The role of spatial information for planning sustainable cities

Sanne BROEKHOF and Ramona VAN MARWIJK, the Netherlands

Key words: geographic data, spatial information, urban planning, sustainability

SUMMARY

Recently, the world has welcomed its 7 billionth inhabitant. It is expected that we will grow to 9 billion persons by 2050. Currently, more than half the world lives in urban areas and urbanisation will continue in the future. Harvard economics professor Glaeser convincingly argues that populations can have magical consequences for business and innovation. At the same time we are aware of the environmental consequences of sprawling suburbs. Thus, sustainability is a core issue for today's spatial planner. However, sustainability entails more than green architecture or re-using building materials (the planet aspect). A city should for example also be an attractive place to live (people aspect) with economic potential for its inhabitants (profit aspect).

The practice of spatial planning greatly influences our environment. Where do we construct new houses? And what type of houses? Given the importance of cities, we argue that sustainability is a necessary mindset of planners. In today's network society geographic information has an increasingly important role to reach this mindset. In this paper we want to research how spatial information may spur the discussion on planning sustainable cities. We do so by analysing cadastral, environmental, socio-economic and real estate data. Yet, the careful interpretation of geographic data into spatial information is essential for the quality of the final result. This is often underestimated by spatial planners.

By means of a case study area (city of Apeldoorn, the Netherlands), we show how geographic information can be used in strategic decision making for sustainable city development. Six spatial visualisations (carbon dioxide emissions, liveability, house density, services, income, average dwelling value) of various sustainability aspects are used to show how geographic information can be used in spatial planning. It is concluded that spatial information can support decision-making in the planning process and help policy makers to identify possible alternatives for 'unsustainable' actions in the planning area. In order to interpret and use geographic data for sustainable development multidisciplinary cooperation is necessary.

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1. INTRODUCTION

Recently, the world has welcomed its 7 billionth inhabitant. It is expected that we will grow to 9 billion persons by 2050. Currently, more than half the world lives in urban areas and urbanization will continue in the future. Harvard economics professor Glaeser (2001) convincingly argues that populations can have magical consequences for business and innovation. At the same time we are aware of the environmental consequences of sprawling suburbs. Thus, sustainability is a core issue for today's spatial planner. However, sustainability entails more than green architecture or re-using building materials (the planet aspect). A city should for example also be an attractive place to live (people aspect) with economic potential for its inhabitants (profit aspect).

The practice of spatial planning greatly influences our environment. Where do we construct new houses? And what type of houses? Where do we strategically locate public services? Given the importance of cities, we argue that sustainability is a necessary mindset of planners. In today's network society geographic information has an increasingly important role to reach this mindset. In this paper we want to research how spatial information may spur the discussion on planning sustainable cities. We do so by analysing cadastral, environmental, socio-economic and real estate data. Yet, the careful interpretation of geographic data into spatial information is essential for the quality of the final result. This is often underestimated by spatial planners.

This paper aims to give insight in types of spatial information that could be useful for planning sustainable cities. Moreover it discussed how this information could be used to support decision making. We apply six potential indicators for social, economic and environmental sustainability and project them on neighbourhood scale in a medium-sized Dutch municipality. We aim not to give a full overview of *the* sustainability of Apeldoorn, but to explore in what way different types of information can be used in the sustainable planning practice. What does the information tell us? What conclusions may we draw and what not? How can we interpret geographic data into workable guidelines to plan? and (How) can we combine different data into univocal policy or plans?

2. THEORY

The need to develop sustainable cities is acknowledged by a wide variety of disciplines from both science and practice. Yet, there is less consensus on the meaning and practical realization of sustainable cities. A broad spectrum of tools and instruments to measure the sustainability of cities has been developed (Bulkeley and Betsill, 2005). These instruments often combine a

number of indicators that provide characteristics of a city, in order to judge the sustainability or liveability of cities.

2.1 Defining urban sustainability

There is no uniform definition on urban sustainability. A sustainable city is often regarded from an ecological point of view, in which concepts as footprint, emissions and energy are important. However, a sustainable city is also a place in which a certain quality of life and a sound economic performance (Figure 1) (Smith et al., 1997).

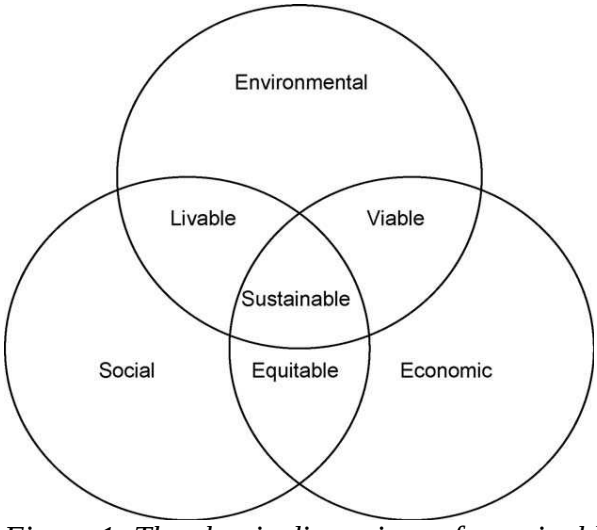


Figure 1: The classic dimensions of sustainable development (source: Tanguay et al. 2010))

2.2 Sustainability indicators?

Both in practice and in science several tools are applied to 'measure' urban sustainability. These tools are mostly based on a number of indicators that can score an area on its sustainability. Tanguay et al. (2010) have analyzed 17 studies in which urban sustainability indicators were used. After clustering the comparable indicators they found 188 different indicators, while the number of indicators per study varied between 10 and 86. The histogram in which they show how often the different indicators where used in the 17 studies, clearly shows the variety of indicators (Figure 2).

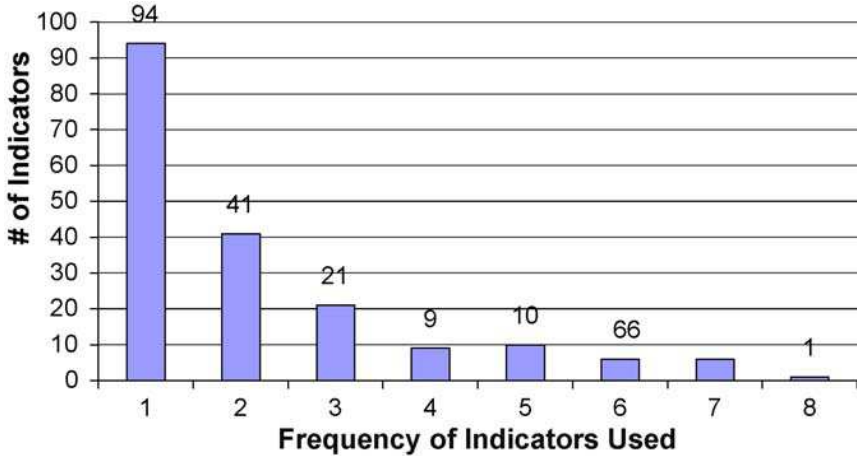


Figure 2: Frequency of use of the 188 divided indicators (source Tanguay et al, 2010)

2.3 Geographical data for land use planning

Land use planners are in need of different types of data in order to design land use and zoning plans. Planning is a reoccurring process: an urban area is never 'finished'. Spatial information on urban areas helps public authorities to develop such plans (König & Muggenhuber, 2009). Geographic data can be used in different phases of spatial planning. First, they can be useful during the spatial analysis of an area (i.e. Xiaohuan et al., 2010). Spatial analysis helps planners to understand the spatial organisation of a city. Also, analysis of land-use change maps help to discover ongoing spatial processes (Koomen E., 2008). Next, geographical maps are used to visualise plans and future directions. Finally, these visualisations could be used to increase cooperation between the different departments and units of the municipal administration and in public participatory processes.

3. METHODS

We collected cadastral, environmental, socio-economic and real estate data from different sources: Kadaster, Central Bureau for Statistics (CBS), and Leefbaarometer (*liveability monitor*). We collected data on indicators for social sustainability (liveability and services), economic sustainability (house value and income), and environmental social sustainability (Carbon Dioxide emissions and building density). The municipality of Apeldoorn (156.355 inhabitants) was used as a test case. We used GeoMedia to visualise the indicators on neighbourhood level.

4. RESULTS

In the following section the results for Apeldoorn's liveability, services, dwelling value, income, carbon dioxide emissions, and the housing density are described and discussed. The potential to integrate different data sets for the development of effective sustainable policy is discussed in section 5.

4.1 Social sustainability of Apeldoorn

4.1.1 Liveability

Data on the liveability of Apeldoorn were extracted from the Dutch website www.leefbaarometer.nl[1]. The website displays the liveability of the entire Netherlands on municipal, district and neighbourhood level. The information is based upon extensive research on the way liveability could be measured and projected. Liveability is defined as the extent to which the living environment fits to the conditions and needs that humans demand. In order to measure the liveability the researchers defined 49 indicators, such as 'proximity of forest', 'share of elderly', and 'number of violent crimes'. These indicators were translated into six dimensions (table 1) of liveability.

Table 1: Six dimensions of liveability (source: leefbaarometer.nl)

Six dimensions of liveability
Housing stock (13 indicators)
Public space (8 indicators)
Services level (3 indicators)
Population structure (6 indicators)
Social coherence (11 indicators)
Safety (5 indicators)

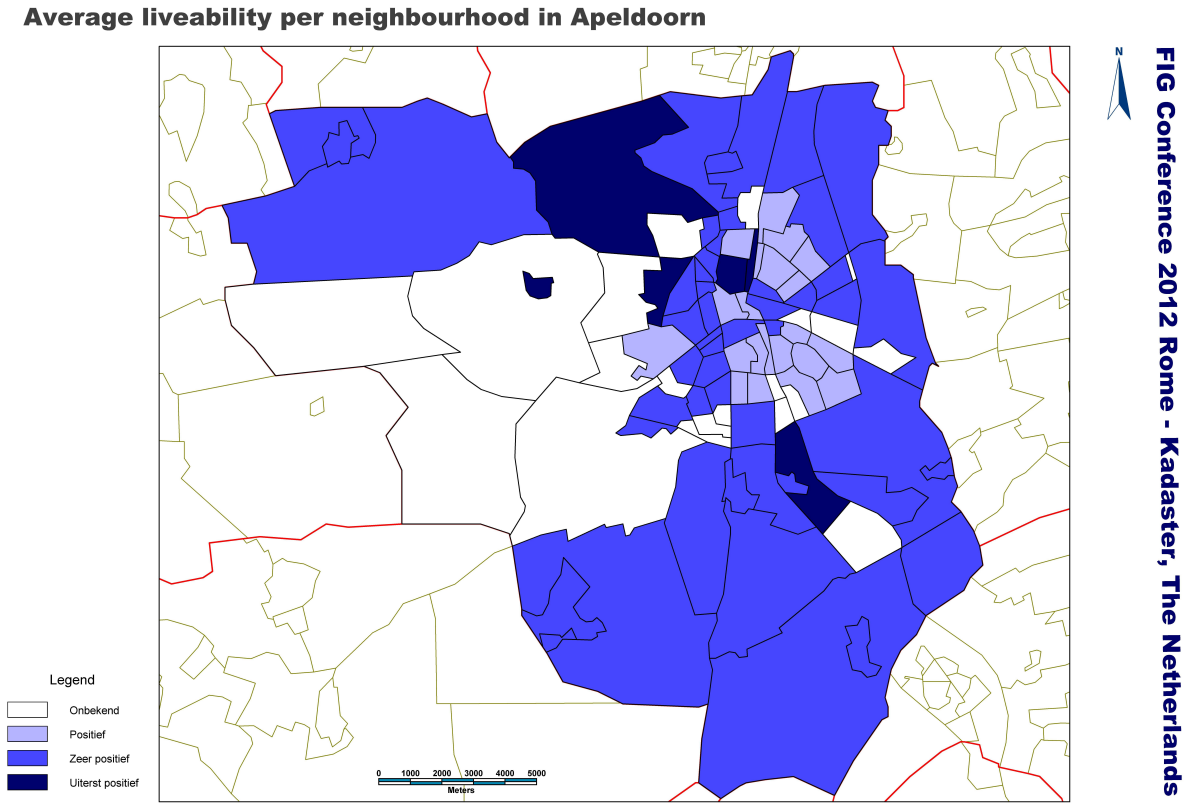


Figure 3: The average liveability per neighbourhood in Apeldoorn (source leefbaaromter.nl)

[1] Leefbaarometer is a combination of the Dutch words for liveability (leefbaarheid) and monitor (barometer).

The liveability of a neighbourhood is composed from the six dimensions of liveability. The scores may range from extremely negative to extremely positive. Apeldoorn scores high on liveability according to the 'leefbaarometer'. The light blue colour stands for a positive liveability, medium blue is very positive and the dark blue neighbourhoods score extremely positive (Figure 3). In the white areas a score on liveability misses due to a lack of sufficient information.
Interestingly, liveability is relatively low in the city centre. However, the lowest score is 'positive, indicating that any neighbourhood in Apeldoorn is a good place to live.

4.1.2 The services level

The second indicator on social sustainability is more specific than liveability, which is combined from a variety of 49 different indicators. In fact we zoom in, to one of the six dimensions of liveability and show its results on the map of Apeldoorn. In contrast to the score on liveability as an absolute measure (Figure 3), the dimension of services was scored relatively compared to the average service level in the Netherlands (Figure 4). As a result, a high service level is not necessary good or bad, rather higher than the average level in the Netherlands. If we compare figure 2 to the topographical map of Apeldoorn it is obvious that the service level corresponds with the level of urbanity in Apeldoorn. The concentrated darker blue areas in the centre of the map correspond to the build-up area of Apeldoorn (the darkest blue colours representing the city centre). The three slightly darker spots correspond from north to south with the villages Uddel, Beekbergen and Loenen.

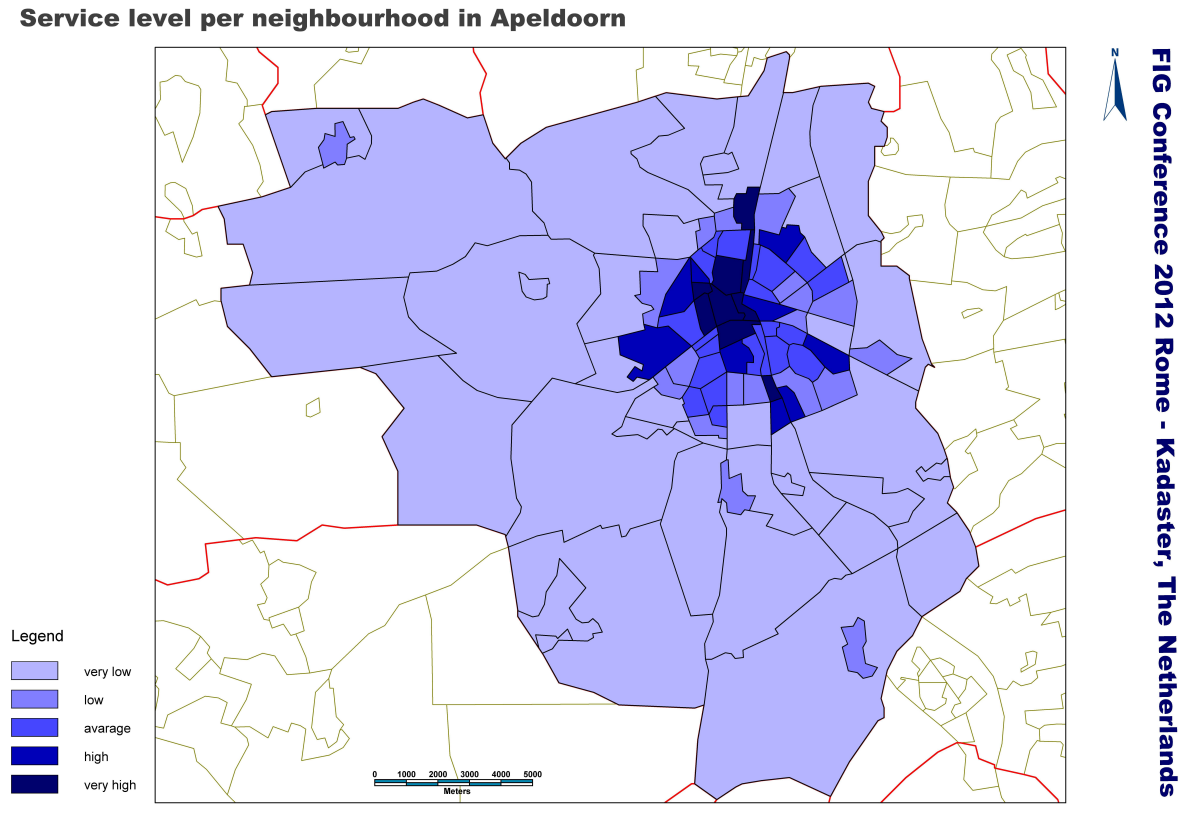


Figure 4: Service level per neighbourhood (source: Netherlands Statistics, www.cbs.nl)

Obviously and not surprisingly, the city centre has the highest level of services.

4.2 Economic sustainability of Apeldoorn

The data on the economic sustainability of Apeldoorn were extracted from databases of Statistics Netherlands (CBS) that provide a broad variety of information on social aspects of the Netherlands that can be used in practice, by policymakers and for research.

4.2.1 WOZ

The WOZ is an average value of immovable housing properties based on the law valuation immovable property. The value is used in the Netherlands as a basis for various taxes. Figure 3 displays the 'WOZ' per neighbourhood. The darker the colour, the higher the average house prices in that neighbourhood (Figure 5). For white areas we have no information (e.g. because there are hardly any immovable properties present). Interestingly, average housing prices are relatively low in the city centre. This figure seems the opposite of Figure 2 (services). In other words: the level of services is not influencing housing prices.

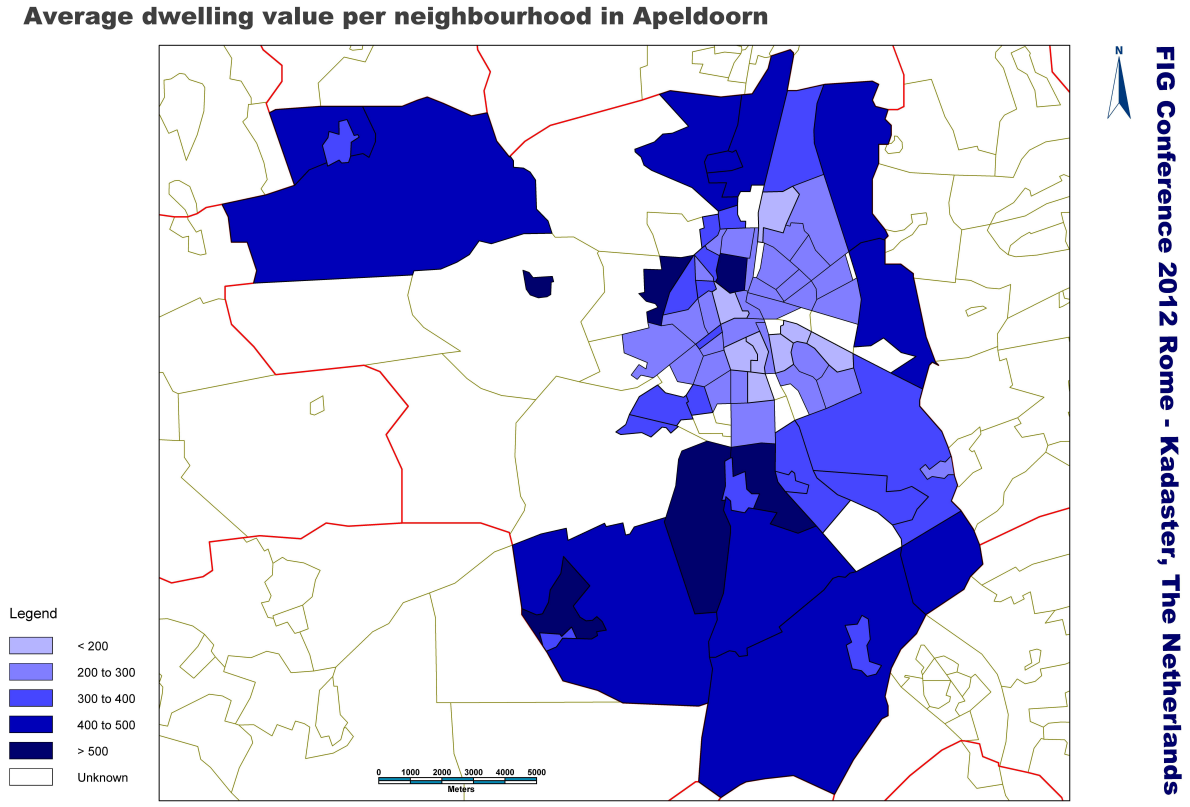


Figure 5: Average dwelling value in thousands of euro's per neighbourhood (source: cbs.nl)

4.2.2 Income

The income displays the average disposable income per person for each neighbourhood with more than 200 inhabitants. As a result, some rural and/or smaller neighbourhoods remain empty on the map (Figure 6). The data result from the regional income research that is conducted each year by Netherlands Statistics. The research uses a spatially spread random sample of income data form the Dutch Ministry of Finances and the Municipal administration. The figure shows that the city centre – where relatively cheaper houses are situated – is inhabited by both low and high income groups. The two darkest blue neighbourhoods represent 'Parken' and 'Berg en Bos', the two villa neighbourhoods in Apeldoorn. It is therefore not surprising that the income in these two neighbourhoods is most high. Income is – in combination with education level and professional status - an important indicator for socio-economic status (Winkleby et al., 1992). Information on the income can thus help to give insight in the socio-economic status of inhabitants of a neighbourhood.

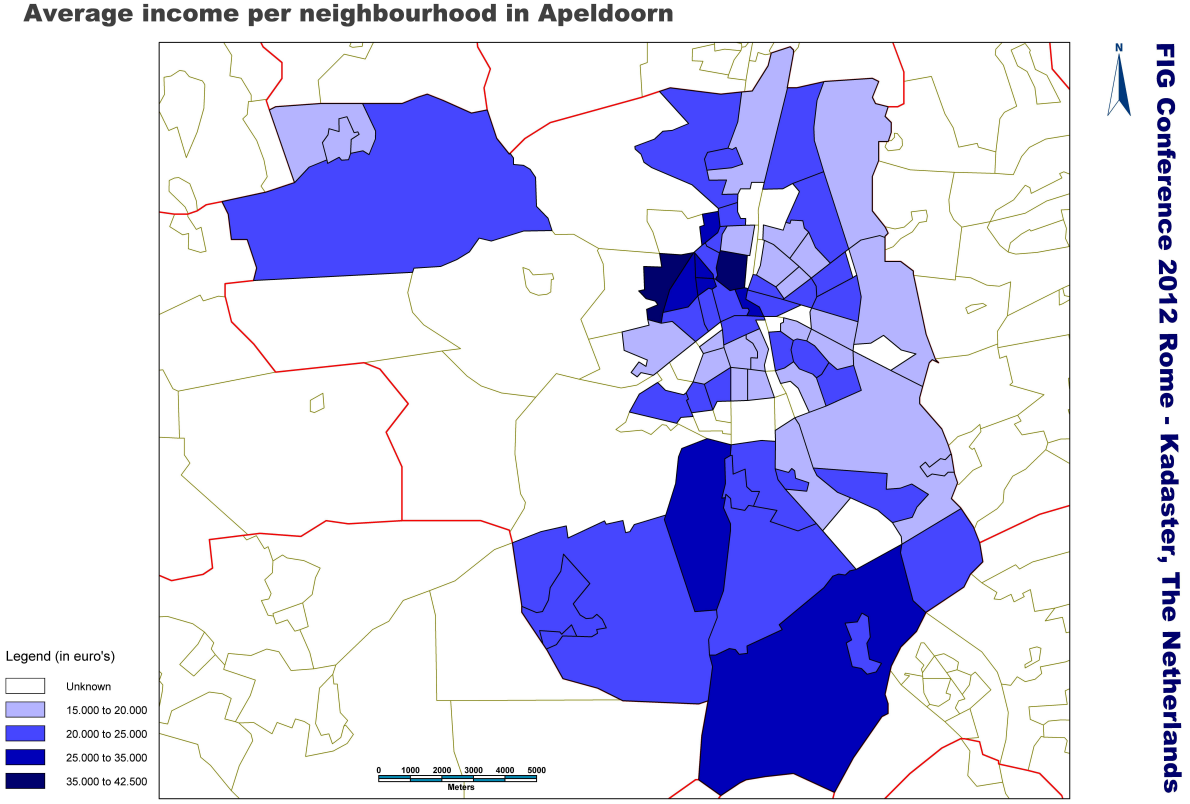


Figure 6: Average disposable income per person per neighbourhood (source: cbs.nl)

4.3 Environmental sustainability of Apeldoorn

4.3.1 Carbon Dioxide emissions

The Netherlands was one of the first countries to develop a national climate change policy in the 1990s (Gupta et al., 2007). Today, the Netherlands have set their climate change targets for 2020, and one of these targets is a 20% reduction of CO2 emissions. The built environment (cities) is accountable for 25% of the CO2 emissions and 70% of these emissions comes from residential buildings. Hence, in obtaining the national targets, special attention is

given to the residential built environment by municipal governments.
Currently 2 million buildings (of the more than 10 million) have a registered energy label. This label indicates a building's energy performance. For houses that do not have registered a label it is possible to estimate the energy label based upon housing type and year of construction. The housing types were extracted from the Cadastral Key Register and combined with the building years from the Addresses and Buildings Key Register. Figure 7 shows the result. Green (A) indicates the best energy label, while dark red (G) indicates the worst label. The figure shows a mixed pattern that cannot be easily translated to the topographical map. However, a difference between the east (newest) and west-side of Apeldoorn is visible. This can be explained by the fact that younger buildings have relatively better energy performances.
Information on the energy performance of buildings in a region can for example be used as a support to the development of policy on the Energy improvement of buildings and to find areas in need for urban renewal.

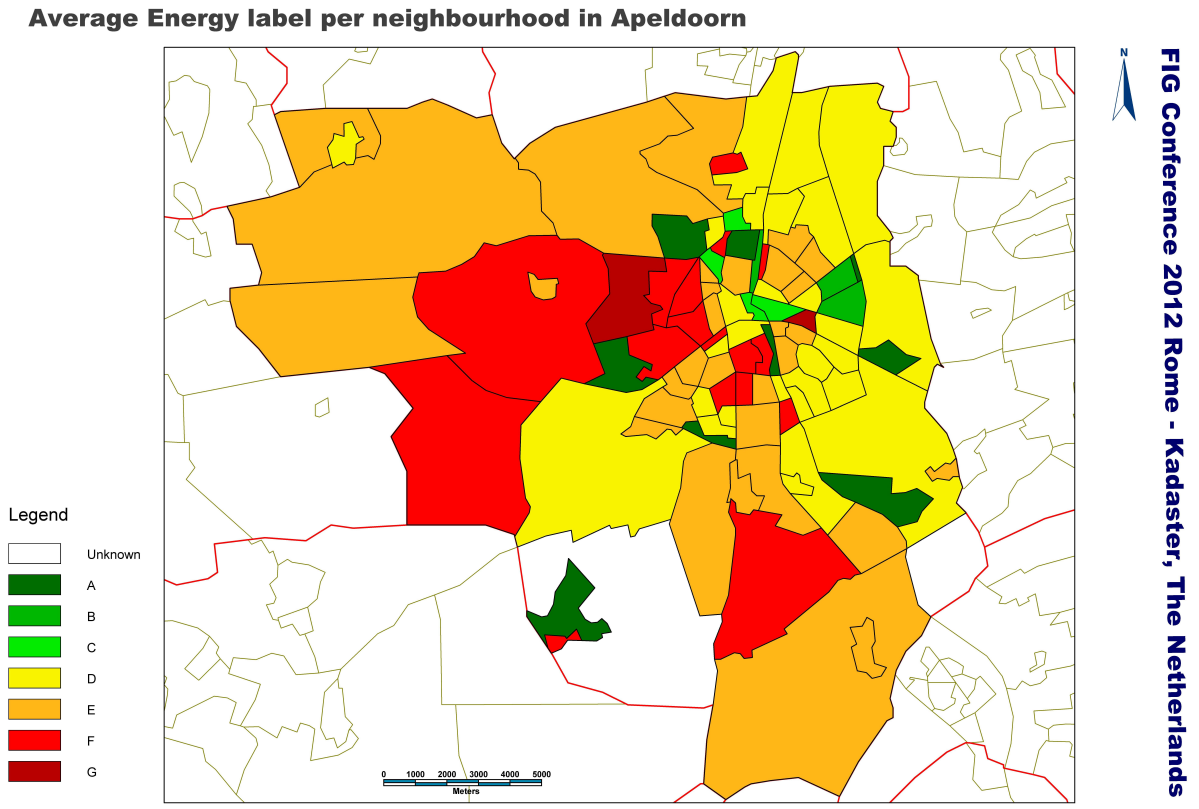
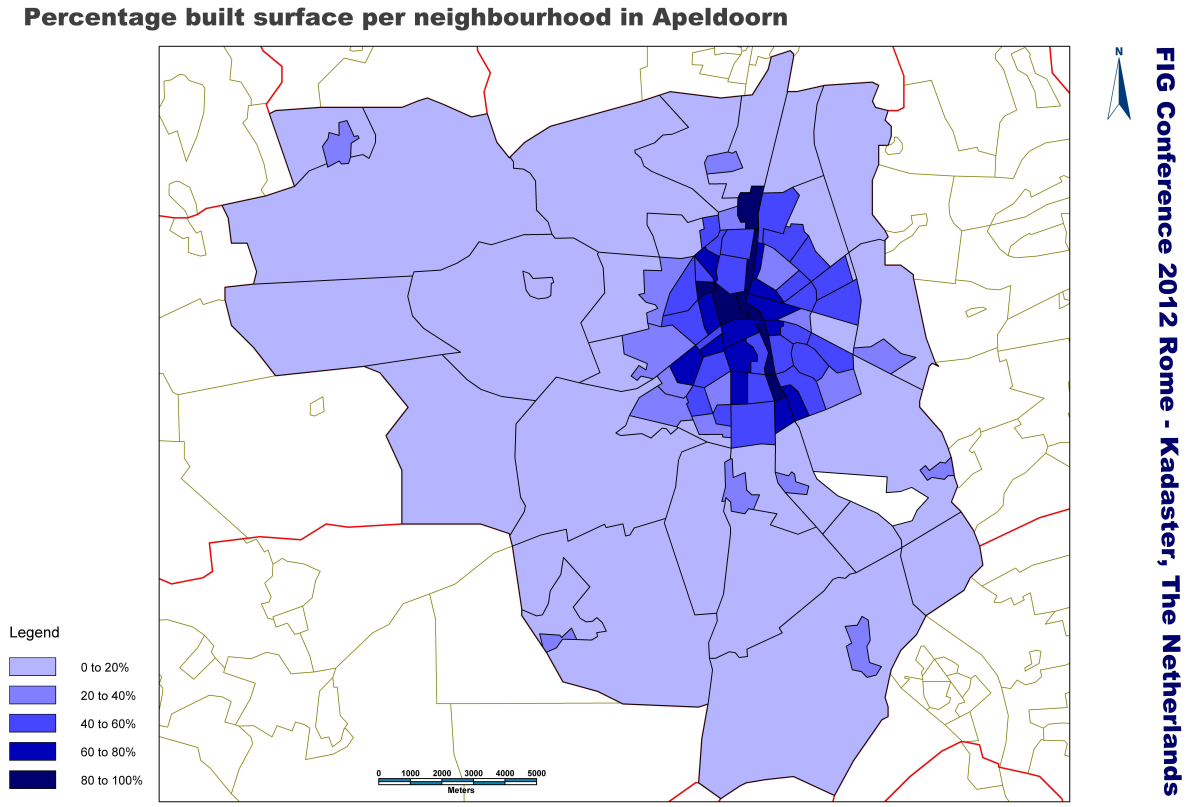


Figure 7: Average estimated energy label per neighbourhood

House density

The house density was obtained by calculating the percentage of the area that is build within the total land surface per neighbourhood. This results in a map (Figure 8) that has striking similarities with the map on the service level (Figure 4). This is understandable as the house density and service level are correlated: more services are offered in areas where more people live. This interdependence may change in the near future as a result of the increased mobility of people and the recent development of placing shopping areas outside the city centre. Information on the housing density could be used by developing policy for extending a city by using existing open spaces instead of adding new construction at the fringes. In contrast, it can as well be used to search for areas that need more urban green.



5. DISCUSSION AND CONCLUSION

Sustainability is a broad concept that encompasses many aspects of the social, economic and ecologic environment. This makes effective policy to develop a sustainable city a serious challenge. The maps that are presented in this paper are neither technologically innovative, nor do we pretend that they represent *the* sustainability of Apeldoorn. However, the maps do give valuable information that can be used to develop sustainable policies on the local scale.

The majority of the data we used to produce the maps in this paper is publicly and without further costs available on the internet. However, a quick search on Google and informal information on the internal organisation of Dutch municipalities learns that the vast majority

of Dutch municipalities currently do not make use of this information in their spatial planning processes. Municipalities are organised with many different departments that make the integral approach of sustainable urban development require much effort.

The presented maps give examples of indicators on the sustainability of a city. When comparing the different maps, it is notable that some maps show almost opposite results of other maps. This may be very well explainable and is as such not problematic. A neighbourhood with a low housing density may consequently have a low service level, although the first may be recognized as indicator of a high (environmental) sustainability and the second as an indicator of a low (social) sustainability. This result shows that we cannot simply count the scores of each neighbourhood on several aspects: the result will be meaningless.

The spatial context and a clear vision on what sustainability means can help to translate and integrate different spatial indicators into effective policy and plans. For example, the context of a rural village will demand other criteria for the service level than the city centre of a large city. Setting goals on what 'type' of sustainability we want to achieve in a specific spatial context can make spatial information even more valuable in supporting sustainable urban development.

Spatial indicators and the geographic visualisation of these indicators can be useful for local sustainable planning. Yet, careful interpretation of the indicators is of essential importance when using it for sustainable development. The incorrect interpretation of spatial information can lead to incorrect conclusions on the sustainable measures that are most desired in a certain area. In order to interpret spatial information correctly it is however crucial to understand the data behind the information. Knowledge on geographical data is therefore crucial.

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BIOGRAPHICAL NOTES

Sanne Broekhof is Spatial Planner (Msc) and is currently assistant project leader at Kadaster spatial planning and consulting. Moreover she conducts PhD research on the establishment of land transactions at Wageningen University.

Ramona van Marwijk is Spatial Planner (PhD) and is currently employed as senior projectadvisor at Kadaster spatial planning and consulting.

CONTACTS

Ir. Sanne Broekhof
Wageningen University and Kadaster
Kadaster Spatial planning and consulting
P.O. Box 9046
7300 GH, Apeldoorn
The Netherlands
Phone: + 31 6 52481883
Email: sanne.broekhof@kadaster.nl

Dr. Ir. Ramona van Marwijk
Kadaster
Kadaster Spatial planning and consulting
P.O. Box 9046
7300 GH, Apeldoorn
The Netherlands
Phone: + 31 6 40329214
Email: ramona.vanmarwijk@kadaster.nl