OF ALTERNATIVE URBANIZATION STRATEGIES IN THE NETHERLANDS

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Significance

1. INTRODUCTION

The Ministry of Infrastructure and Environment of the Netherlands has launched a new policy program to explore a wider approach to improve accessibility. The program should avoid a single focus on infrastructure investments and advocates an integrated regional approach, to be worked out by national, regional and local stakeholders, including multi-modal, ICT and land-use strategies. This paper focuses on the accessibility impacts of alternative urbanization strategies. The paper presents the results of a study, commissioned by the Ministry of Infrastructure and Environment, with the aim to calculate and assess the accessibility impacts of alternative urban strategies.

The population, and especially the number of households, in the Netherlands is still forecasted to grow in most parts of the country. Statistics Netherlands CBS forecasts in their household forecast a growth of around 1 million households in the Netherlands in the period up to 2040. This growth in households, combined with a lack of housing construction during the crisis period of 2008 – 2014, sets a challenge to intensify housing construction developments. Regional scenarios indicate that the majority of this demand for housing in the coming decades is expected to be located in the larger urban regions. The urban development strategies for these urban regions is therefore a relevant topic of research closely related to future accessibility challenges. This paper presents the accessibility impacts of eight different urbanization strategies for the Netherlands.

A wide set of accessibility indicators was used to demonstrate the various aspects of accessibility, including network-, geographical- and monetary indicators for accessibility. Together these indicators present a comprehensive picture of the accessibility impacts of changes in travel times as well as of changes in the proximity of activities. The changes in travel times and changes in the spatial distribution of activities are calculated with the TIGRIS XL model, a land-use and transport interaction model for the Netherlands.

The paper is structured as follows. In the next section the research framework and policy indicators for accessibility are described. Section 3 presents an overview of the eight alternative urbanization strategies addressing the scope of the alternatives and their differences. The various accessibility impacts of the urbanization strategies are discussed in section 4 including congestion, geographical accessibility and welfare benefits of changes in accessibility. Finally Section 5 presents conclusions and recommendations based upon this study.

2. RESEARCH METHOD

The research framework for this study, as outlined in figure 1, follows a 'standard' research approach. The research steps consist of setting the reference situation and designing alternative urban strategies, applying a model to calculate the effects and applying post-processing modules to translate the effects into policy indicators. In practice these steps are applied in an iterative way and the outcomes on policy indicators are used to discuss and fine tune the variants.

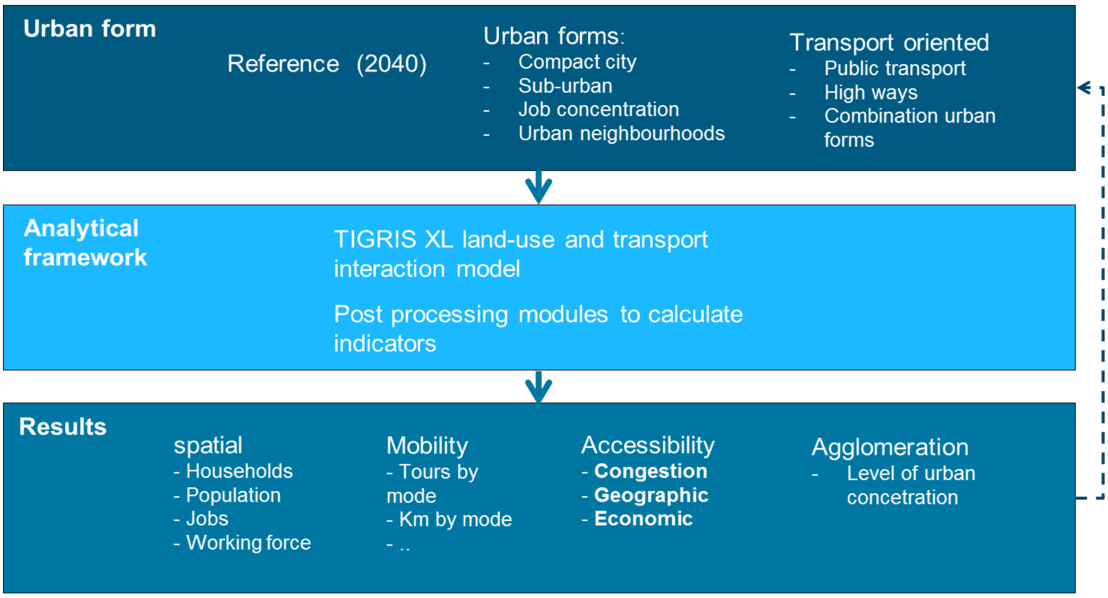

Figure 1: research framework for the urban strategy study

The first step of setting the reference situation for 2040 and designing eight alternative urbanization strategies is further discussed in section 4. In the second step the TIGRIS XL model is at the core of the analytical framework. TIGRIS XL is a so-called land use and transport interaction model for the Netherlands and can be characterized by its dynamic in structure, as it iterates between transport and land-use components, to model how the system evolves over time (Zondag 2007; Zondag et al. 2014). Main characteristics are that both the residential location choices and firm location choices are estimated on detailed spatial data sets covering different economic sectors and household types . Further the model uses a flexible modular set-up and the standard National Model System is integrated as its transport module. Post-processing modules are attached to calculate the policy indicators of interest.

2.1. Policy indicators

A broad set of output indicators is generated within this study consisting of spatial indicators, such as distribution of population or employment, transport indicators, such as mode split or average distances travelled and accessibility indicators. In this paper we focus in particular on accessibility indicators and their role in the evaluation of land use policies. Originating from different research disciplines, such as transport, geography and economy, a wide variety of accessibility indicators exists. Geurs and van Wee (2004) classify different types of accessibility indicators, in line with this we distinguish here between network indicators, geographical accessibility indicators and/or geographical economic indicators.

This study includes an example of all three types of accessibility indicators to analyze the accessibility effects from different perspectives. The discussed accessibility indicators are:

- As network accessibility indicator a congestion indicator, expressed as travel time losses on the network, is included. This indicator is frequently used by the department of transport as output indicator to measure the effectiveness of transport measures. The indicator is very responsive to changes in the network especially if bottlenecks are solved, but the indicator only responds indirectly to changes in land use following its impact on travel time losses. Any impact on the proximity of activities is not measured by this indicator;

- A geographical indicator is included to measure both changes in speed and proximity. The indicator consists of either number of population or employment, as measure for the attractiveness of destination, and a mode specific distance decay function is estimated on observed travel behaviour in the National Travels Survey for the Netherlands. The parameters for the distance decay functions by mode in this study are gratefully borrowed from the Netherlands Environmental Assessment Agency. The distance is represented by the travel time by mode between A and B, using congested travel rimes for car and for PT the fastest public transport connection between A en B including access, egress and waiting time. The geographical indicator responds to changes in travel times, and frequencies of public transport, in the region as well as to changes in the spatial distribution of jobs and population;

• As economic-geographical indicator, a so-called logsum indicator measuring changes in utility, is used. In the Netherlands the rule-of-half method is standard used to calculate the consumer benefits. However, in the literature it has been pointed out repeatedly that the rule-of-half gives incorrectly measured welfare effects of land-use policy plans (e.g., Neuburger, 1971) and transport strategies where land uses are forecasted to change as a result of the strategy (Bates, 2006; Geurs et al., 2006; Simmonds, 2004). The logsum indicator is capable of addressing the monetary benefits resulting from speed improvements as well as proximity improvements. The logsum method is therefore well suited to calculate the benefits of accessibility changes as a result of either a transport (generalised cost) change or a land-use change.

This paper discusses the different type of accessibility effects for the alternative urbanization scenarios. The study aims to present a practical way to include wider accessibility impacts, like changes in proximity, in addition to a more traditional focus on travel time improvements alone.

3. ALTERNATIVE URBANIZATION SCENARIOS

3.1. Eight variants

The reference scenario assumes a housing demand of around one million houses for the Netherlands, in addition to the existing housing stock of 7.2 million houses, in the period up to 2040. This is still a substantial growth and regional scenarios indicate that the majority of this growth is expected to be located in the larger urban regions. The study assumes that in the variants the housing demand for each urban region is similar to the reference situation. Within an urban region the reference situation and urbanization variants differ in the spatial distribution of activities.

In this way the study focusses on the impacts of alternative urbanization options for the larger urban regions in the Netherlands by addressing issues as the tension between green field and brown field developments. In general there is a policy ambition to realize brown field developments but green field developments are pushed by lower costs and sometimes land positions of local governments.

In total eight different urbanization variants have been defined for the land use developments within the urban regions up to 2040. The land use variants vary between more or less concentration in urban or suburban areas and are implemented at a municipality or at a neighbourhood level by type of neighbourhoods (e.g. urban centre with high densities or residential green and low density neighbourhoods). Furthermore two variant focus specifically on existing infrastructure and the land use developments take advantage of either well accessible transit or high way locations.

Table 1: overview of alternative urbanization strategies for the urban regions in the Netherlands

Nr	Name	Description
1	Compact city	Concentration of housing developments within the central cities of 22 urban regions in the Netherlands
2	Sub urban	Concentration of housing developments in urban regions outside the central cities in suburban municipalities
3	Job concentration	Increased concentration of employment in urban centres
4	Public transport	Concentration of housing development at well accessible public transport locations (ToD)
5	High way	Concentration of housing developments at well accessible high way locations
6	Urban neighbourhoods	Concentration of housing developments in urban neighbourhoods
7	Green and rural neighbourhoods	Concentration of housing developments in green and rural neighbourhoods within larger urban regions
8	Combi urban and Public Transport	Combination of concentration in urban neighbourhoods and at well accessible PT locations

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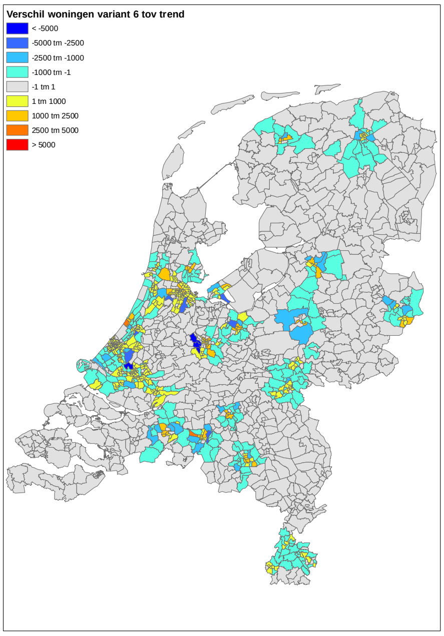
The urbanization strategies in table 1 differ from the reference situation for around 20% of the location of housing developments, this is around 200 thousand houses out of a total housing development of 1 million. The alternatives were implemented at a regional scale and as regional scale we have used the 22 urban regions in the Netherlands as identified by the Statistics Netherlands. This regional approach means that the population for each region is in all variants similar to the reference scenario and the population figures differ at the level of zones within a region. All the variants assume that there are no changes in the transport system in comparison with the reference scenario.

Figure 2 presents an example of a strategy. In this strategy housing development within the urban regions is concentrated within urban neighbourhoods. The maps shows a shift in housing developments from more suburban neighbourhoods to more urban neighbourhoods. In the grey areas outside these urban regions the situation is assumed to be unchanged in comparison with the reference situation.



In this study the housing developments are implemented in the TIGRIS XL model as exogenous inputs (note: housing supply can be endogenous as well depending on user settings). The model calculates the spatial distribution of households by type and jobs by sector. These changes in the spatial distribution of activities, resulting from differences in the housing supply, influence each other as well. The location choice of economic sectors respond to changes in the population and to changes in other economic sectors. Furthermore the travel behaviour and patterns are influenced by the changes in the spatial distribution of activities. The outputs of the TIGRIS XL model are processed into various accessibility indicators as presented in the next section.

4. ACCESSIBILITY IMPACTS

4.1. Congestion

The alternative urbanization strategies have a modest impact on number of tours and kilometres travelled by mode. In case of concentration of activities in urban areas there is slight shift in number of tours towards public transport , both train and bus/tram/metro, and active modes. The impact on passenger kilometres travelled by mode differ from this pattern as urban tours for slow mode or public transport are on average shorter than non-urban tours. In case of concentration in urban areas a slight decrease in number of car tours and kilometres travelled can be observed. Overall the eight variants vary between minus -0,6% and plus 0,4% in travelled kilometres by car. Please note that in the variants around 2,5% of the population resides at an alternative location.

The impacts on congestion, as presented in figure 3, are much more substantial than could be expected from the change in number of car kilometres. The figure 3 presents that urbanization strategies have an impact on national congestion levels between -7% and plus 9%. Especially developments in suburban locations increases the geographical mismatch between jobs and residents and results in additional travellers on already heavily used connections.

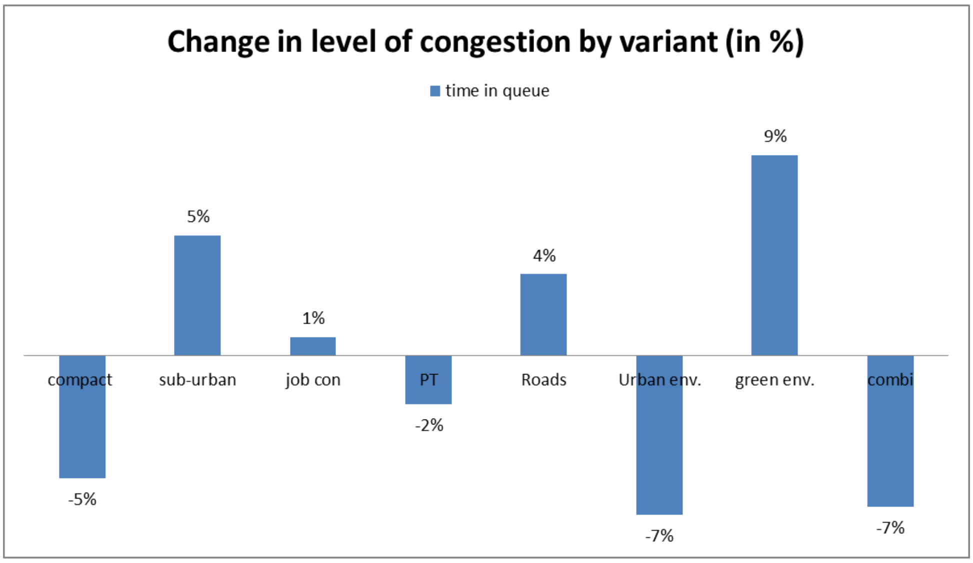


Figure 3: changes in level of congestion for the eight urbanization strategies

A more concentrated residential development in urban areas results in a better geographical match between jobs and residents and diminishes the pressure on heavily congested connections between residential suburbs and central cities. The figure presents national figures but more detailed analysis shows that there is a strong regional variation for the impacts of urbanization strategies on regional congestion levels.

4.2. Geographical accessibility

The geographical accessibility indicator presents the accessibility of jobs, within acceptable travel times, for car and Public transport travellers. In this case study the travel time for Public transport is unchanged for all eight variants and the travel time by car various only with the changes in congestion levels. The alternative locations of housing developments in the variant influence directly the spatial distribution of residents and via the relationship between people and jobs also indirectly the location of jobs, which is called the destination effect. The direction and magnitude of the impact differs by economic sector depending on its estimated sensitivity for changes in the population.

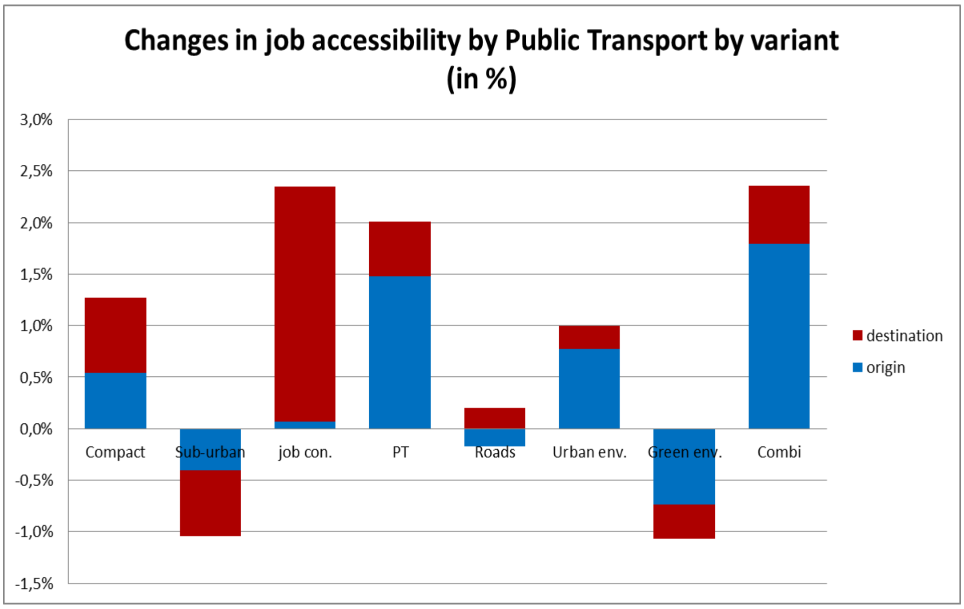


Figure 4: job accessibility by public transport

Figures 4 shows that the job accessibility for public transport travellers can be improved by concentrating housing developments in urban areas and/or at public transport locations. Furthermore an increased concentration of jobs in the urban centres makes these jobs more accessible for a larger group of public transport travellers. The magnitude of the change in job accessibility, between -1,0% and +2,5%, can be considered as substantial. For example, the proximity of jobs in the Netherlands has increased by 2,5% in the period 1995-2016 (PBL, 2016). In this period of 20 years around 1,2 million additional houses were constructed with a slight focus on urban areas. Comparison with this historical development shows that a specific strategy for around 0,2 million houses can have a similar impact.

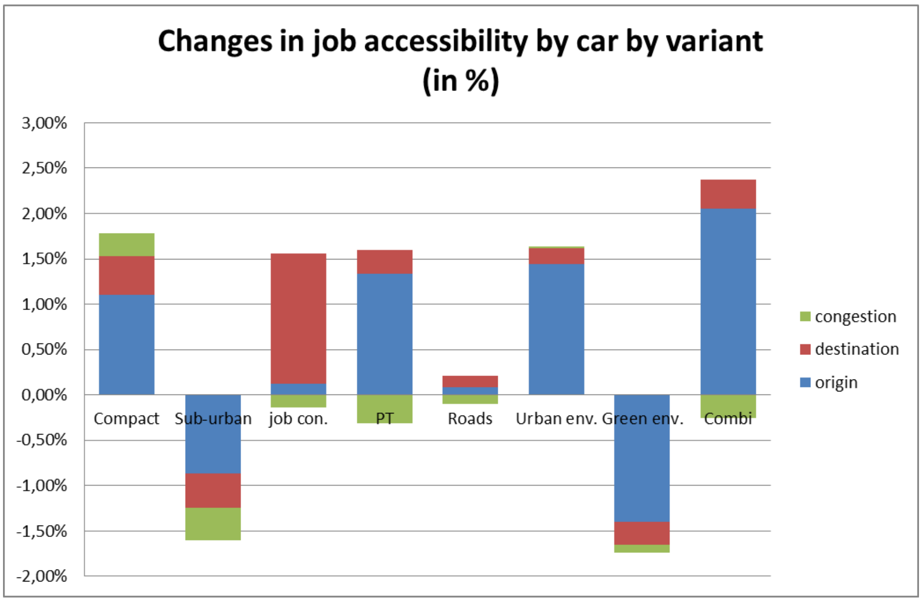


Figure 5: Job accessibility by car

The job accessibility by car indicator shows comparable effects and includes besides changes in proximity also changes in travel times (as travel time losses differ for the eight scenarios). The urban concentration variants show positive effects and the decomposition in aspects shows that the proximity effects, both origin and destination, are dominant above the changes in travel times.

4.3. Accessibility benefits

The accessibility benefits represent the changes in welfare and consist of benefits resulting both of increases in proximity as well as in travel speed. The Table 2 shows that land use strategies can have high accessibility benefits ranging between -300 million and plus 500 million a year in 2040. This means that it is important to include the accessibility benefits of land use strategies in the evaluation of land use strategies. Furthermore it also indicates that land use planning can indeed be an potential instrument to improve accessibility in addition or as replacement of infrastructure investments.

Table 2: Accessibility benefits of the eight urban variants in 2040, in million Euro's per year (in 2010 prices)

	Commute	Business	Other	Total
Compact city	200	20	110	330
Sub urban	-170	-15	-100	-285
Job concentration	70	10	30	110
Public transport	225	20	116	361
High way	-1	-1	15	14
Urban neighbourhoods	208	17	149	374
Green and rural neighbourhoods	-214	-21	-115	-351
Combi urban and Public Transport	312	28	181	522

The urban concentration variants show substantial positive benefits and opposite the suburban variants show a lost in accessibility benefits. A more refined variant combining urban concentration with an additional focus on public transport locations results in the highest benefits. The vast majority of the benefits of land use strategies are proximity benefits resulting from a better spatial matching of activities. Two sensitivity tests on the impacts of travel time changes have confirmed that travel time gains are less than 20% of the total benefits. This is in line with the results of the geographical accessibility indicator.

5. CONCLUSIONS AND RECOMMENDATIONS

This paper has presented the various accessibility impacts of alternative urbanization strategies A summary of these findings is presented below:

The impacts of urbanization strategies on transport indicators as number of tours or km by modes is rather modest. Only a small share of the population, around 2%, is affected by an alternative residential location. Urbanization strategies have therefore only a very modest potential to contribute to energy consumption or CO_2 emission targets. The impacts on congestion levels are more substantial than the changes in car kilometers, varying between +9% and -7% congestion at a national level. These national averages differ strongly between regions depending on their sensitivity for land use changes.

The urbanization strategies have a substantial impact on the accessibility of jobs by car or PT within an acceptable travel time. Increases or decreases in the proximity of activities, as a result of the urbanization strategies, have an important impact on the values for this indicator. Reflecting that a person living in an urban neighbourhood can reach much more job opportunities within an acceptable travel time than a person living in a more suburban environment. The urban concentration variants and public transport variant improve the accessibility scores for this indicator. This indicator is closely linked to what economist consider effective density as a measure for the level of agglomeration in a region.

The geographical-economic indicator shows that very substantial accessibility benefits can be realized consisting of both changes in proximity and travel times. The accessibility benefits of the variants in 2040 vary between -350 million a year, for the suburban and green variant, and plus 500 million a year, for the combined urban and public transport concentration variant. The vast majority of the accessibility benefits consists of proximity benefits.

It is important to note that this study shows only a partial analysis, focusing on accessibility benefit, of the impacts of urbanization strategies. For a full overview of the costs and benefits of urbanization strategies additional research work on other subjects is needed, including the differences in constructions costs or loss of open spaces.

Based on these findings several recommendations were proposed for the Ministry of Infrastructure and Environment. Main recommendations were:

- A regional robustness indicator is proposed to test the sensitivity of accessibility, like congestion or job accessibility, within regions for alternative land use patterns. This information should be part of the discussions between the national and regional government on infrastructure spending, or considering alternative approaches, to improve accessibility conditions within the region;

- Use wider geographically based accessibility indicators as land use variants have a large potential to improve the proximity of activities and therewith the accessibility of regions. Network based accessibility indicators do not include these benefits and the use of wider geographical indicators is needed to avoid a single focus on network measures. In the evaluation phase the wider accessibility benefits should be part of a cost benefit analysis including among others investment and maintenance costs, open space, public transport budgets, etc.

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