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Crossing boundaries

Mapping spatial dynamics of urban phenomena at micro scale to support urban management in the Amsterdam urban region

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Over de grens! Het in kaart brengen van stedelijke dynamieken op micro schaal ter ondersteuning van stedelijk management in de regio Amsterdam

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Introduction

- 1 Urban societies are changing at unprecedented rates and are becoming more diverse (Tasan-Kok *et al.*, 2013). Urban populations are growing and the ethnic composition of the population has become more heterogeneous as a result of large-scale migration. Socio-economic processes and advances in transportation and communication technology turned monocentric cities into polycentric metropolitan regions (Burger, 2011). These trends create new opportunities such as stronger regional economies due to agglomeration benefits (Faludi, 2004) and innovation due to ethnic diversity (Lee, 2014). However, these trends may increase problems and create new challenges as well such as competitiveness between urban centres, increased traffic congestion, increasing inequalities, deprivation, unemployment and segregation.
- 2 In the Amsterdam region, the increasing polycentricity is reflected in the demographic and economic sphere and in intraregional residential mobility. As a consequence, traditional monocentric views on the city need to be revised: social deprivation, ethnic minorities and employment are no longer phenomena typical for the city of Amsterdam only. The share of inhabitants of non-western origin is growing rapidly in the surrounding municipalities. Both the labour market and housing market function at the

regional level. Different concentrations of employment have developed in the urban region and different urban centres become attractive during different phases in people's lives. Households without children are over-represented in Amsterdam and in smaller older cities such as Haarlem while family households appear particularly in new towns such as Almere and Haarlemmermeer. Although Amsterdam remains the major centre of activities and employment the newer and older urban subcentres in the region (such as Amstelveen, Almere, Haarlem, Haarlemmermeer, Purmerend and Zaanstad) have become increasingly important. Rather than competing with Amsterdam, they develop in a complementary way (Musterd *et al.*, 2006).

- 3 In such polycentric, diverse and dynamic urban environments space-time information is indispensable to formulate adequate policies containing both local and regional components (Musterd *et al.*, 2006). Recently, the increasing ability to collect data from multiple sources with higher spatial and temporal resolutions, also referred to as 'big data', offers opportunities to enhance our understanding of urban dynamics and the functioning of cities and urban regions. However, these 'big data' poses a number of epistemological, methodological and ethical challenges (Kitchin, 2013). In order to be useful for urban managers and policy makers new methodologies and tools are needed to turn the huge amount of available data into meaningful and accessible information.

Maps as information mediators

- 4 Maps have always been important in communicating spatial information. They reveal spatial patterns not easily identified by tables or graphs. With the increased availability of micro-scale data and the evolution of advanced information and communication technologies, the application of Geographical Information Systems (GIS) within the urban policy practice has increased rapidly. To date, several easy-to-use online GIS applications have been developed to inform urban policy and to make urban management more efficient and effective. In this context, we can distinguish four types of tools. The first type are interactive thematic online applications. Such applications offer thematic maps on a wide-range of urban indicators or composite indices at different geographical scales and for different moments in time, with varying functionalities regarding interactivity, map representation and analysis (Smith, 2016). Second, GIS-based e-governance tools have been developed, to both inform citizens on the state of urban neighbourhoods and to provide a means to citizens to inform the government on the malfunctioning of particular municipal services. (Gullino, 2009; Pfeffer *et al.*, 2015). A third type concerns tools that support participatory planning and policy making, where citizens can provide their inputs through a GIS-based online application (Kytta *et al.* 2013). Finally, with the wider availability of all sorts of data - increasingly real-time or near real-time - the most recent tools are city dashboards, where different kinds of data visualizations are combined, including interactive thematic maps on different urban phenomena (Kitchin *et al.*, 2014).
- 5 The Regional Monitor Amsterdam discussed in this article relates to the first type of tools. Many of the interactive thematic online applications represent population and housing registries and statistics in graphs and thematic maps. The majority of these tools spatially represent individual indicators such as the percentage of 1-person households, with *DataShine* (<http://datashine.org.uk>) or the online neighbourhood monitors of several Dutch municipalities (www.buurtmonitor.nl) being illustrative cases. There are also tools

that focus on a particular theme and visualize its spatial pattern through a composite index. Examples are the Dutch *Leefbaarometer* to monitor the perception of quality of life (www.leefbaarometer.nl), the *Demowijzer* to monitor demographic change (www.demowijzer.nl), the British *Luminocity* tool (<http://luminocity3d.org>) to map multiple themes, the *London Profiler* (Gibin *et al.* 2008) to monitor, among other things, multiple deprivations, or the Peruvian socio-economic index application *Sisfoh* (<http://www.sisfoh.gob.pe>).

Methodological considerations of mapping

- 6 In the Netherlands, public and private bodies collect a lot of data at six-digit postcodes level. In urban areas, these are rather small units sized approximately 50 x 50 meters and include 10 to 20 households. Mapping such small units results in maps which do not provide clear patterns and are difficult to read and to interpret. Hence, in order to produce meaningful spatial information, such data should be aggregated and grouped into larger mapping units. Aggregating spatial data can be done in different ways, is endowed with methodological challenges and produces different outcomes (e.g. Monmonier, 1991).
- 7 Interactive thematic online applications aggregate base data to standard administratively defined areas and provide thematic maps (so-called choropleth maps) to visualize geographical patterns and to compare districts or wards. However, maps displaying information at the scale of administratively defined spatial units do not sufficiently capture the current situation of increasingly diverse and dynamic urban environments. Especially maps based on larger administrative units, such as wards and districts, are prone to scale and boundary problems (Openshaw, 1984a; Rees, 1997). *Scale problems* refer to the underlying assumption of choropleth maps that the phenomenon to be mapped is homogeneous within a mapping unit and evenly distributed across the unit. As a result, the accuracy of these types of maps decreases as distribution variability increases (MacEachren, 1982). Considering today's diverse environments, administratively defined areas may be too large to explore micro scale spatial variability. For instance, pockets of urban poverty within an administrative ward may be hidden because very deprived areas may be compensated by less deprived areas within the same ward (Martinez *et al.*, 2016). Obviously, averaging low and high values within administrative areas results in a loss of information.
- 8 *Boundary problems* refer to the fact that choropleth maps suggest an abrupt change in a phenomenon at the administrative boundary whereas changes are typically more gradual (Harris *et al.*, 2004; Schuurman *et al.*, 2007; Martin, 2009; Poulsen *et al.*, 2011). While inner-city boundaries are not able to reveal urban dynamics operating on a micro-scale in *increasingly diverse urban settings*, outer city boundaries are losing relevance in *increasingly polycentric urban settings*. Several phenomena, such as the labour and the housing market, cross municipal boundaries and should be approached both locally and regionally (Musterd *et al.*, 2006). Examining maps of urban phenomena at both the local and the regional scale can reveal the position of municipalities within the region and can lead to new insights in developments in and between municipalities.
- 9 Both scale and boundary problems are related to the Modifiable Area Unit Problem (MAUP), which is a common and well-documented problem associated with data aggregation. The MAUP discusses the considerable effect of choice for a particular

mapping unit on the representation of a phenomenon (Openshaw, 1984a). Another problem of aggregated data is ecological fallacy, which refers to the erroneous assumption that an individual being part of an area will have a characteristic which is predominant in the area as a whole (Openshaw, 1984b).

- 10 To some extent, scale and boundary problems can be overcome by raster approaches which aggregate data to a regular grid consisting of equally sized cells. The finer the grid the more detail can be mapped. The kernel density method is an illustrative example as it deviates from standard administratively defined areas and accounts for within area-variation (Ratcliffe and McCullagh, 1999). It turns base data (mostly point data) into density surfaces (rasters) which can be used to identify hotspots. This method is particularly useful to map event data and is therefore frequently applied in crime and disease mapping. The number of crimes or infections is aggregated within a specified search radius producing a continuous surface (raster) of event distribution. However, while this procedure addresses to some extent the MAUP, it requires considerable expert knowledge for implementation.
- 11 For a more detailed discussion of methods to map micro-scale data we refer the reader to Pfeiffer *et al.* (2012). In general, the choice for a specific aggregation method depends on the nature and spatial detail of the base data to be mapped and the purpose of the map.

The Regional Monitor Amsterdam

- 12 The Regional Monitor Amsterdam (RMA), an interactive thematic online application, monitors urban dynamics with respect to the demographic and socio-economic situation and the housing market in the Amsterdam urban region. It turns local statistics collected at the level of six-digit postcode into useful information for urban managers and researchers. It also addresses the scale and boundary problems addressed above. Unlike other online GIS applications which focus on general spatial distributions within administrative areas, this tool focuses on *spatial concentrations*. These spatial concentrations are polygon objects consisting of adjacent six-digit postcode areas that meet a set of rules for identifying spatial concentrations (further elaborated in Section 2). In these areas the rate of occurrence of a particular phenomenon (for example the share of people receiving unemployment benefit) is far above its average occurrence.
- 13 Using the concept of spatial concentrations has two advantages. First, relevant information is filtered from large data registries available at the six digit postcode level. The resulting maps of spatial concentrations direct the attention to areas that deviate from the average situation, which can be helpful in identifying potential problem areas and prioritizing areas for policy intervention. Second, spatial concentrations are *data-driven flexible* objects: not bound to administrative boundaries and determined by the data of the phenomenon under consideration. Accordingly, the size and shape of the resulting polygons differ between phenomena and years. As these objects are determined by the underlying data, concentration maps provide a more realistic representation of spatial patterns and dynamics compared to conventional choropleth maps based on fixed administratively defined areas.
- 14 The monitoring tool accommodates the monitoring of spatial dynamics of urban phenomena at the *local* and the *regional* scale to meet both local and regional policy information needs. For each phenomenon, both local and regional spatial concentration areas are constructed. Local concentration areas are based on the city average of a

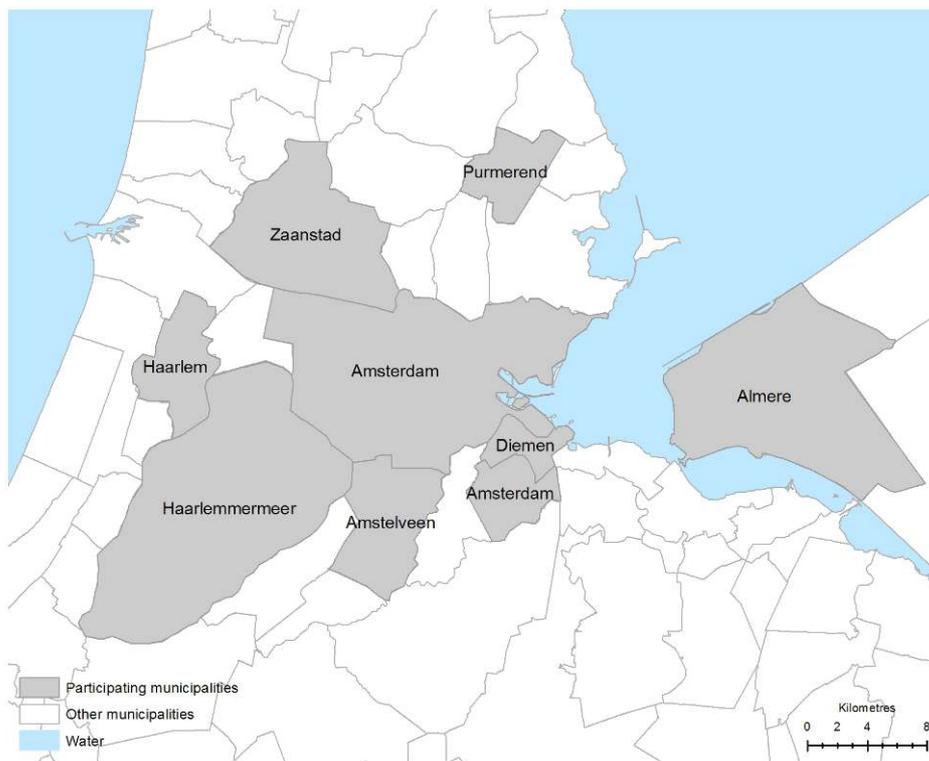
particular phenomenon in a particular city while regional concentration areas are based on the regional average (see further Section 2). To our knowledge this is the first interactive thematic online application using a data-driven approach that creates flexible spatial units and pays attention to the rate of occurrence and dynamics of urban phenomena both at the local and regional scale. In the next sections we will explain the procedure to create spatial concentration areas and show relevant application areas of the tool.

History and mapping methodology of the regional monitor Amsterdam

History

- 15 The development of the RMA is rooted in the Amsterdam City Monitor (ACM). The ACM was a joint initiative of the Urban Geography research group of the University of Amsterdam (UvA) and the department of Research and Statistics of the municipality of Amsterdam, which developed an interactive GIS application consisting of map layers of spatial concentrations in Amsterdam for a variety of themes from 1994 onwards.
- 16 With the increasing diversity and polycentricity of the Amsterdam region and a gradual policy shift towards area-based interventions (Andersson & Musterd, 2005), the ACM actors recognized the relevance of producing information on micro-scale urban dynamics within a regional perspective. Such information was considered to be useful for informing urban policy and research on developments in the region. It triggered the idea to develop a regional monitoring tool. In 2003, a small pilot, based on the design and mapping methodology of the ACM and data from just a few municipalities, served as an incentive to get other larger municipalities in the Amsterdam region involved. Within a year, the eight major municipalities, displayed in Figure 1, committed to the project.

Figure 1. Participating municipalities.



Source of GIS data: CBS, 2014

- 17 Now the RMA provides public access to maps on several urban themes at both the local and the regional scale and from the year 2000 onwards. The mapped themes include ethnicity, age, household composition, social security benefits, home ownership, average property value, building periods of houses, and employment. The tool is intensively used to provide information for fact sheets and annual reports such as ‘The State of the City’ produced by the department of Research and Statistics (Gemeente Amsterdam, 2013).
- 18 The RMA is the product of a collaborative effort of a variety of actors. The larger municipalities in the region of Amsterdam contribute by delivering their data, local knowledge and knowledge about information needs. The University of Amsterdam coordinates the project and offers support in terms of scientific expertise in urban studies and geographic information analysis. I-mapping, a company experienced in web-cartography, takes care of the technological implementation. Representatives of all participating partners attend the bi-annual meetings of the working group RMA. In these meetings further development of the tool with respect to functionality, content, design and usage is being discussed.
- 19 Key aspects of monitoring are systematic data processing and representation in a standardized and regular manner (de Kool, 2008). The base data of the RMA consist of time series of local statistics for the six-digit postcode on demography, socio-economic issues, housing, employment and locational data (XY co-ordinates and postcodes of home addresses). Since municipalities collect and prepare these data according to collaboratively developed standards these local datasets can be combined into a regional dataset. To provide meaningful information for urban management, the RMA

methodology aggregates postcode areas with over-representation of a phenomenon into new, larger spatial units: spatial concentration areas.

Mapping methodology

- 20 Spatial concentrations are clusters of adjacent postcode areas where the occurrence of an urban phenomenon is *far above* the average rate of occurrence of that phenomenon within the overall geographic area of interest, either an individual municipality (local/city scale) or the combination of the larger municipalities of the Amsterdam region (regional scale). *Far above* is defined as the mean plus two standard deviations of the respective characteristics. Furthermore, the idea of mapping concentrations is based on binominal variables (one category against all others). In Box 1 the steps to create the spatial concentrations are described in a nutshell. More details on the procedure including justification for the various choices are given in Pfeffer *et al.* (2012).

Box 1: Construction of spatial concentration areas

- 1 Spatial delineation of the six-digit postcodes obtained by applying the convex hull algorithm to the point locations of home addresses belonging to the same postcode. This results in polygons of different sizes, depending on the street layout.
- 2 Matching the thematic data to the postcode geography created in step 1.
- 3 Calculating descriptive statistics for each group (e.g. household categories) and the concentration threshold, determined by the mean plus 2 times the corresponding binomial standard deviation (stdev)*.
- 4 Marking a postcode area as a concentration area based on the statistically derived concentration threshold in step 3.
- 5 Removal of marked postcode areas with low densities to avoid statistical bias (less than 20 / hectare).
- 6 Spatially extending the remaining marked postcode areas (buffer of 25 metres width) to create adjacency or overlap with neighbouring postcode areas.
- 7 Aggregating extended marked postcode areas that are adjacent or overlap into postcode aggregates to create delineated spatial clusters representing concentration areas.
- 8 Recalculating the attribute data for each postcode aggregate (spatial concentration area).

*NOTE THAT IN CASES OF VERY SMALL REFERENCE GROUPS A STANDARD DEVIATION OF 1 IS APPLIED.

- 21 To keep close to recognizable geography on the ground, postcode areas are delineated as polygons around home addresses in a vector GIS. Users may feel more familiar with these kinds of objects which reflect the actual street layout compared to the geography of raster cells.
- 22 In the following, the clustering of 1-person households in 2011 is used as an example to illustrate the procedure applied to create spatial concentrations at the local and regional scale.

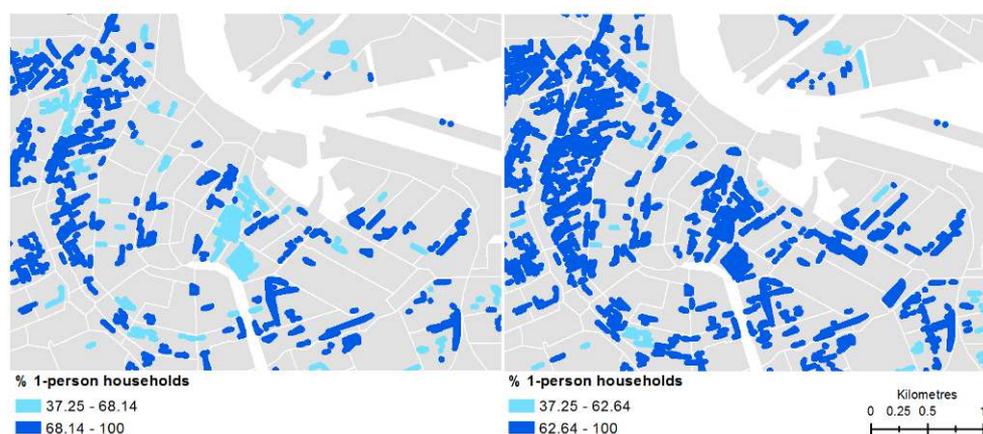
Local concentration areas

- 23 In 2011, 381,155 households lived in Amsterdam, of which 178,820 were 1-person households. The city mean of this household category is 46.92 %, with the associated binomial standard deviation of 10.61. Considering the definition of the concentration threshold in step 3 (Box 1), postcodes with a share of non-family households above 68.14 % are marked as concentration postcodes and are combined with adjacent or overlapping concentration postcodes into clusters of 1-person households according to steps 5-8. It results into maps of spatial concentrations of 1-person households for the year 2011 as visualized in Figure 2 on the left hand, zoomed to the centre of Amsterdam. By default, the monitor classifies all spatial concentrations into two categories. Objects coloured in darker blue indicate that in these clusters the share of 1-person households is above 68.14 %. The objects in light blue refer to clusters with a percentage of 1-person households below 68.14. The latter category represents clusters that, after buffering, also include postcode areas that do not meet the concentration criterion. As these postcode areas are included in the aggregation of 1-person households to the concentration cluster (step 8), the percentage of 1-person households drops below 68.14.

Regional concentration areas

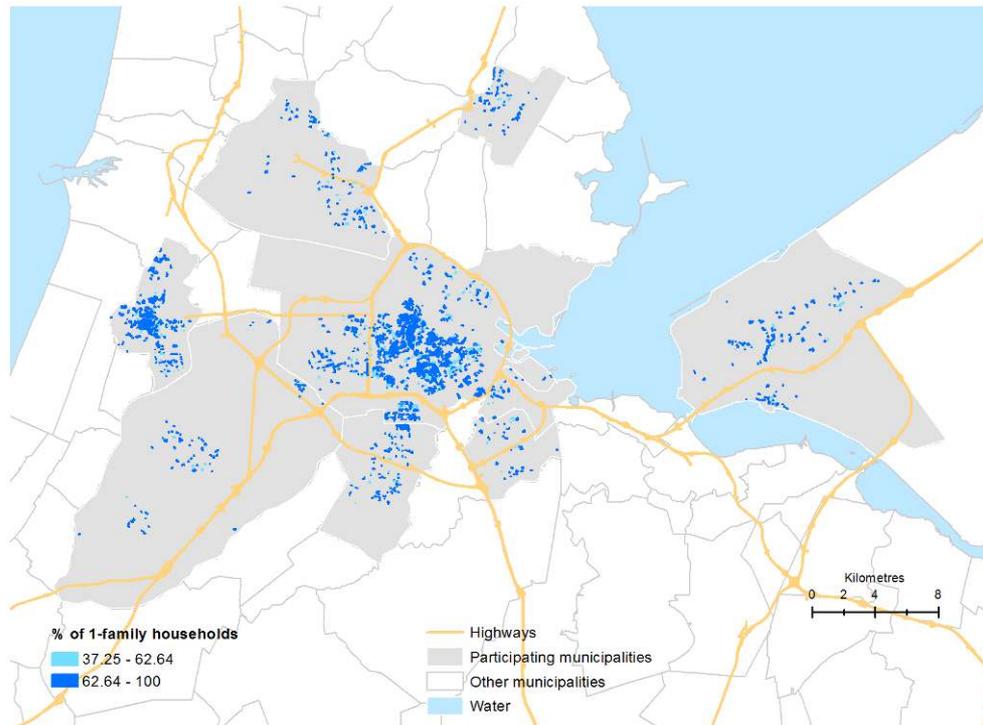
- 24 In 2011, 737,503 households lived in the seven larger municipalities of the Amsterdam region, of which 300,090 were 1-person households. The regional mean of 1-person households of 40.69 % together with a binomial standard deviation of 10.97 results in a regional spatial concentration threshold of 62.64 %. So postcode areas with a share of 1-person households above 62.64 % are marked as concentration areas to be aggregated into postcode aggregates according to step 5-8. This results in a regional map of spatial concentrations of 1-person households for the year 2011 as visualized in Figure 3. The importance of the regional perspective is illustrated by Figure 2. The map on the right side shows that if spatial concentration areas are examined at the regional scale, the center of Amsterdam has a considerably higher number of concentration areas. This is a result of the lower concentration threshold due to the lower regional mean.

Figure 2. Concentration areas of 1-person households in the center of Amsterdam based on the local (left) and regional (right) concentration threshold.



Source of GIS data: RMA, 2015

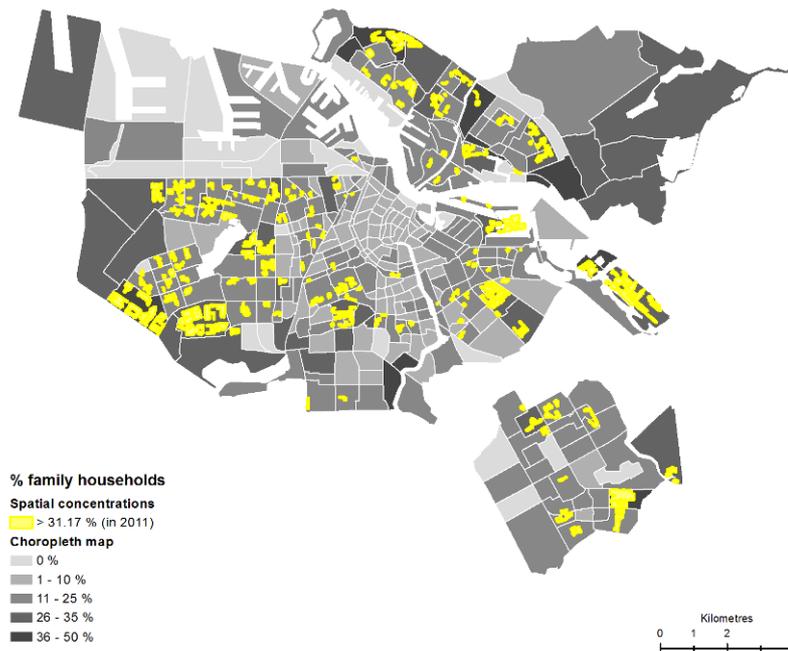
Figure 3. Regional concentration areas of 1-person households in the larger municipalities of the Amsterdam region in 2011.



Source of GIS data: RMA, 2015; CBS, 2014; Rijkswaterstaat, 2014

- 25 Figure 4 compares the local concentration areas of family households in Amsterdam with the conventional choropleth map showing the same variable. The choropleth map provides a *general spatial distribution* of family households, but is not able to reveal the heterogeneity within or across neighbourhoods. Moreover, the choropleth map attracts the attention to the larger neighbourhoods. The map with spatial concentrations shows the *specific spatial pattern* of micro zones with an over-representation of family households. In the choropleth map an administrative unit can be part of the 36-50 % class, without having one or more postcode areas included in the unit that have a value greater than 31.17 % (the threshold value for concentration areas). This is the case in situations of values within postcodes just below the threshold (tested in rule 4) combined with filtering postcodes of low densities (rule 5).

Figure 4. Local concentration areas of family households in Amsterdam on top of a conventional choropleth map.



Source: GIS data: RMA, 2015

Accessibility

- 26 The RMA is an open online GIS application (<http://www.regiomonitor.nl>). Through a graphical user interface users without GIS expertise can view and query the spatial concentration layers and create tailor-made maps that meet their information needs. They can select the desired spatial scale (local or region), phenomenon, year, the type of reference map for orientation and the zoom level. In addition, users can adapt the map by changing the default selection criteria, number of ranges and the symbology. In order to protect privacy of residents, the monitor does not display spatial concentrations which contain less than 15 cases. For people with GIS-expertise the tool offers the possibility to export map layers to a standard GIS file format (shapefile) in order to perform additional, more advanced spatial analyses in a GIS environment.

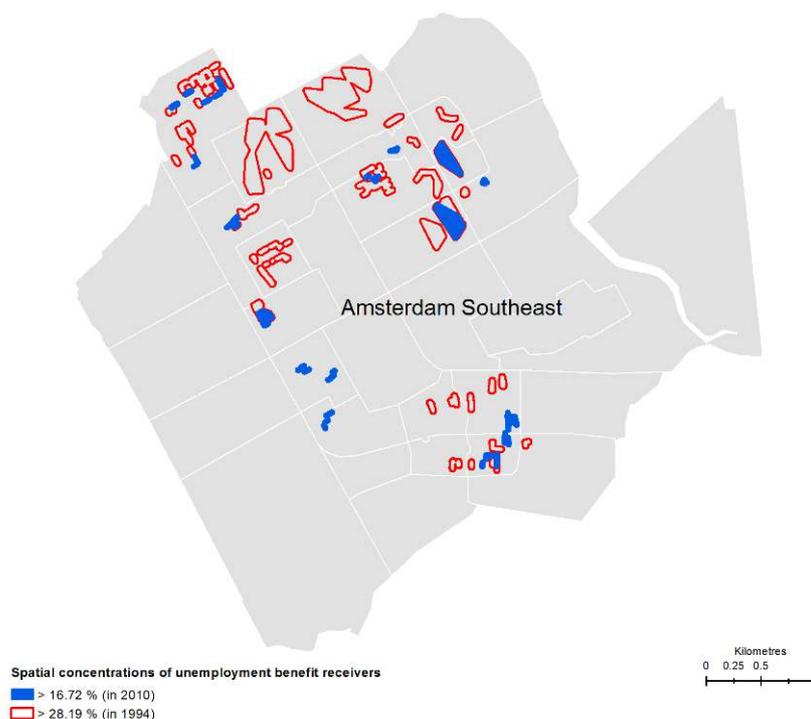
Application areas

- 27 The Regional Monitor Amsterdam can be applied for exploring and monitoring urban phenomena and formulating and testing of hypotheses about spatial concentrations and local and regional developments. We give some examples of application areas based on three types of questions which are considered relevant for urban policy and research.

Which changes occur in a specific concentration area in a specified period?

- 28 For a long time, the district Zuidoost in Amsterdam has had a negative image because of a clustering of problems related to drugs, crime, early school leaving, and unemployment. To improve this neighbourhood, an elaborate physical and socio-economic renewal programme was implemented between 1992 and 2009. Socio-economic renewal was strongly focused on job creation. A key question for assessing the effectiveness of urban policy is whether the efforts led to improvements. Between 1994 and 2010 the concentration criterion changed significantly from 16.7 to 28.2 percent indicating that the overall situation in Amsterdam has improved. Examining spatial concentrations of unemployed inhabitants in the district Zuidoost between 1994 and 2010 (see 5) shows that although the situation has improved considerably some concentration areas are persistent, for example the two areas in the northern part. This might be an incentive for further research to find out what is going on in these specific areas.

Figure 5. Local concentration areas of people receiving unemployment benefit in 1994 and 2010.



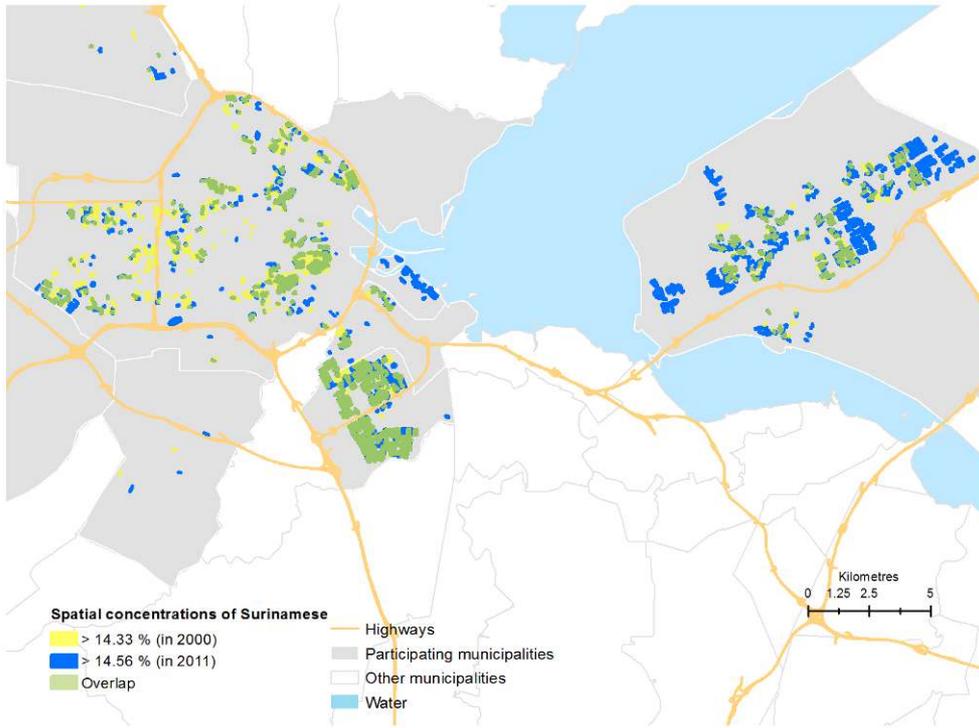
Source: GIS data: RMA, 2015

Which changes occur in the spatial distribution of concentration areas of a phenomenon in the region?

- 29 The presence of (clusters of) ethnic groups is often considered a typical characteristic of major cities like Amsterdam. Maps produced with the RMA show that this perception is out of date. Examining the maps of concentration areas of Surinamese (Figure 6) and

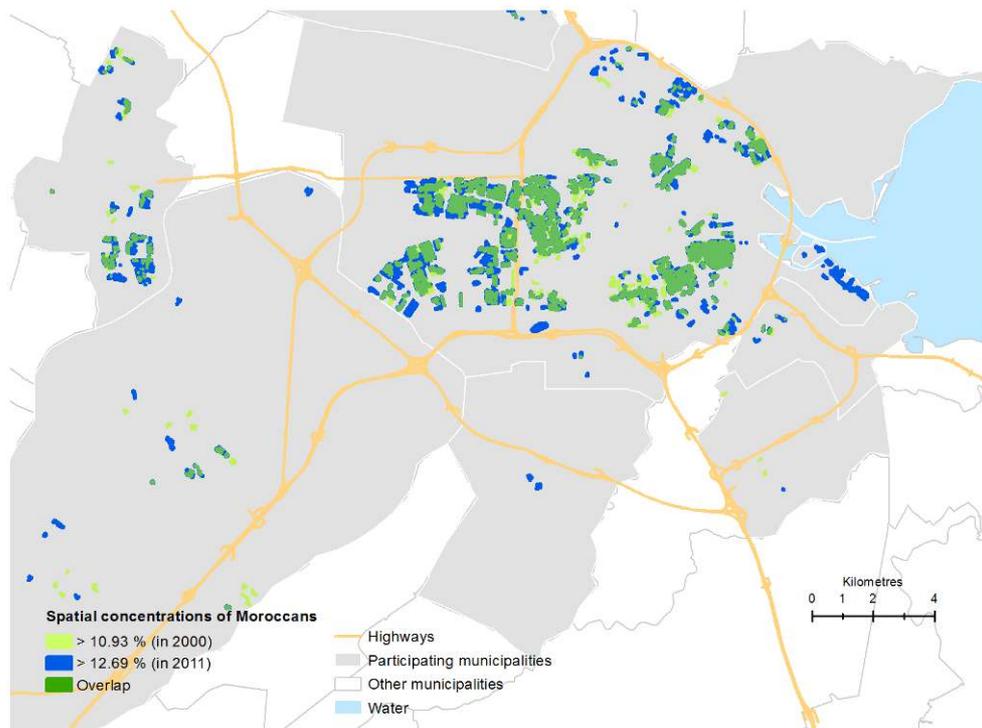
Moroccans (Figure 7) shows that these groups are increasingly migrating and also tend to cluster in other municipalities in the region. Surinamese are increasingly migrating to Almere and concentration areas of Moroccans arise particularly in Almere and Haarlem.

Figure 6. Regional concentration areas of Surinamese in 2000 and 2011, zoomed to Amsterdam and Almere.



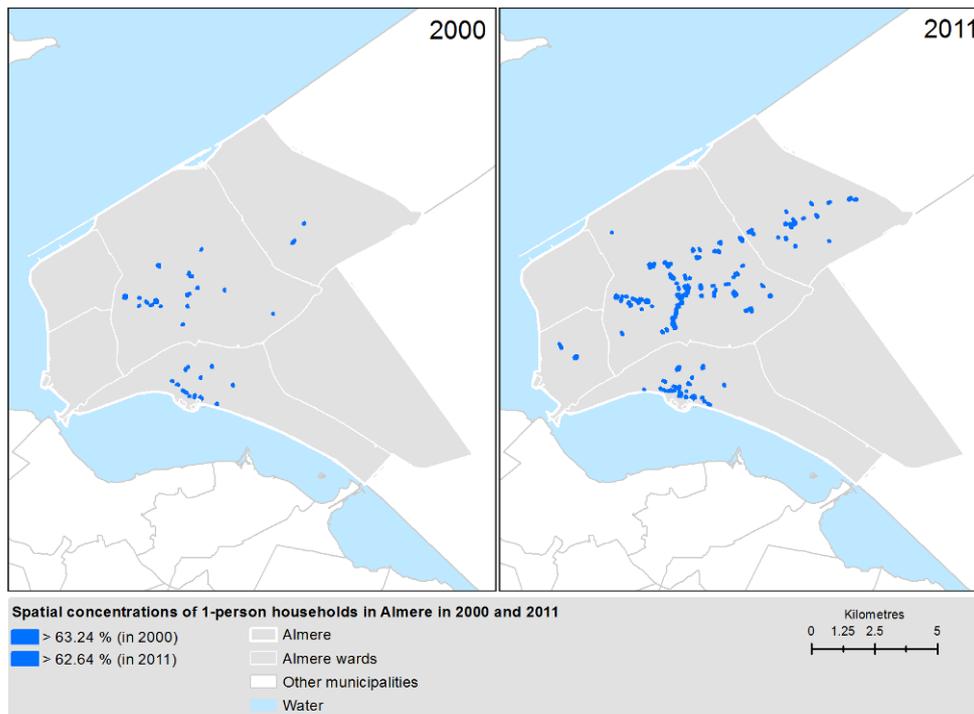
Source: GIS data: RMA, 2015; CBS, 2014; Rijkswaterstaat, 2015

Figure 7. Regional concentration areas of Moroccans in 2000 and 2011, zoomed to Amsterdam and Haarlem.



Source: GIS data: RMA, 2015; CBS, 2014; Rijkswaterstaat, 2015

- 30 Another persistent idea which is out dated concerns the assumption that 1-person households prefer to live in cities, while family-households choose for the sub-urban region. Figure 8 illustrates the increasing popularity of Almere for 1-person households. Changes in the distribution on 1-person households within the region may have consequences for planning appropriate housing for this group in some municipalities.

Figure 8. Local concentration areas of 1-person households in Almere in 2000 and 2011.

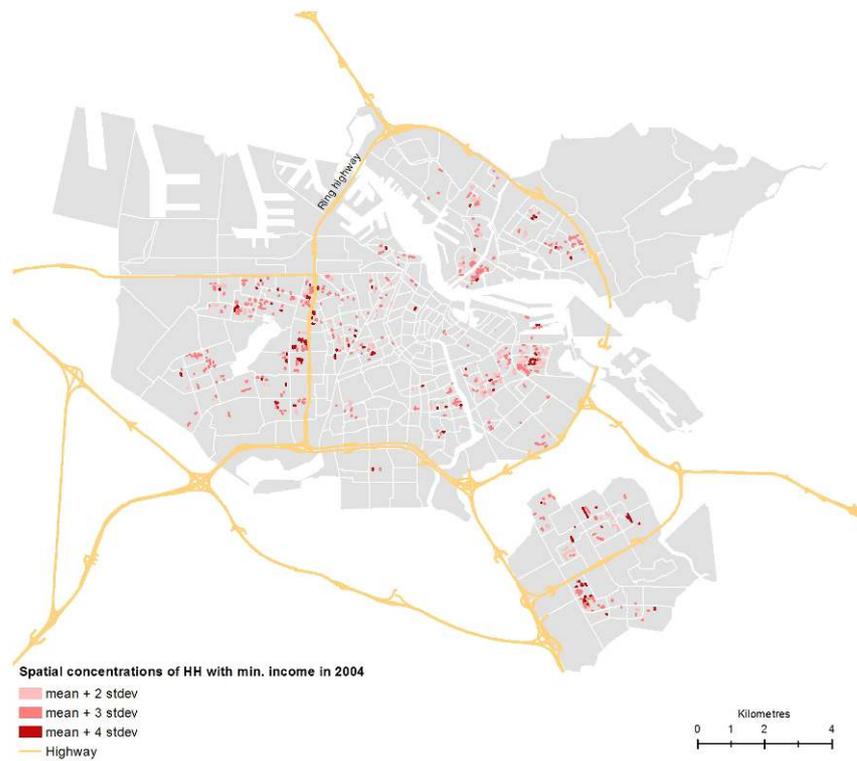
Source: GIS data: RMA, 2015; CBS, 2014; Rijkswaterstaat, 2015

What is the spatial relation between different phenomena in the municipality (or region, ward, district)?

- 31 One of the ambitions of local governments is to reduce concentrations of deprivation and to prevent the emergence of new ones. To achieve this, a policy of neighbourhood mixing has been promoted in most European countries. The monitor can be used to evaluate the effectiveness of this policy.
- 32 Figures 9 and 10 show local concentration maps of minimum income households in 2004 and 2012. The maps classify the concentration areas in 3 types: standard concentrations (based on the average percentage of households with minimum income plus 2 stdev), strong concentrations (3 stdev) and very strong concentrations (4 stdev). The maps show that concentration areas increased in size and number. New concentration areas have emerged in several parts of the city: in the Western and Eastern district and in some parts of the Northern and Southeastern districts. Nowadays, more deprived people are living in areas with a large share of other deprived people. This is not in line with a policy of reducing socio-economic segregation.
- 33 These spatial concentration maps of minimum income households fed a recent public discussion in Amsterdam on whether poverty increased beyond the typical ring highway of Amsterdam, being regarded by some as a distinct border dividing Amsterdam in two very different parts: a poor one and a rich one. Partly based on these maps, van Gent *et al.* (2014) state that demographical developments and housing policies undermine the Amsterdam ambition to be an 'undivided city'. They relate the shift of concentrations to the outer parts of the city to the decrease of social housing which mainly takes place

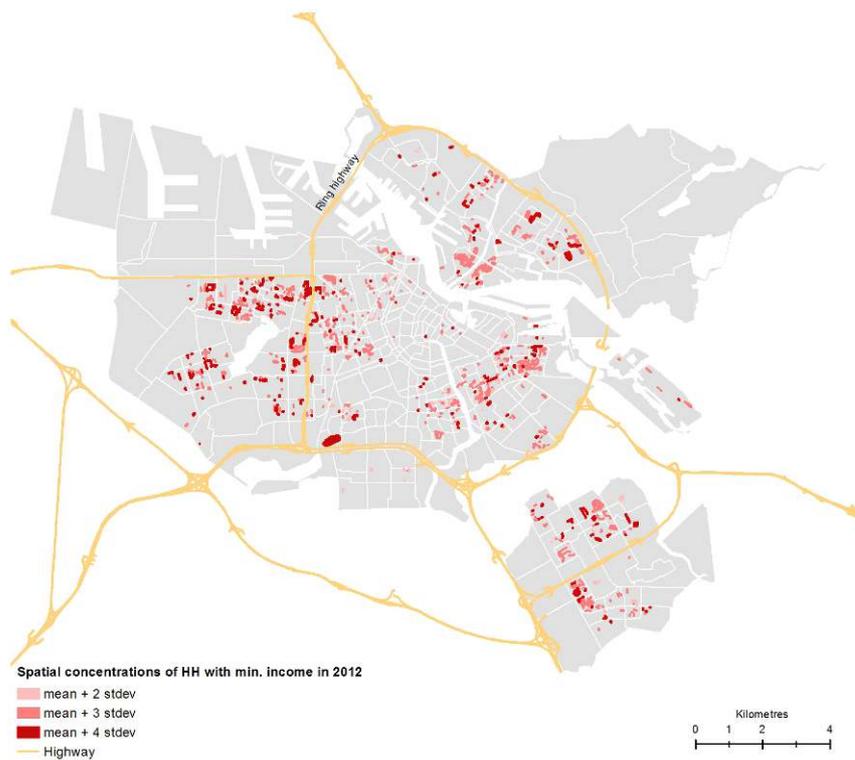
within the ring highway. As a consequence low income inhabitants have to rely on housing in the outskirts and pockets of not yet restructured housing stock. Maps showing concentrations of characteristics of the housing stock and composition of the population can be very helpful when studying issues like this.

Figure 9. Local concentration areas of households with a minimum income in 2004.



SOURCE: GEMEENTE AMSTERDAM / o&s, 2004; CBS, 2014; RIJKSWATERSTAAT 2015

Figure 10. Local concentration areas of households with a minimum income in 2012.



NOTE THAT ALTHOUGH THE RMA MAPPING METHODOLOGY HAS BEEN ADOPTED TO CREATE THE MAPS THIS PHENOMENON IS NOT (YET) INCLUDED IN THE RMA MONITORING TOOL.

Discussion

- 34 This article has highlighted the importance of mapping beyond standard administrative boundaries in the current situation of extremely diverse urban settings and increasingly polycentric regions. Unlike other interactive thematic online applications, the RMA differs in the following aspects. First, it focuses on concentration areas, and not on the average spatial pattern commonly displayed in standard thematic maps. It shows micro-scale spatial information in the form of deviating and striking urban phenomena. Second, the concentration areas are data-driven aggregates that are flexible, independent of administrative boundaries. Third, the RMA recognizes the importance of both the local and the regional scale and therefore applies local and regional concentration thresholds. Finally, the RMA tool offers high flexibility in terms of thematic queries or adjusting the presentation and design of maps; in other tools interactivity is often limited to indicator and theme selection and zoom options.
- 35 In order to demonstrate the usefulness of this tool in assisting urban policy and research, we have presented three illustrative examples.

Opportunities and limitations

- 36 The RMA provides spatial information about the dynamics of a variety of urban phenomena at a relevant scale. The graphical user interface of the RMA tool assists in

exploring maps and adapting a map to specific information needs making information accessible for people without much time and/or experience in mapping. The maps can be used for monitoring urban phenomena and formulation and testing of hypotheses about developments at a local and a regional scale. Although the methodology uses the typical Dutch six digit postcode areas as base data, a similar procedure can be applied to other types of base data such as enumeration blocks of a population census like the one in Argentina (Martinez *et al.*, 2016). We warn that many data, for instance survey data or geo-located social media data, are not suitable for mapping spatial concentrations because these are not complete enumerations.

- 37 The RMA is not only the product of a collaborative effort to produce information but it also accommodates increasing information needs about urban dynamics. It is an excellent way to mediate spatial thinking at multiple scales and to create awareness of the sensitivity of data aggregation to the choice of boundaries. It brings together researchers, policy makers and other professionals interested in urban dynamics both at the local and the regional scale. The regular meetings of the working group and public events accommodate discussions of both local and regional issues and further development of the tool. The long-term commitment of actors and the investments in maintenance and improvement of the tool illustrate the importance attached to the information provided by the RMA. The monitor is regularly used in publications (e.g. Ostendorf *et al.* 2008; Gemeente Amsterdam, 2013) and in various teaching modules at the University of Amsterdam.
- 38 Nevertheless, there are also some limitations. First, because each municipality is responsible for the provision and quality of the input data for the maps, mistakes are likely to occur. The input data would be less error-prone if centrally collected databases could be used. However, this requires either institutional commitment from Statistics Netherlands who collects, standardizes and validates the required data from multiple data agencies or a considerable budget to purchase the necessary data.
- 39 Second, in order to be used as a monitor maps need to be up-to-date (de Kool, 2008). Therefore, input data should be provided in time. A regional mean can only be calculated if all municipalities deliver their data in time. This is sometimes hard to realize and could be overcome by acquiring data centrally from Statistics Netherlands.
- 40 Third, concentration areas are quite complicated spatial objects and are different from choropleth maps normally used in urban practice. This makes interpretation of the maps difficult incurring for example ecological fallacies. Although the tool can be accessed by everyone with internet access, it is questionable whether many people will interpret the maps correctly. An extreme example of misinterpretation would be if overlapping concentration areas of unemployed and concentrations of Antilleans lead to the conclusion that all Antilleans are unemployed.
- 41 We further regret the absence of the smaller municipalities in the region. The main reason for their absence is lack of the necessary capacity and resources for processing the base data. Acquiring postcode data centrally from Statistics Netherlands could overcome this problem as well.
- 42 Finally, although many urban planners and decision makers recognize the need to cross boundaries, they are used to work with choropleth maps and do not want to lose 'their' boundaries at once. For this reason choropleth maps based on administratively defined areas have been included in the RMA recently. Now maps of spatial concentration areas

can complement choropleth maps to enhance the understanding of the spatial nature of a phenomenon.

- 43 Future development of the RMA includes expanding the thematic content to meet new information needs such as adding health-related maps and some interface improvements. A useful functional extension would be the implementation of a toolbox that facilitates exploring spatial associations between multiple variables. While most monitoring tools focus on querying a single variable, targeting complex urban problems requires the combination of multiple dimensions. Analysing residential segregation or urban poverty in relation to other urban variables such as the composition of the housing market will help in understanding the resulting patterns of residential ‘choices’. Another urban issue to be addressed would be the changing dynamics of crime hotspots, for instance in combination with changes in socio-economic area characteristics. Obviously it will be a challenge to implement such functionality without making the tool too complicated reducing accessibility.

Conclusion

- 44 The purposes of this article were to explain the mapping methodology adopted in the RMA and to illustrate the usefulness of the tool in urban management.
- 45 We have shown that by introducing ‘data-driven dynamic geographies’ instead of using fixed administrative boundaries we can filter relevant information from large data sets at the scale at which urban phenomena occur. Furthermore, the tool improves our understanding of the dynamics of urban phenomena at both the local and regional scale.
- 46 Offering this type of information through an interactive thematic online application facilitates the construction of tailor made maps for different years that can address information needs of urban policy makers and researchers. Hence, the monitoring tool assists in answering policy questions such as the existence of the persistence of concentrations of unemployment, the need to adapt housing policies to regional demographic dynamics, or whether social mix policies should be promoted due to the spatial clustering of social housing and low-income households.
- 47 The RMA has been collaboratively developed with policy professionals, urban managers and urban researchers. This ensures that the thematic content offered by the RMA matches their information needs. A collaborative effort is required to embed such a tool in institutions and processes to ensure long-term existence and use.

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ABSTRACTS

Maps are widely used to provide urban managers with information on critical urban issues such as deprivation, unemployment, and segregation. Although administrative boundaries have always played an important role in map making, they are not meaningful for revealing the spatial dynamics of urban phenomena that vary within wards, cross ward boundaries and do not necessarily stop at the city boundary.

Recently, very detailed (spatial) data have become available providing opportunities for new types of urban mapping. To process these data into meaningful maps, three aspects are important. First, information on maps should be produced at a spatial scale that is relevant for a particular urban phenomenon. Second, to reveal and monitor urban dynamics, maps of a phenomenon at different moments in time are needed. Finally, to accommodate access to these maps for potential users without (much) expertise in mapping, they should be provided through an easy to use tool.

The Regional Monitor Amsterdam (RMA), an online GIS application, deals with these aspects. The purposes of this paper are to explain the mapping methodology adopted in the RMA and to illustrate the usefulness of the tool in urban management. This methodology goes beyond

administrative mapping areas with fixed boundaries by introducing 'data-driven dynamic geographies'. We argue that this methodology produces relevant information by recognizing the scale at which urban phenomena occur. The monitoring tool assists in answering policy questions by easy access to relevant maps for different moments in time.

Kaarten worden vaak gebruikt om informatie te verschaffen over stedelijke kwesties zoals armoede, werkloosheid en segregatie. Alhoewel administratieve grenzen altijd een belangrijke rol hebben gespeeld in kaarten, zijn ze niet geschikt om de ruimtelijke dynamiek van stedelijke verschijnselen in kaart te brengen omdat deze variëren binnen administratieve grenzen, administratieve grenzen overschrijden en ook niet zomaar stoppen bij stadsgrenzen.

Tegenwoordig zijn er veel ruimtelijke data beschikbaar op een veel lager schaalniveau dan vroeger. Dat schept mogelijkheden voor het ontwikkelen van nieuwe soorten kaarten. Drie aspecten zijn van belang bij het omzetten van data in zinvolle kaarten. In de eerste plaats moet de informatie op de kaart op een ruimtelijk schaalniveau worden weergegeven dat relevant is voor het betreffende stedelijk verschijnsel. In de tweede plaats is het voor het in kaart brengen en monitoren van stedelijke dynamiek nodig dat er kaarten zijn van verschijnselen op verschillende tijdsmomenten. Tot slot moeten de kaarten via een gebruiksvriendelijke tool worden aangeboden om zo ook mensen met weinig ervaring in het maken van kaarten toegang te geven tot de informatie op de kaarten.

De Regiomonitor Amsterdam (RMA), een online GIS applicatie, geeft gehoor aan deze aspecten. In dit artikel beschrijven we de methodologie die is toegepast in de RMA en laten we zien hoe de tool zinvol kan worden ingezet in stedelijk beleid en onderzoek. Door het introduceren van 'data-driven dynamic geographies' gaat de methodologie verder dan de gebruikelijke manier van kaarten maken op basis van vaste administratieve grenzen. We laten zien dat de methodologie relevante informatie oplevert omdat uitgegaan wordt van het voor een stedelijk verschijnsel relevante schaalniveau. Daarnaast ondersteunt de RMA in de beantwoording en het verkennen van beleidsvragen door ook mensen zonder GIS kennis snelle toegang te geven tot relevante kaarten van verschillende tijdsmomenten.

INDEX

Keywords: Amsterdam, urban monitoring, GIS, micro scale

motsclesnl stedelijke vraagstukken, stedelijk beleid, stedelijke dynamiek, online mapping, monitoring, interactief

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