Residential segregation of poverty

A longitudinal study of socio-economic segregation in Stockholm County 1991-2016

Mingus Wass

Department of Human Geography
Master's Degree 30 HE credits
Master's Programme in Urban and Regional Planning
Spring Term 2020
Supervisor: Karen Haandrikman

Stockholms universitet

Residential segregation of poverty

A longitudinal study of socio-economic segregation in Stockholm County 1991-2016

Mingus Wass

Abstract

Segregation refers to the uneven spatial distribution of social groups over space. Segregation can be perceived as the spatial representation of social, cultural, and economic exclusion. There is no accepted standard way segregation is measured; instead, studies have used a wide range of methods, measurements, and indices to estimate levels of segregation. Existing studies are seldomly longitudinal in character, mostly because of lack of data, and have only been conducted until 2010 for Stockholm. The aim of this thesis is to investigate trends of residential poverty segregation in Stockholm County for the period 1991-2016. This study has utilized *the isolation index, the dissimilarity index, percentile plots* and *location quotients* on data aggregated to both *administrative units* and *individualized neighborhoods* on multiple scales to assess how these common techniques influence results. Results show that segregation patterns vary depending on technique, but most results indicate increasing levels of segregation of individuals at risk of poverty for the period 1991-2011, in line with previous research. On the other hand, the results indicate stagnating or decreasing levels of poverty segregation in recent years. Poverty segregation varies substantially by scale level, and therefore this thesis recommends multiscalar methods in segregation studies.

Keywords

Segregation, socio-economic segregation, Stockholm, multiscalar, MAUP, bespoke neighborhood, individualized neighborhood, EquiPop, welfare regime, housing policies, Sweden.

Acknowledgements

First, I would like to thank my supervisor Karen Haandrikman for helping me throughout the process of writing this paper. Without her guidance, feedback, and assistance with data compilation this study would not have been possible. Additionally, I want to dedicate a special thanks to other researchers at the institution of Human Geography at Stockholm University who have contributed to the dataset covering the years 1991-2016 which has been essential for this study.

Contents

Introduction

Segregation as a social phenomenon refers to the uneven spatial distribution of social groups over space (Andersson & Kährik 2016; Massey & Denton 1988). The phenomenon has been researched from diverse perspectives, such as residential-, workplace-, and educational-segregation. For human geographers and urban planners, the topic is of special interest due to the explicit spatial nature of the phenomenon. Within academic, political and media discourses, segregation has negative connotations being perceived as both a concrete representation of societal inequalities in the urban landscape, as well as an obstacle for integration and social mobility (Yao et. al 2018).

Individuals who reside in segregated neighborhoods might experience limited access to alternative social networks, which in turn has implications for social capital and capabilities (Musterd 2005). On a larger scale, segregation may cause social antagonism and conflict in communities due to structural experiences of isolation and exclusion (Biterman 2010; Aldén & Hammarstedt 2016). Segregation is therefore commonly researched and discussed in relation to vulnerable sub-populations, such as ethnic minorities and economically vulnerable groups. In the Swedish context public policies and reports describe the segregation of vulnerable social groups as a risk factor for future outcomes of individuals and communities (ibid.). Proactive efforts to reduce segregation can therefore be perceived as a normative goal of urban development which is reinforced by political discourse in the Swedish context.

Policymakers and professionals rely on quantitative estimations of segregation to assess segregation trends as well as the effects which urban development policies and social interventions have on segregation in local contexts. Previous quantitative segregation research has utilized and suggested a wide range of instruments and measurement techniques for such estimations. For example, some segregation research refers to analysis based on administrative areas which highlight segregation trends based on a single predefined scale, while other have utilized multiscalar methods which highlight segregation patterns on multiple scales simultaneously. Furthermore, previous research commonly refers to several indices and forms of analysis such as the *dissimilarity index*, *the isolation index*, *percentile plots* and *location quotients* amongst others. Consequently, there is no prevalent method in terms of quantifying and estimating levels of segregation.

This thesis will provide a longitudinal quantitative study of socio-economic segregation in Stockholm County 1991-2016. The study will utilize several methods, based on both administrative units and multiscalar analysis, to estimate changes in the segregation of people at risk of poverty during this period. The study will highlight potential discrepancies between commonly employed measurement techniques in quantitative segregation studies. Additionally, concrete findings of segregation trends over time will be compared with previous research to highlight potential similarities and discrepancies.

Aim, Research Questions & Relevance

Aim

The aim is to provide a multiscalar analysis of residential socio-economic segregation 1991-2016 based on multiple estimates in the context of Stockholm. This will be done utilizing several indices and measurement techniques. The use of multiple methods in this study is motivated by the fact that previous studies have found diverging results between commonly employed segregation estimates (Massey & Denton 1988). Results between the employed measurements will therefore be compared to highlight potential similarities and discrepancies. Moreover, these results will be compared with previous research to shed light on potential analytical discrepancies. Previous research on socio-economic segregation in the Stockholm metropolitan region over comparable time periods, such as Andersson & Kährik (2016) and Östh et. al (2014), have indicated increasing levels of socio-economic segregation 1990-2010. Furthermore, results related to the years 2010-2016 will be of special interest since they have not been covered by previous studies of socio-economic segregation in this context.

Previous longitudinal studies of segregation in Stockholm using *multiscalar methods* have focused mainly on ethnic segregation (Malmberg et. al 2016; Nielsen & Hennerdal 2017). Consequently, an additional aim of this study is to provide a comprehensive analysis of socio-economic – rather than ethnic – segregation in a longitudinal, multiscalar study of Stockholm County.

Research Questions

- How can patterns of segregation be described over time using the dissimilarity index, the isolation index, percentile plots and location quotients?

- How have patterns of socio-economic residential segregation developed in Stockholm County over the period 1991-2016?

- How do these findings relate to previous research that found increasing levels of socio-economic segregation in the period 1990-2010?

- To what extent are segregation indices such as the dissimilarity index and the isolation index affected by methods based on administrative areas or bespoke neighborhoods?

Social and Academic Relevance

This study will provide an extensive analysis of recent segregation trends in the Stockholm Metropolitan region 1991-2016. This period is relevant to study due to political transitions, changes in public housing policies and increased migration flows in the Swedish context from 1990s and onwards. In the Swedish context, targeted subsidies and housing policies have historically been dedicated to achieving mixed tenure forms within areas, with the aim of reducing segregation (Wimark, Andersson & Malmberg 2020). After the financial crisis in the early 1990s, however, the housing market came to be increasingly determined by market forces, with less interventions by public policies and subsidies (Andersson & Kährik 2016). This political transition coincided with increased immigration to Sweden which had further implications for segregation developments at the turn of the millennium (ibid.). It is therefore relevant to investigate the period 1990-2016 to assess the impact of these processes on residential patterns of socio-economic segregation in the Stockholm metropolitan region. Moreover, the data for 2016 is relatively new and has not yet been utilized in descriptive studies of socio-economic segregation. Results for the most recent years (2011-2016) will therefore be relevant as an indication of up-to-date trends of socio-economic segregation in the Stockholm metropolitan region.

For the previous years (1990-2010) this study will be relevant in terms of a re-evaluation of studies of socio-economic segregation in the Stockholm Metropolitan context. Results from previous studies have indicated increasing levels of socio-economic segregation over the period 1990-2010 (Andersson & Kährik 2016). In relation to previous findings, the proposed study including multiple measurements might; *i)* replicate previous findings using different measurements and increase the reliability of those studies, *ii)* find divergent results depending on measurement type, calling for further methodological considerations, *iii)* falsify previous findings using multiple methods, challenging previous assumptions related to segregation trends in this context.

Policymakers and professionals who are working in the field of urban development, integration and housing policies are reliant on estimations of segregation to appreciate contemporary trends, as well as evaluate the effect of strategies, interventions, and events on segregation in local contexts. Such assessments are commonly based on quantitative methods to estimate longitudinal segregation trends. This study is therefore relevant for politicians and professionals as; *i)* an indicator of contemporary socio-economic segregation trends in Stockholm, *ii) a* methodological reference for future assessments. Similarly, this study will be relevant for researchers both in terms of reference to concrete findings as well as discussions on appropriate methods for future assessments. Quantitative studies have historically employed a wide range of measurements, indices, and instruments to estimate levels of segregation, both in contextual studies and experimental models. Studies which utilize several measurements in experimental models have revealed discrepancies in the results (Massey & Denton 1988). It is therefore evident that the choice of methods has implications for the results of contextual estimations of segregation. This study will therefore be relevant since it will highlight analytical similarities and discrepancies across commonly employed methods in a contextual study of segregation.

Background

This section discusses theories, concepts and frameworks which have been utilized in previous segregation research. The first section covers the foundations of phenomenological descriptions of segregation. Additionally, this section distinguishes between, and compares *socio-economic* and *ethnic* dimensions of segregation. The second section describes theoretical frameworks related to *causes and effects* of segregation. The third section provides a comprehensive overview of *previous research on segregation in the Swedish context.* This section provides a description of theories, concepts, and processes which are frequently discussed in segregation research in Sweden. This part is concluded with a summary of previous research findings in this context to facilitate cross-references of results with this study. The fourth and final section outlines how previous research has operationalized segregation quantitatively to provide empirical support for the selection of methods used in this study.

Definitions of Segregation

For social scientists, segregation can be briefly defined as the uneven spatial distribution of social groups (Andersson & Kährik 2016; Massey & Denton 1988). Most frequently, segregation research has defined social groups based on ethnic or socio-economic characteristics. Common contemporary examples of social categories are *ethnic minorities, non-European migrants*, *people at risk of poverty* and *unemployed* amongst others. Furthermore, segregation has been investigated from various perspectives such as *educational segregation* (Hansen & Gustafsson 2016), *workplace segregation* (Strömgren et. al 2014), and *residential segregation* (Andersson & Kährik 2016; Malmberg et. al 2016). It will be apparent in later discussions on *methods of estimating segregation* and *conceptualizing the neighborhood* that the notion of *uneven spatial distribution* is more intricate than what might be initially assumed.

While the proposed study is dedicated to an investigation of *socio-economic residential segregation*, theoretical foundations of segregation research are often described in terms of *ethnic segregation*. This is partly due to the large influence of American theorists on the subject and the historically evident demographic discrepancies between Anglo-American and Afro-American/Latin-American communities. In the European context segregation is rarely encountered based on single ethnic identities, it has therefore been more common to discuss ethnic segregation in relation to multi-ethnic categories such as *non-European migrants* or *visible ethnic minorities* (Musterd 2005). Furthermore, while ethnic and socio-economic segregation are conceptualized separately, they should rather be understood as interrelated phenomena since ethnic minorities tend to be over-represented amongst lower socio-economic classes and vice versa (Andersson & Kährik 2016; Tammaru et. al 2016).

Briefly accounting for the history of segregation research, Tammaru et. al (2016) describe the first examples of modern segregation research deriving from the Chicago School of Sociology in the early 20th century. Researchers such as Park, Burgess & McKenzie (1925) questioned the naturalist notion that communities reflected characteristics which were endogenous to inherent traits of the neighborhood's residents. On the contrary, *the ecological approach* described uneven living conditions in the urban environment as a reflection of social distance between classes in society. In other words, social distress in urban environments was increasingly perceived in relation to systematic concentrations of individuals with lower social status in certain neighborhoods rather than being due to innate qualities of categories of individuals within these areas. Tammaru et. al (2016) add that the *ecological approach* defined segregation as a universal phenomenon which would unfold similarly across contexts. The *ecological approach* has been distinguished from subsequent approaches which came to focus on contextual factors, such as local *welfare regimes, housing policies* and positioning localities in relation to *global networks* (ibid.).

Research on causes and effects of Segregation

The following discussion will summarize theoretical frameworks and concepts that account for the causes and effects of segregation. The first section provides a description of theoretical frameworks and concepts related *to causes of socio-economic and ethnic segregation*. The second part provides brief accounts of potential effects of segregation to further reinforce the relevance of the proposed study.

Causes of segregation

To account for the causes of residential segregation Wimark (2018) distinguishes between the concepts of *residential segregation* (boendesegregation) and *segregated housing* (bostadssegregation). From a causal perspective *residential segregation* refers to segregation as a phenomenon that is actively produced by individuals through selective preferences on housing markets. *Segregated housing* on the other hand refers to the spatial segmentation of residences on housing markets based on price, type, form of ownership, or other factors that are relevant to consider in relation to processes of social sorting. If we apply this distinction to causes of segregation, the former refers to *behavioral* causes of segregation whereas the latter refers to *structural* causes of segregation.

Structural causes of socio-economic segregation are frequently described in relation to global political transitions under neo-liberal laissez faire politics. The anthology *Socio-Economic Segregation in European Capital Cities: East meets West* (Tammaru et al. 2016) provides an explanatory framework for the perceived growing levels of socio-spatial inequalities in Europe during the second half of the 20th century. Recent developments in terms of socio-spatial inequalities are described in relation to broad transitions of the political economies in western Europe. In the last decades of the 20th century, western European economies transitioned from industrial to post-industrial economies. Simultaneously these economies were increasingly pursuing liberal economic policies in the context of global neoliberal economic restructuration's (Tammaru et al. 2016). Effectively, this led to *increased economic inequalities,* as well as the dismantling of *welfare state functions.* Neoliberal reforms entailed that the housing markets in the western European context were increasingly segmented based on market price. Abandoned housing policies and reduced housing subsidies effectively resulted in the residualisation of social and affordable housing (Tammaru et al. 2016) (Wimark 2018). However, these reforms have unfolded differently across contexts. Western European countries still implement interventionist welfare strategies to actively reduce segregation in urban areas. This may partly explain the relatively low levels of socio-economic segregation in European cities in comparison to American counterparts (Musterd 2005). From this perspective, increasing levels of segregation are described as an expected outcome in unregulated *laissez faire* conditions, whereas welfare interventions are perceived as a mitigating factor for these processes. Research on segregation in the Swedish context commonly use this theoretical framework to account for the perceived increase in segregation occurring in the last 20 years (Wimark, Andersson & Malmberg 2020; Andersson & Kährik 2016). This topic will therefore be discussed further in the section covering *'Welfare and housing policies in Sweden'.*

Behavioral causes of socio-economic segregation are mainly related to selective preferences of individuals who have the means to choose where they live based on life-style preferences. Examples of such life-style preferences are tenure and housing form, proximity to infrastructure and recreational areas, as well as proximity to commercial and cultural facilities amongst other factors (Wimark 2018). If selective preferences tend to be similar for socio-economic groups such as academics or the "creative classes", this will in effect result in socio-economically homogenous areas due to collective behavioral patterns on housing markets based on social class. Accounting for the behavioral patterns of marginalized socio-economic groups makes it more difficult to argue for collective behavioral patterns related to life-style preferences since affordable residential options tend to be limited in metropolitan areas. Consequently, from a behavioral perspective segregation processes can be perceived in relation to the behaviors of the economically affluent rather than the economically marginalized. Perhaps this could provide an explanation as to why some empirical studies have found higher levels of segregation of high-income earners compared to low-income earners in Europe (Musterd 2005; Haandrikman et. al 2019; Andersson & Kährik 2016).

Researchers and public authorities in the European context have defined segregation as a phenomenon which is rooted in economic rather than ethnic inequalities (Tammaru et. al 2016; Biterman 2010). From this perspective, ethnic segregation can be perceived as a spatial representation of the economic inequalities which ethnic minorities commonly experience in relation to ethnic majorities. However, it should be acknowledged that there might be ethnic components of segregation processes which operate irrespective of socio-economic dimensions. Therefore, three causal theoretical frameworks that are conceptualized in relation to ethnic dimensions of segregation will be described, *the spatial assimilation theory, the ethnic preference theory,* and *the place stratification theory*. Deriving from the Chicago School, the *spatial assimilation theory* describes the residential trajectories of economically marginalized immigrant groups. The theory infers that marginalized immigrants, who initially tend to reside in economically distressed areas, will ascertain their socio-economic status by moving to more affluent areas when they have the financial means of doing so. On the contrary, the *ethnic preference theory* suggests that ethnic minorities are prone to continually reside in neighborhoods with a relatively high presence of co-ethnics due to preferences of residing close to viable social-networks and cultural institutions. Studies by Åslund (2005) amongst others have utilized this theoretical framework, suggesting that segregation – both economic and ethnic – is reinforced by voluntary residential choices of immigrants, who prefer to move to and continually reside within areas with already large shares of ethnic minorities. Conversely, research on compositional trajectories of neighborhoods have suggested that ethnic natives tend to move from - and avoid moving to - residential areas where ethnic minorities are relatively over-represented. Quantitative studies by Böhlmark & Willén (2020) have affirmed this phenomenon in Sweden utilizing *the tipping point theory* in a longitudinal study of ethnic compositions of metropolitan neighborhoods. Complementary to the previously mentioned theories, the *place stratification theory* accounts for structural discrimination against ethnic minorities on housing markets, preventing them from moving to economically affluent areas. A few examples of potentially discriminatory actors and institutions are financial institutions, real estate agents, private and public rental institutions.

Segregation effects

A wide range of research has conceptualized and investigated potential negative effects of segregation. In many cases empirical studies of these effects have been tested with varying results. Hence, these effects have been subject to vigorous discussions due to difficulties of establishing causal relationships in empirical research (Wimark 2018). Especially so considering that it is difficult to control for external effects in non-experimental studies. Consequently, this section will summarize the commonly discussed effects of segregation to reinforce the relevance of this study rather than establishing causal relations.

Politicians, professionals, and researchers alike perceive segregation as a risk-factor for future outcomes of individuals, communities, and society at large (Tammaru et. al 2016). Segregation is frequently perceived as a debilitating factor for individuals living in economically marginalized communities since it limits their capability of realizing *social mobility*. The *spatial mismatch theory* developed by Kain (1968) provides a theoretical framework for this effect. Kain (1968) explains consistent levels of economic deprivation in certain communities by the spatial separation and lack of infrastructure between these communities and sites of economic opportunities such as workplaces, educational facilities, and other institutions. Additionally, concentrations of economically marginalized individuals in segregated neighborhoods lead to diminishing tax bases and unfavorable commercial opportunities in these localities, which further reinforces institutional deficiencies and the lack of access to economic opportunities (Wimark 2018). Furthermore, segregation is frequently associated with increasing levels of social unrest in European cities (Tammaru et. al 2016).

From this perspective, the spatial clustering of socio-economically marginalized people may cause *social antagonism* and negative socialization processes (Tammaru et. al 2016; Wimark 2018). Processes of negative socialization and social antagonism are consequently related to issues of security and health, such as crime, violence, and drug use. Segregation is therefore perceived as a risk factor for individual life-outcomes as well as the social cohesion and sustainable development of society at large. Musterd (2005) claims, however, that the segregation discourse in Europe has focused mainly on the effects of segregation on *social mobility* rather than *social antagonism*. In the light of recent developments and public displays of social unrest in marginalized urban areas across Europe, one could argue that the discourse on segregation in Europe has come to increasingly revolve around issues of *social antagonism* (Tammaru et. al 2016). A contextually viable example are the riots in Husby in Stockholm in May 2013 and the repercussions this event had for the public segregation discourse in Sweden (Vogiazides 2018; Wimark 2018; Östh et. al 2014).

Having outlined previous research and theories related to causes and effects of segregation, the following section will provide an account of theoretical frameworks and concepts which have been commonly employed in segregation research in the Swedish context.

Segregation in the European and Swedish context

This section will give an overview of commonly applied theoretical frameworks and concepts in previous segregation research of Sweden. The first section describes the historical transformations of the Swedish *welfare regime* in relation to processes of segregation. The second section briefly describes the increased migration flows at the turn of the millennium in Sweden as they affect patterns of segregation during the proposed study period 1991-2016.

Welfare and Housing policies in Sweden

Researchers on segregation in the Swedish context often distinguish a paradigm shift in Swedish housing policy taking place in the 20th century shifting from a heavily regulated and subsidized *folkhem* model, apparent in the 1930-1980s, to an increasingly liberal model with fewer subsidies and regulations from the 1980s (Andersson & Kährrik 2016; Grundström & Molina 2016; Wimark, Andersson & Malmberg 2020). This shift has been especially apparent in the context of significantly reduced public investments after the 1990s financial crisis (Andersson & Kährik 2016).

Historically, public institutions in Sweden have been described as having an active and privileged role on the housing market. Municipal housing companies provided affordable housing with the support of public subsidies. Such housing commonly catered for the needs of vulnerable economic groups on the housing market, especially so in metropolitan regions. Additionally, housing mix policies were introduced on a national level in the 1970s to actively promote a diversity of tenure forms within neighborhoods (Andersson & Turner 2014;

Wimark 2018). Policies promoting neighborhood diversity of tenure forms could perhaps be perceived as a response to the criticism of the homogenous nature of areas built under the Million Housing Program (miljonprogrammen) in the 1960-1970s that had implications for economic segregation at that time. Mixed tenure forms within neighborhoods were thereafter increasingly promoted with the aim of increasing social diversity within areas to reduce segregation (Wimark, Andersson & Malmberg 2020; Wimark 2018).

While some of the regulatory frameworks of the *folkhem* model are still in place in the Swedish context to this day, the housing market in the post 1990s context in Sweden has been described as liberal with limited public interventions (Andersson & Turner 2014). Subsidies which previously incentivized the construction of affordable rentals have been discarded (Wimark 2018). Concurrently, tenure conversion programs have provided residents in targeted areas with the option of buying and converting rental units into market-based cooperative housing (Andersson & Turner 2014). In metropolitan areas these processes have significantly reduced the share of rentals on the housing market since the 1990s. The proportion of individuals living in public rentals in Stockholm declined from 32% in 1990 to 18% in 2010 (ibid.). In the inner-city this process was even more apparent, where corresponding proportions declined from 19% to 7% in the same time period (ibid.). In effect these processes have limited the residential options of economically marginalized individuals to areas in the peripheries of metropolitan regions and larger cities. Such areas are commonly dominated by affordable tenure forms – often rentals constructed in the *million-housing program*. In the context of Stockholm, commonly discussed examples of such areas are Rinkeby, Tensta, Skärholmen and Rågsved amongst others. More recently, these areas have been targeted by conversion programs with the explicit aim of stimulating mixed tenure forms in areas that are dominated by rentals (Stockholm Stad 2018).

In addition to the effects which the financial crisis of the early 1990s has had on public housing policies in Sweden, one might also consider broader effects of increasing income inequalities in the post 1990s context. For example, income inequality estimated by the Gini coefficient has increased significantly since the 1990s (Österberg 2013). Disposable income growth has been significantly lower for the lowest income deciles compared to the economically affluent during the period 1991-2010 (ibid.). From this perspective, one should also consider the implications that the increasingly unequal distribution of wealth has for processes of socio-economic segregation in the post 1990s context.

Increased migration flows at the turn of the millennium

In addition to the political transformations described above, previous research has highlighted the increased in-migration in the post 1980s context as a factor to consider in terms of effects on processes of both ethnic and socio-economic segregation (Andersson & Kährik 2016; Malmberg, et. al 2016; Nielsen & Hennerdal 2017). Especially so taking into consideration that non-Western migrant groups experience structural discrimination on labor and housing markets and are generally overrepresented in the economically marginalized population (Malmberg et al. 2016).

The share of first-generation immigrants in Sweden rose from 9% in 1990 to 17% in 2015 (Nielsen & Hennerdal 2017). Concurrently, the share of immigrants originating from outside of Europe (among immigrants) has increased from about 28% in 1990 to about 40% in 2012 (Malmberg et al. 2016). In the Stockholm region, the share of first-generation immigrants in the population increased from 16 to 22% in the period 1990-2010 (Andersson & Kährik 2016). Furthermore, it is evident in Stockholm that the most significant increases in the relative share of first-generation migrants took place in the outer-city multifamily housing segment (ibid.). The increased in-migration is therefore viable to consider in terms of effects on both ethnic and socio-economic segregation.

Measuring Socio-Economic Residential Segregation

Socio-economic segregation can be investigated from diverse perspectives such as *school segregation, workplace segregation, commercial segregation, mobility-based approaches,* and *residential segregation.* This study will investigate *residential segregation,* with the aim of appreciating segregation processes in relation to places of *residence*. Individual statistics will be aggregated to larger spatial units to *represent the neighborhood*, whereas compositional differences between neighborhoods indicate segregation.

The following subsections will discuss data structures and analytical methods which have been utilized in previous segregation research. First, I will describe how previous research has operationalized socio-economic segregation through definitions of socio-economic groups. Second, I will elaborate on how previous studies have used aggregations of individual data as *representations of neighborhoods*. This is important since the concept *neighborhood* is fundamental for segregation research. At the same time, the neighborhood has been conceptualized in multiple ways. Thereafter, quantitative approaches of *estimating segregation levels* based on *neighborhood* statistics will be described with a focus on commonly used methods in recent segregation research. These two discussions will be particularly viable in relation to the selection of methods to employ in this study. The chapter is concluded with a comprehensive overview of previous findings of quantitative research on socio-economic segregation.

Definitions of socio-economic groups

To perform a quantitative analysis of socio-economic segregation, the population in the studied context is commonly divided into subgroups defined by specific socio-economic traits. Previous research has operationalized socio-economic segregation from various perspectives, I will here list a few examples of commonly used socio-economic categories within segregation research; individuals with tertiary education (Hennerdal & Nielsen 2019), unemployed individuals (Biterman & Franzén 2007), welfare recipients (ibid.), individuals who are economically self-sufficient (ibid.), the economically affluent (Andersson & Kährik 2016; Haandrikman, Costa, Malmberg, Rogne & Sleutjes 2019) and people in - or at risk of - poverty (Andersson & Kährik 2016; Biterman 2010; Östh et al. 2014; Haandrikman et. al 2019). While all the aforementioned categories are relevant to consider in relation to neighborhood composition and socio-economic diversity, the analysis in this paper will focus on economically impoverished individuals based on the Eurostat definition of individuals at risk of poverty. The exact definition of this subgroup will be described in greater detail in the methods section.

Conceptualizing the neighborhood

Traditionally, segregation research has relied on demographic statistics aggregated to administrative units or census tracts to account for neighborhood effects. In the Swedish context, Small Areas for Market Statistics (SAMS) have commonly been employed in research to approximate *neighborhoods* since their release in 1994 (Amcoff 2012). There are about 9000 SAMS areas in Sweden which were constructed with the aim of delineating homogenous areas based on topography, natural borders, tenure type, income, electoral participation, amongst other attributes (Amcoff 2012). See *figure 1* below for a visual illustration of SAMS zones in central Stockholm.

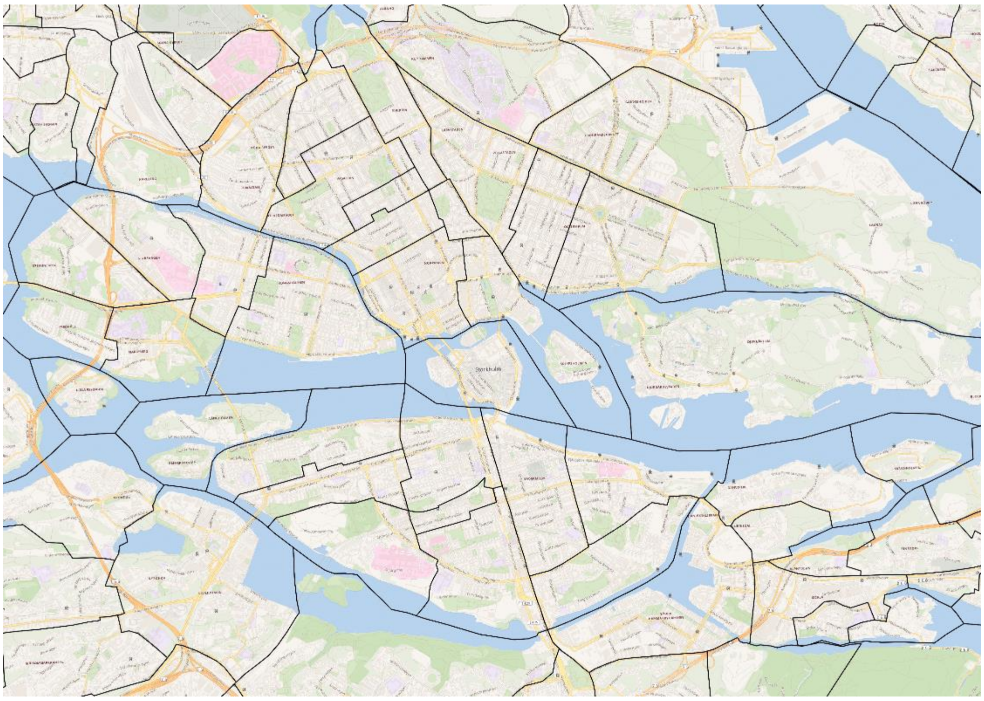


Figure 1 – Illustration of SAMS delineations in central Stockholm (Sources: Lantmäteriet/SCB, Wikimedia Maps).

While it has been common for researchers to rely on SAMS-units (or other spatially predefined units) to represent neighborhoods in segregation research, these types of analyses based on arbitrarily defined units on *singular scales* have been criticized by researchers referring to a wide range of issues known as *the modifiable areal unit problem* (MAUP) (Openshaw 1984; Wong 2009; Hennerdal & Nielsen 2017). Essentially, MAUP refers to the biasing effect which appears when individual observations or objects are aggregated into larger areal units, this issue is referred to as the *zoning effect* (Wong 2009). For example, consider the three different areal delineations used below in *figure 2* to describe point density per areal unit. While the points are the same in the three models the polygons describe population density in differing ways which is only due to how these zones have been defined. Consequently, relying on static predefined borders in any geospatial analysis might over and/or under-estimate the estimates for spatial units when viable concentrations can be perceived close to these borders (Andersson et. al 2018). The zoning effect is an issue inherent to all spatial analysis which is based on aggregations of individual cases to larger spatial units (Wong 2009). While one could circumvent this issue by performing the analysis on individual data, it is often not a viable alternative since segregation analysis based on individual data is methodologically difficult and computationally demanding. Additionally, geocoded data on individual level is often unavailable or restricted due to ethical considerations.

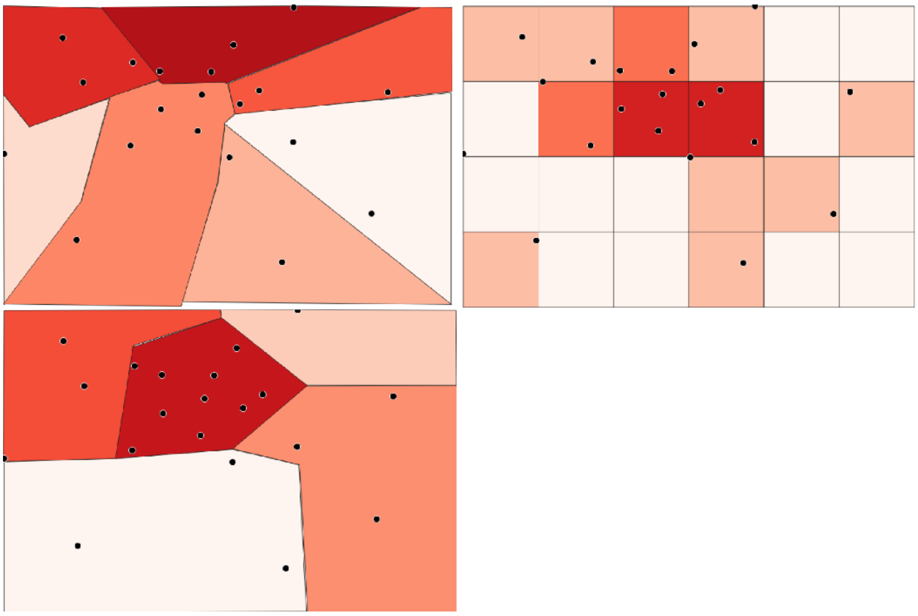


Figure 2 – Illustration of MAUP. Three different areal divisions were used to count the number of points within respective area. Polygon colors range from white (low density) to deep red (high density) referring to areal density in terms of points/area. Source: Author's illustration.

In addition to the zoning effect, researchers have described a related issue which is discussed in relation to the *scale of analysis* (Musterd 2005; Wong 2009). In *figure 3* below a checkerboard is used to illustrate the scale issue. The yellow borders here symbolize areal delineations, whereas the left checkerboard is delineated per square and the right on groups of four squares. The highly resolute delineations used on the left would indicate maximum segregation since black and white never share space. On the other hand, the right checkerboard consists of slightly larger units and indicate no segregation since there are equal black and white squares in each spatial unit.

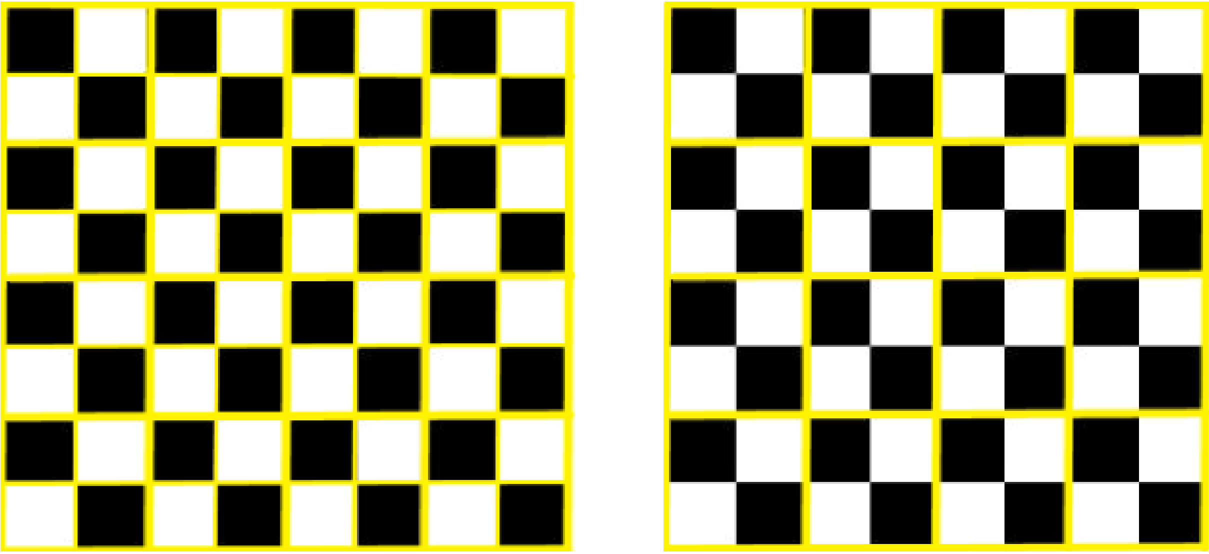


Figure 3 – Two checkerboards divided on different scales which is exemplified with two different square sizes to illustrate MAUP scale issues. left checkerboard would indicate maximum segregation and the right would indicate no segregation. Source: Author's illustration.

The issues discussed above raise critical questions for any spatial analysis based on aggregated data: If a spatial analysis finds results in an analysis based on a single scale, how can we be sure that results hold over other scales? How viable are results if they are only apparent on certain scales? These questions have no generic answer but are rather important to consider in relation to the research topic and context at hand.

In response to issues related to MAUP, various techniques have been suggested to circumvent such analytical biases. In recent studies, the concept of *bespoke neighborhoods* (sometimes referred to as *individualized neighborhoods)* have become increasingly popular, especially within segregation research in the Swedish context. For examples see Hennerdal & Nielsen (2017), Nielsen & Hennerdal (2017), Malmberg et. al (2016) and Demografisk Rapport (Östh et. al 2014) amongst many others. Bespoke neighborhood analysis is commonly based on spatial data with relatively high resolution; in the Swedish research context this form of analysis is often based on data which is aggregated to a gridded data structure. Neighborhoods are thereafter conceptualized by calculating statistics for relative surroundings. Surroundings are estimated based on the principle of radial expansion in Euclidean distance. This form of analysis frequently investigates several scales at once and is therefore *multiscalar*. Scales can be defined metrically, using fixed distance bands, or by measures defined by population size, specifying certain threshold values, so-called *k*-values. Consequently, this technique partly circumvents both issues discussed above since it; *i)* is based on generic spatial units in the form of relatively highly resolute squares, and *ii)* investigates multiple scales simultaneously whereas multiple results facilitate assessments across scales. The analytical benefits of multiscalar assessments have been recognized by researchers who argue for estimates on several scales to highlight multiple patterns, ranging from the immediate surroundings to larger districts where individuals regularly engage in reoccurring activities (Fowler 2016). Illustrating a few examples of recurring activities related to neighborhood scales defined by population thresholds, Östh et. al (2014) describes neighborhoods of the 400 nearest individuals as the scale where neighbors tend to recognize each other by appearance. The closest 1.600 individuals can be assumed to shop at the same local grocery store, whereas the closest 25.600 might send kids to the same high-school or participate in recreational activities in the same locales such as libraries and sports facilities. On larger scales, the nearest 102.400 neighbors correspond to relatively large city districts or the regional level with further implications for everyday inter-neighborhood encounters and activities. It should be acknowledged, however, that while it is possible to investigate scales which are larger than the original data structure, it is not possible to make inferences on scales which are smaller than the original data structure with the *bespoke neighborhood* method. See figure 4 below for a simple illustration of the *bespoke neighborhood* method.

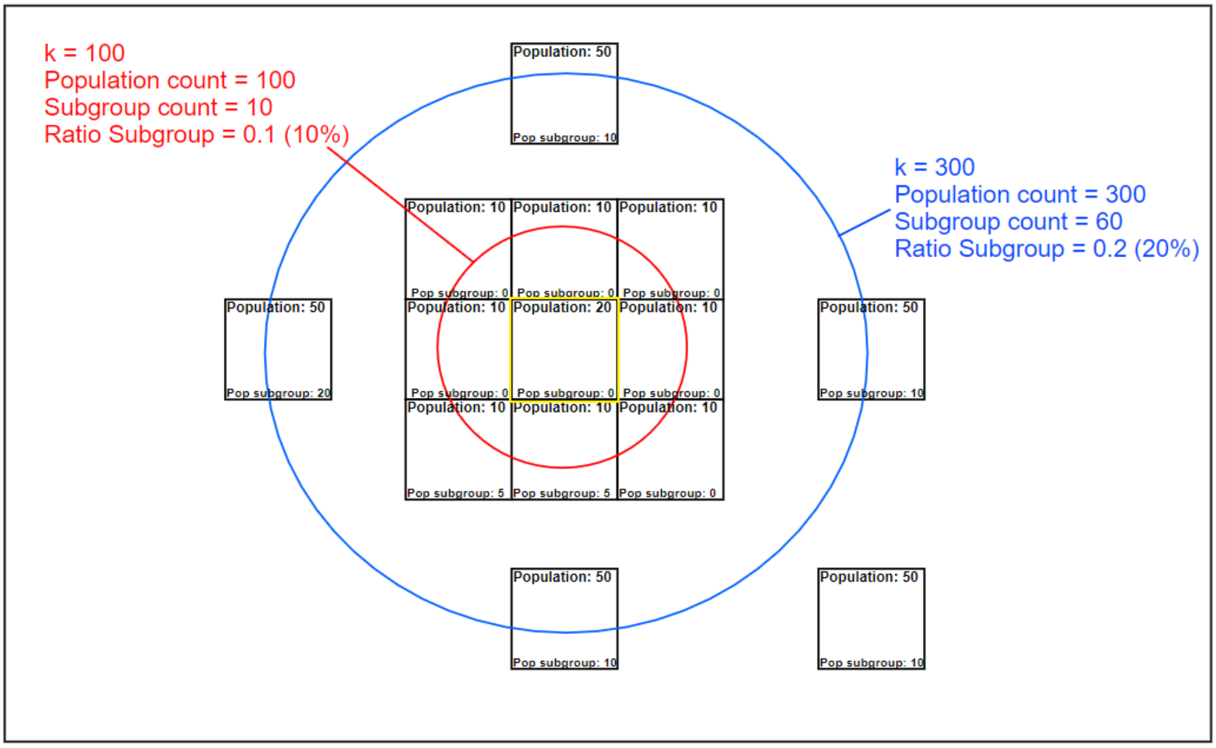


Figure 4 - Illustration of the bespoke neighborhood method, in this case illustrating neighborhood sizes k=100 and k=300 for the most central grid marked with yellow borders. Source: Author's illustration.

While the bespoke neighborhood method might address MAUP-issues, the method is subject to other forms of critique. Since the bespoke neighborhood method defines neighborhoods by population threshold values, one may assume that bespoke neighborhoods in scarcely populated areas have a significantly higher areal than corresponding neighborhoods in densely populated areas (Haandrikman et. al 2019). In the case of this study of Stockholm County it should be acknowledged that bespoke neighborhoods for grids outside of the more densely populated urban environments may be significantly larger in size even for relatively low threshold values. Consequently, one could question if these neighborhoods are comparable. For example, the nearest 1.600 neighbors in the rural outskirts of Stockholm County might be perceived as a relatively large scale while corresponding neighborhoods in central Stockholm often correspond to the population size of the local grid cell of 250x250m. Additional critique of the bespoke neighborhood method can be discussed in relation to the methods reliance on Euclidean distance to estimate neighborhoods defined by population threshold values. Depending on the contextual factors, this could be a convincing method of approximating neighborhoods. However, topography, natural borders, infrastructures, and other factors might suggest that networks which constitute a neighborhood are not based solely on Euclidean distance but are rather affected by contextual factors. Accounting for this critique of solely relying on Euclidean distance in bespoke neighborhood analysis however, recent software developments have implemented options of integrating terrain and mobility in bespoke neighborhood analysis by utilizing friction filters which gives the researcher possibilities of integrating cost distance parameters to the Euclidean radial expansion (Östh & Türk 2020). This technique is very new and has so far only utilized in the pilot study by Östh & Turk (2020).

To some extent, SAMS areas might be more convincing in terms of encapsulating neighborhood effects since they have been created with the aim of accounting for topography, infrastructure, and other elements which may reflect local conceptions of neighborhoods (Amcoff 2012). For a concrete example consider the borders of SAMS areas aligning with larger bodies of water, inner/outer city divisions and some larger highways in *figure 1*. However, Amcoff (2012) criticize SAMS areas since they are not as homogenous as it has been explicitly defined. The critique has highlighted that; *i)* delineations of SAMS areas differ significantly between municipalities, and *ii)* SAMS areas in peripheral urban areas fail to delineate homogenous areas based on tenure ownership. Consequently, this critique has implications for the potential of highlighting neighborhood effects with an analysis based on SAMS-areas.

Segregation estimates

Quantitative research on segregation relies on estimations in the form of indexes and standardized statistical measures to condense large amounts of spatial and other data into comprehensible forms. Without such estimations, it would be difficult if not impossible to draw conclusions and compare segregation over time or contexts. Massey & Denton (1988) described segregation research in the 1980's as "[…] presently in a state of theoretical and methodological disarray, with different researchers advocating different definitions and measures of segregation" (p. 282). Briefly assessing the diverse estimates employed in contemporary research on segregation, one could argue that little has changed since Massey & Denton's publication. A significant share of estimates employed in contemporary research is covered in the methodological overview by Massey & Denton (1988).

While Massey & Denton included 20 measures in their systematic methodological evaluation, this study will mainly utilize *the Isolation Index* and *the Dissimilarity Index*. These were chosen since they are commonly employed within segregation research, especially so in the Swedish context. Additionally, Massey & Denton (1988) concluded that these two were the most viable alternatives in terms of representing segregation in terms of *evenness* (*the*

Dissimilarity Index) and *exposure* (*the Isolation Index*). *Evenness* refers to the extent to which categorically defined subpopulations are evenly distributed across spatial units in relation to the overall population composition. From another perspective, *exposure* highlights the relative exposure of a categorically defined subpopulation towards the majority population. Conversely, *exposure* can be estimated by appreciating the *isolation* of a subpopulation by estimating the mean intergroup exposure. In other words, *isolation* refers to the extent to which members of a categorically defined subpopulation are exposed to each other rather than the majority population. While both of these indexes are "*aspatial"*, since they do not account for spatial relationships between geographical units (Massey & Denton 1988; Reardon & O'Sullivan 2004), one could argue that the spatial relationships such as clustering is accounted for when these measures are employed on bespoke neighborhoods on multiple scales.

The following section will outline the fundamental properties of these indexes. This discussion will include concrete formulas as well as potential interpretations and biases of these two segregation indexes. In addition to the dissimilarity index and the isolation index, this analysis has utilized *percentile plots* in the analysis and *location quotients* for cartographic illustrations. Consequently, these will be described briefly before the background chapter is concluded with a comprehensive overview of the results of previous research on socio-economic segregation in Stockholm.

Dissimilarity Index

$$D = \frac{1}{2}\sum_{i=1}^{n} abs\left(\frac{x_i}{X_T} - \frac{y_i}{Y_T}\right)$$

n = number of tracts or spatial units

x_i= number of individuals at risk of poverty in tract i

X_T= total number of individuals at risk of poverty in Stockholm County

y_i= number of individuals not at risk of poverty in tract i

Y_T= total number of individuals not at risk of poverty in Stockholm County

The above formula describes the concrete method of calculating the dissimilarity index. For each spatial unit, the absolute difference between the relative share of individuals at risk of poverty as a fraction of all individuals at risk of poverty, and the relative share of individuals not at risk of poverty as a fraction of all individuals not at risk of poverty is calculated. For each spatial unit, the absolute difference is summed up and multiplied by 0.5. *The dissimilarity index* is an estimate which measures segregation of a population group by appreciating deviations from *evenness* (Massey & Denton 1988). The index ranges from 0 to 1. A value of 0 can be interpreted as absolute even representation of the subpopulation across spatial units – in other words the subpopulation would be represented with similar proportions in each spatial unit as the overall subpopulation proportion – hence indicating no segregation. A value of 1 can be interpreted as absolute separation across spatial units – indicating that the subpopulation is completely separated from the majority population across all spatial units – hence indicating maximal segregation. The value of the DI can be interpreted as the relative share of the subpopulation which would need to move in order to be equally represented across all spatial units. More specifically, this share ranging between 0 and 1 should be perceived in relation to the proportion of the subpopulation which would need to move under maximum segregation conditions (0.5 i.e. half of the subpopulation) (Massey & Denton 1988).

While this measurement is one of the most frequently used segregation indices, it has come to receive critique due to inherent assumptions and biases. The dissimilarity index assumes that no segregation – or the opposite of segregation – occurs when a subpopulation is completely evenly distributed across all spatial units. This assumption has been criticized by researchers who argue that the opposite of segregation should be perceived as random distribution over spatial units. Cortese, Falk & Cohen (1976) consequently argue for indexes which are insensitive to statistically insignificant stochastic variance by estimating segregation based on statistically significant deviations of population composition. In addition, Cortese et. al's (1976) study exposed potential biases of the dissimilarity index. Utilizing the index in experimental models, they exposed that the dissimilarity index is biased to return higher values when; *i)* the investigated subpopulation group is relatively small in proportion to the total population; *ii)* the geographical area of investigation is divided into relatively small subunits rather than fewer larger ones (Cortese, Falk & Cohen 1976). Furthermore, while the calculation of the dissimilarity index is uncomplicated for the data structured on SAMS areas, potentially biasing issues are perceivable when the dissimilarity index is applied to bespoke neighborhood data, this topic will be discussed further in the discussion.

Isolation Index

$$I = \sum_{i=1}^{n} \left(\frac{x_i}{X_T}\right) * \left(\frac{x_i}{t_i}\right)$$

n = number of tracts or spatial units

x_i = *number of individuals at risk of poverty in tract i*
X_T =*total number of individuals at risk of poverty in Stockholm County*
t_i = *total number of individuals at in tract i*

The above formula describes the concrete method of calculating the Isolation Index. The relative share of individuals at risk of poverty in each cell is calculated with $\left(\frac{x_i}{X_T}\right)$ which is thereafter multiplied by the relative share of individuals at risk of poverty within corresponding cell $\left(\frac{x_i}{t_i}\right)$. *The isolation index* is an estimate which appreciates segregation in terms of *exposure.* Instead of appreciating segregation in relation to the concept of evenness, this estimate highlights the potentials for intergroup interaction across population categories

(Massey & Denton 1988). *The isolation index* ranges from 0 to 1 and can be perceived as the mean probability for members of a particular subgroup to encounter an individual of the same subgroup if they were to randomly encounter an individual within the spatial unit of residence, assuming that the probability of encountering any one individual within the spatial unit is the same. Conversely, *the interaction index* refers to the same premise but accounts for the probability of encountering an individual of the majority population (ibid.). Consequently, the interaction and isolation index always sum to 1 when the population has been categorized into two categories.

Unlike the dissimilarity index, these indexes are biased to changes in group size. The value of the isolation index under conditions of completely even representation across spatial units is the same as their overall proportion in relation to the total population. The isolation index should therefore always be interpreted in relation to the relative group size of the subgroup under investigation. Isolation index values which are significantly higher than the overall proportion can therefore be perceived as an indicator of segregation. Consequently, the analysis in this study will at times refer to a *relative isolation index* to encapsulate segregation trends irrespective of changes in population compositions over time. The concrete formula for the *relative isolation index* will be described in the *Data & Methods* chapter below.

Percentile Plots

Previous research on segregation with multiscalar bespoke neighborhood methodology has frequently utilized *percentile plots* to highlight the varying *exposure* of the overall population to a specific minority group. While the Isolation Index investigates the mean intergroup exposure, percentile plots highlight the overall populations varying exposure to a subpopulation which is defined in relation to the research topic at hand. Examples of contemporary segregation research which has utilized percentile plots are Haandrikman et. al's (2019) study of socio-economic segregation in Stockholm, Oslo, Brussels, Amsterdam, and Copenhagen, which investigated the overall population's varying exposure to individuals at risk of poverty as well as the highest decile income earners, and Malmberg et. al's (2016) study of segregation of European- and non-European migrants in Sweden 1990-2012. This study will similarly utilize percentile plots to highlight *the overall populations varying exposure to individuals at risk of poverty over time*. The percentile plots will be based on the results of the bespoke neighborhood analysis on multiple scales rather than the analysis being based on SAMS areas. This is the case since the bespoke neighborhoods in this study, unlike the SAMS areas, consist of at least 400 individuals whereas these results can be considered as statistically significant.

Location Quotients

The *dissimilarity index* and *isolation index* have been frequently employed in segregation research to reduce large amount of spatial information into an *overall score* which facilitates comparisons over time and across contexts. However, researchers such as Brown & Chung (2006) have criticized the one-sided focus on these *overall estimates* since they do not reveal results in relation to local areas. Since these measures fail to illustrate patterns of residential clustering in relation to the specific geographical areas, Brown & Chung (2006) argue for spatial approaches such as *location quotients* which is described with a formula below.

$$LQ_i = \frac{\left({x_i}/{t_i}\right)}{\left({X}/{T}\right)}$$

x_i = *number of minority members in tract i*
t_i = *total population in tract i*
X = total number of minority members in the study context
T = total population in the study context

Location quotients can be understood as fractional representations of local presence of minority members in relation to the overall proportion of minority members in the study context. LQ_i can consequently be used to highlight patterns of segregation in relation to specific localities on choropleth maps which are easy to interpret (Brown & Chung 2006). Previous research such as Haandrikman et. al (2019), Hennerdal & Nielsen (2017) and Nielsen & Hennerdal (2017;2019) have used location quotients on bespoke neighborhood data on various k-levels to highlight patterns of segregation in cartographic illustrations. While Haandrikman et. al's (2019) study utilize *location quotients* to highlight ratios for bespoke neighborhoods on various scales in relation to the overall proportions, Hennerdal & Nielsen (2017) and Nielsen & Hennerdal (2017;2019) have calculated *location quotients* based on ratios for bespoke neighborhoods on multiple scales in relation to ratios of bespoke neighborhoods on larger scales. For the latter studies, the overall proportions were consequently based on individualized surroundings rather than overall proportions in the study context which provides a distinct form of analysis. This will however not be covered in greater detail in this study, whereas those interested are referred to the studies by Hennerdal & Nielsen (2017) and Nielsen & Hennerdal (2017;2019) for more information.

Previous research findings on socio-economic segregation in Stockholm 1990-2010

This section will summarize the results of previous quantitative research on segregation in the Stockholm metropolitan context post 1990 to provide a point of reference for this study. Previous research refers to the results of studies of socio-economic segregation defined in terms of disposable income (Andersson & Kährik 2016; Östh et. al 2014; Biterman 2010). Results of previous research of socio-economic segregation in Stockholm will be illustrated in graphs to provide a comprehensive visual overview for the reader.

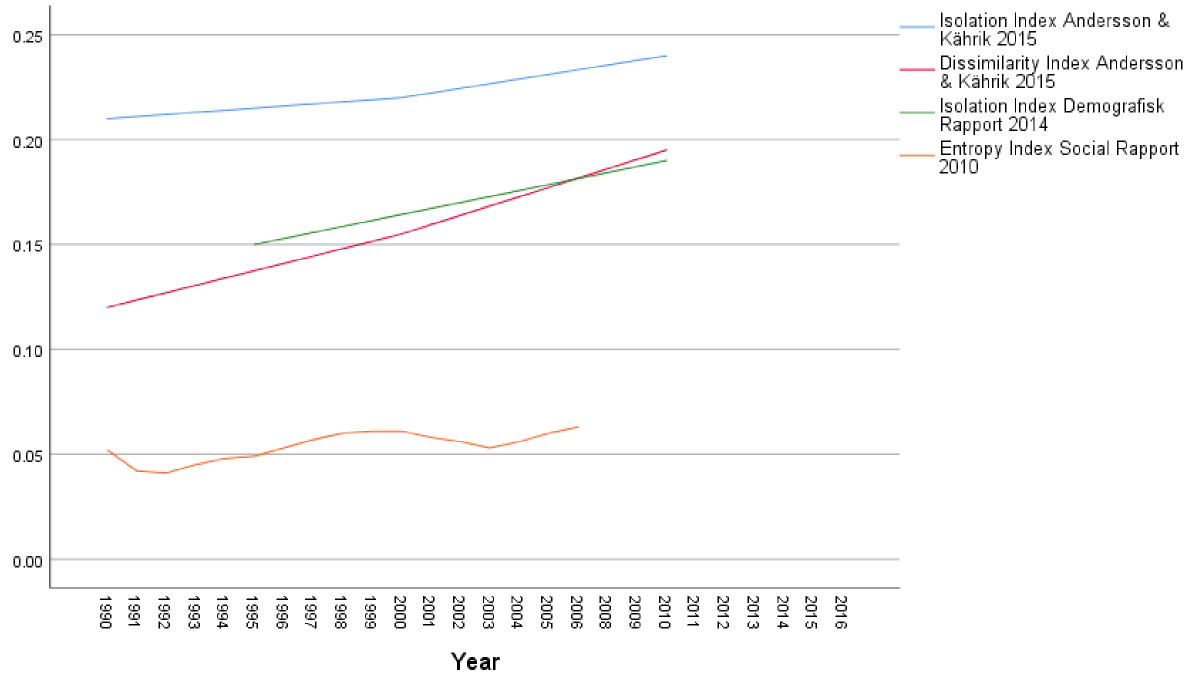


Figure 5 – Estimates of socio-economic segregation in Stockholm 1990-2010 based on previous research (Andersson & Kährik 2016; Östh, Amcoff & Niedomysl 2014; Biterman 2010).[1]

Andersson & Kährik (2016) provide a longitudinal study of socio-economic and ethnic segregation in the Stockholm metropolitan region 1990-2010 with cross-sections in the years 1990, 2000 and 2010. Their analysis was based on individual register data aggregated to 655 fixed areal units (SAMS-areas). Income was estimated by an individually equalized household income for individuals aged 20-64, whereas differences over time were estimated based on *the isolation index* and *the dissimilarity index*. Based on both estimates the study concludes that socio-economic segregation of the bottom quintile in terms of disposable income has increased throughout the study period (ibid.). The significantly higher values of the isolation index compared to the dissimilarity index should be interpreted with caution. Since the isolation index measures mean intergroup exposure the expected value of the isolation index under no segregation is equal to the overall proportion. The expected value of the isolation index for the bottom quintile under no segregation is therefore 0.20, whereas lower values are mathematically impossible to attain when investigating a subpopulation of that size.

In 'Demografisk Rapport' (2014), Östh, Amcoff & Niedomysl similarly utilized the Isolation Index in a study of socio-economic segregation in the Stockholm metropolitan region with cross-sections in the years 1995 and 2010. Differing from the previous study, these results refer to the isolation index of people at risk of poverty defined as at 60% or below of median income. Unfortunately, the report does not specify if it is based on individual income or

[1] *It should be stated that these graphs have been constructed by the author using linear interpolation to facilitate visual interpretation. One should therefore perceive interpolated values as indicators of trends rather than representations of empirical findings of previous research.*

equalized household income for these estimates. Unlike the previous study this study utilizes several bespoke neighborhoods with population sizes of 12 -12 800 individuals, whereas the results illustrated in *figure 5* refer to the means of these estimates across scales. In accordance with Andersson & Kährik's (2016) study, these results indicate trends of increasing levels of socio-economic segregation in Stockholm since the isolation index increased from 0.15 in 1995 to 0.19 in 2010. The fact that the isolation index in this study is significantly lower than in Andersson & Kährik's study can be explained by the fact that these studies measured poverty differently. As previously mentioned, Andersson & Kährik investigated the bottom quintile which represents 20% of the population while Östh, Amcoff and Niedomysl's (2014) study utilized a definition of people at risk of poverty, representing 14% of the population in 1995 and 13% of the population in 2010. The expected value for the isolation index under no segregation is therefore 20% throughout the study period for the former and for the latter 14% in 1995 and 13% in 2010.

In '*Social Rapport*' (Biterman 2010), Biterman highlighted socio-economic segregation trends in the Stockholm metropolitan region using *the entropy index* which is similar to the dissimilarity index since it appreciates segregation in terms of evenness (Massey & Denton 1988). Unlike the dissimilarity, it is relatively sensitive to increases in minority group proportions (ibid.). The entropy index was calculated for individuals aged 25-64 for consecutive years during the period 1990-2006 based on administrative units called MI-areas. These are similar to SAMS-areas, consisting however of fewer larger spatial units (337 for Stockholm in comparison to 655 SAMS areas). While previously mentioned studies investigated the spatial segregation of the socio-economically vulnerable population, the entropy index was in this study used to investigate the spatial segregation between low-, medium- and high-income earners. Unlike the dissimilarity index, the entropy index may be calculated in relation to multiple groups to estimate evenness in relation to the spatial representation of multiple population categories. Unfortunately, no references as to how these groups have been defined can be found in *'Social Rapport'* (Biterman 2010) nor in the related chapter *'Residential Segregation in Swedish Metropolitan Areas'* (Biterman & Franzén 2007). Biterman's (2010) study reported estimates for consecutive years 1990-2006, consequently, the trends are perceivably more ambiguous than previously mentioned studies which utilized significantly fewer cross-sections. Socio-economic segregation declined in the periods 1990-1992 and 2000-2003 with relative increases in the periods 1992-2000 and 2003-2006. The fact that the entropy index ranges from 0.04-0.06 could be interpreted as an indicator of relatively low and constant levels of segregation between low-, middle- and high- income earners.

Data & Methods

This chapter will provide concrete descriptions of the data and methods used in this study. The first section will briefly outline the *research design*. The following section provides descriptions of the *data* that has been utilized in this study. The third section will outline how socio-economic segregation has been operationalized with concrete descriptions of the quantitative definition of the subpopulation *'at risk of poverty'*. The fourth section will describe the software and threshold values which have been used in the *bespoke neighborhood analysis*. The fifth section will describe segregation estimates in further detail, referring to methods which have been used to calculate and transform estimates to highlight developments over time. The *Data & Methods* chapter is thereafter concluded with brief discussions on reliability, validity, ethical considerations, and limitations.

Research Design

This study will estimate segregation quantitatively over time in a longitudinal analysis of the Stockholm Metropolitan Region. The study will mainly be descriptive in nature whereas discussions on potential explanatory factors are quite limited to focus on comparisons of results across measurement techniques. The analysis has been limited to individuals residing within the boundaries of Stockholm County illustrated in *figure 6* below. Stockholm County was defined by merging all the SAMS-areas with municipal codes corresponding to the 26 municipalities which constitute Stockholm County.

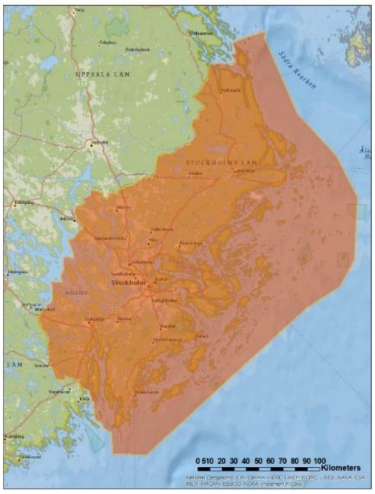


Figure 6 – Illustration of the extent of the study area referred to as Stockholm County or Stockholm Metropolitan Region. Sources: National Geographic, Lantmäteriet.

The period 1991 - 2016 will be studied with cross sections in the years 1991, 1996, 2001, 2006, 2011 and 2016. This period is of special interest due to transformations of welfare politics and housing policies as well as increased in-migration during this period as has been discussed in the background chapter. Estimates for the *dissimilarity index* and *isolation index* for the years 1991-2011 will be cross-referenced with previous studies while results for 2011-2016 are unique for this study and should be interpreted as an indicator of contemporary trends. Additionally, trends over time will be highlighted and commented based on graphs illustrating *percentile plots* as well as cartographic illustrations of *location quotients.*

Data

The data used in this study is a collection of register data compiled by Statistics Sweden, that includes geographic, demographic, and socioeconomic registers on the entire Swedish population for the period 1990–2016. The data is derived from the three databases: *the register of the total population* (RTB), *the longitudinal integrated database for health insurance and labor market studies* (LISA), and the *geodatabase* (Geoddatabasen). This data is accessible to researchers working on research projects that have received approval from the ethical vetting board, within the Department of Human Geography at Stockholm University. The data were produced within the research project "Residential segregation in five European countries - A comparative study using individualized scalable neighborhoods" funded by JPI Urban Europe (www.residentialsegregation.org). For this thesis, I could only access aggregated data on grid cell level, based on certain conditions signed in a Confidentiality Agreement.

The data has been aggregated to grids of 250x250 meters in densely populated areas and 1000x1000m in scarcely populated areas. See *table 1* below for brief descriptive information on proportions of grid cells within respective size below.

Table 1. Proportion of grids 1000x1000m / 250x250m 1991-2016

Year		250 x 250m	1000 x 1000m	Total
1991	Count	12755	3570	16325
	% within Year	78.1%	21.9%	100.0%
1996	Count	13266	3714	16980
	% within Year	78.1%	21.9%	100.0%
2001	Count	13757	3815	17572
	% within Year	78.3%	21.7%	100.0%
2006	Count	14100	3879	17979
	% within Year	78.4%	21.6%	100.0%
2011	Count	14394	3895	18289
	% within Year	78.7%	21.3%	100.0%
2016	Count	14664	3958	18622
	% within Year	78.7%	21.3%	100.0%

Table 1 – Number and relative % of grids with respective size for the years 1991-2016.

Since data with relevant socio-economic variables structured by SAMS areas were not available for this study, I decided to restructure the gridded data to SAMS areas in order to be able to do a comparative analysis of the bespoke neighborhood analysis with an analysis based on administrative units. The 250x250m and 1.000 x 1.000m grids frequently transcend boundaries of SAMS areas. Consequently, the gridded data was transformed into grids 1/100.000 of the size of the original cells (2.5x2.5m and 10x10m respectively), where each new cell consists of a population 1/100.000 of the original cells. These cells where thereafter aggregated to SAMS areas to approximate how the population would be distributed across multiple SAMS areas. It should be acknowledged that this assumes that the population is equally distributed within cells. With a relatively limited time frame I argue that this is an adequate method of restructuring the gridded data into administrative units. While differences between this approximation and data which has been originally produced on administrative scale might be perceivable on small scales, they should not affect the estimates calculated for the whole Stockholm Metropolitan Region significantly. Descriptive population statistics for the data restructured into SAMS format is illustrated below in *table 2*.

Table 2. SAMS area population statistics 1991-2016

Year	Pop. Mean	Pop Std. Dev.	SAMS Tracts	Min Pop.	Max Pop.	First Quartile	Second Quartile	Third Quartile
1991	1238	1666	890	0	13 220	306	721	1529
1996	1317	1738	890	1	13 859	336	789	1593
2001	1407	1834	890	2	14 588	380	847	1707
2006	1453	1847	890	2	14 418	412	877	1740
2011	1572	1992	890	1	15 356	461	953	1860
2016	1778	2198	890	1	16 754	530	1095	2125

Table 2 – Descriptive population statistics for the data restructured into SAMS format.

Definitions of subpopulations

While socio-economic segregation can be investigated from diverse perspectives as has been discussed in the background chapter, this paper will operationalize socio-economic segregation based on one single subgroup defined as individuals at risk of poverty. This subgroup is estimated using the EUROSTAT definition of individuals at risk of poverty, as those individuals with a disposable income at 60% or below the median disposable income (Eurostat 2020). In this study, the median has been estimated on a national level rather than referring to the median of Stockholm County.

Individual disposable income was estimated for all investigated years by summarizing the disposable income on household level and thereafter individualizing it by multiplying the household disposable income by a standardized consumption weight for the age categories of household members. The variable is thereafter divided by the sum of consumption weights based on the household composition which results in the individualized household disposable income variable. For more detailed information on these weights see *'DispInkPersF'* in the

LISA documentation (SCB 2016). Furthermore, the subgroup individuals at risk of poverty is limited to individuals aged 25 or above since the data has been structured in this manner previously to facilitate cross-contextual comparative studies (Nielsen et. al 2017). The same principle has been applied to data on the total population which is limited to individuals aged 25 and above.

Bespoke neighborhoods

The multiscalar bespoke neighborhood analysis was made using the gridded data in the Equipop software developed by John Östh at Uppsala University (for more information see https://equipop.kultgeog.uu.se/). The user defines the desired neighborhood population sizes (k-levels) which are investigated for each populated grid cell in the dataset. Additionally, the user defines subgroups to be counted (in this case individuals at risk of poverty as defined above) and a variable containing the total population whereby the software returns a ratio (proportion of total neighborhood population) of respective subgroups for the corresponding neighborhood size.

Table 3. Grid cells with more/less than 400 residents 1991-2016

Year		Frequency	Percent
1991	<= 400 Residents	15 757	96.5%
	> 400 Residents	568	3.5%
Year	Total	16 325	100.0%
1996	<= 400 Residents	16 350	96.3%
	> 400 Residents	630	3.7%
	Total	16 980	100.0%
2001	<= 400 Residents	16 870	96.0%
	> 400 Residents	702	4.0%
	Total	17 572	100.0%
2006	<= 400 Residents	17 248	95.9%
	> 400 Residents	731	4.1%
	Total	17 979	100.0%
2011	<= 400 Residents	17 461	95.5%
	> 400 Residents	828	4.5%
	Total	18 289	100.0%
2016	<= 400 Residents	17 637	94.7%
	> 400 Residents	985	5.3%
	Total	18 622	100.0%

Table 3 – Number and relative % of cells with a population size larger than 400 for corresponding years.

Since it is not possible to make inferences on neighborhood population sizes which are smaller than the gridded data, I decided to choose a smallest k-value which is larger than most population sizes in the original grid cells. Since the population size of most of grids cells (about 95%) were less than 400, k-400 was used as the smallest scale. See *table 3* above for relative percentages of squares with a population size large and smaller than 400 for corresponding year. The rest of the k-values were estimated by quadrupling values from the smallest scales. Consequently, the k-values 400, 1.600, 6.400, 25.400, and 102.400 were selected for the bespoke neighborhood analysis. These scales reflect various scales of immediate surroundings (k= 400), to neighborhoods and city districts (k= 1.600 – 25.600), to regional levels (k= 102 400). The selection of k-values has been made with a rationale identical to Nielsen & Hennerdal's (2017) study. To provide a correct account of the relative surroundings for individuals living at the peripheries of Stockholm County the bespoke neighborhood analysis was performed on a dataset which included individuals residing in an 80km buffer around Stockholm County. The grids in the buffer zones where however removed for the calculations of segregation estimates and were only included as neighbors since the study is limited to segregation in the Stockholm Metropolitan Region.

Estimates

In the background chapter, concrete formulas were provided for the isolation index, the dissimilarity index, and location quotients. These estimates have been calculated using the statistical software SPSS. The syntax files for these calculations are available on demand to facilitate third-party validation of results.

The percentile plots have been calculated by sorting the data based on proportions of individuals at risk of poverty on corresponding k-level and thereafter constructing percentile bins of individuals for multiple percentile values. This operation was performed in the statistics software SAS where this could be performed on aggregated data weighted by population in corresponding cell. The output in the SAS software was limited to the p-values 0.01, 0.05, 0.10, 0.20, 0.25, 0.30, 0.40, 0.50, 0.60, 0.70, 0.80, 0.90, 0.95, and 0.99. The graphs which illustrate the percentile plots were constructed based on linear interpolation between these p-values. Values between these explicitly defined p-values should therefore be interpreted with caution.

The *location quotients* have been used to provide cartographic illustration of segregation trends over time. These are available for the reader in the appendix where the location quotients have been illustrated for Stockholm City and surrounding suburbs as well as for Södertälje. The cartographic illustrations have been limited to these two contexts to facilitate visual interpretation of these relatively densely populated areas. Cartographic illustrations for the whole Stockholm County would either need to be based on numerous large-scale maps or fewer maps on relatively small scales. Results for the whole county would therefore be more difficult to interpret for the reader. Furthermore, the location quotients have been based on one single scale referring to proportions of the nearest k= 1.600 nearest neighbors at risk of poverty in relation to the overall proportion of individuals at risk of poverty. These illustrations have been limited to one scale to reduce the number of maps to 6, one for each cross section in the study period 1991-2016. Threshold values for significant under and over representation have been set to 0.85 and 1.20 respectively in accordance with Brown & Chung's (2006) suggestion of appropriate threshold values. Grid cells with location quotient values in the range 0.85-1.20 are therefore colored grey while significant underrepresentation (<0.85) are colored in shades of blue and significant overrepresentation (>1.20) are colored in shades of red.

Both the *isolation index* and the *percentile plots* are sensitive to relative changes in group sizes. They are therefore difficult to compare over time or between studies when the relative proportion of the studied subpopulation differs. Therefore, the analysis will frequently refer to relativized estimates when the *isolation index* is compared over time as well as between studies. Similarly, the analysis based on *percentile plots* will refer to relativized estimates when they are used to illustrate changes over time. Consequently, the relative scores should be interpreted as a representation of the differences between these estimates in relation to the overall proportion expressed in percentages, ranging from -100 - ∞ for percentile plots and 0 - ∞ for the isolation index. ∞ here refers to a theoretical maximum since the upper limits have no boundary equivalent to the lower limit of -100. The relative scores were calculated by the researcher by dividing *isolation index* and *percentile scores* by the overall proportion for the corresponding year. The method is described below with concrete formulas.

Relative Isolation Index

$$RI = \left({}^{II_y}/_{p_y} - 1 \right) * 100$$

II_y = *Isolation Index Score year y*

p_y = *Overall proportion at risk of poverty in Stockholm County year y*

The fraction is thereafter converted to a % value expressed in whole numbers where 0 indicates no difference, by subtracting 1 from the initial fraction and thereafter multiplying it by 100.

Relative Percentile Plots

$$RPS_{py} = \left({}^{PS_{py}}/_{p_y} - 1 \right) * 100$$

PS_{py} = *Percentile Score for percentile p year y*

p_y = *Overall proportion at risk of poverty in Stockholm County year y*

The fraction is thereafter converted to a % value expressed in whole numbers where 0 indicates no difference, by subtracting 1 from the initial fraction and thereafter multiplying it by 100.

Reliability & Validity

The proposed research is based on a complete dataset, there are therefore no issues of reliability in relation to sampling errors. The analysis can be perceived as reliable to the extent that the dataset used can be considered a reliable source of data. One should acknowledge that human error during data compilation might result in minor discrepancies. It is not likely however that discrepancies in the data based on human errors are extensive enough to impact the analysis in a substantial way.

To strengthen the replicability of the study, the researcher should be explicit with all steps taken in the analysis. This has therefore been one of the main goals of the data and methods chapter.

The validity of the study can be discussed in relation to how socio-economic segregation has been operationalized by the quantitative definition of individuals at risk of poverty. I would argue that the quantitative definition of individuals at risk of poverty which has been used in this study is viable in relation to segregation theory which has been summarized in the background chapter. It should be acknowledged however that the quantitative definition of *individuals at risk of poverty* is one of many viable quantitative operationalizations of socio-economic segregation.

Ethical Considerations

The researcher should be aware of and actively counteract ethical issues since this study utilizes aggregated data based on individual register data. Since the data has been aggregated to grids within a relatively densely populated area, it is impossible to trace data to specific individuals. The researcher should however be attentive and avoid exposing data for sparsely populated areas whereas the publication of data in these cases could result in exposure of personally sensitive data. Consequently, the cartographic illustrations of location quotients have been limited to relatively densely populated areas around central Stockholm and Södertälje.

Furthermore, segregation is a topic which is closely linked to political and public interests. Malmberg et. al (2016) describe the potential affirmation bias of segregation research. Studies which find increasing levels of segregation provides incentives for active interventions and redistribution of resources to counteract such processes. Consequently, research might be inclined to highlight increasing trends over ambiguous or stagnating trends since they provide imperatives for political interventions. Additionally, studies which indicate increasing levels of segregation might receive more attention than studies which find ambiguous, constant, or declining trends. The researcher should therefore be considerate in terms of actively reducing and exposing potential affirmation and negation bias throughout the research.

Limitations

While this study could have investigated patterns of segregation in relation to several social categories, the study has been limited to individuals at risk of poverty due to time restrictions. Moreover, the study has been limited to a single variable to provide a comprehensive analysis of one socio-economic dimension.

In this study, the analysis of administrative areas has been based on SAMS-area delineations. While these have officially been replaced by *'Demografiska Statistikområden' (DeSo)* as of January 2018 (see https://www.scb.se/hitta-statistik/regional-statistik-och-kartor/regionala-indelningar/deso---demografiska-statistikomraden/), this study has utilized the older delineations based on decisions in initial stages of the analysis. Consequently, it might be relevant to perform similar comparative studies of DeSo areas and bespoke neighborhood data, as well as comparing results of analyses based on DesSo- and SAMS-areas.

The graphs which illustrate results in the analysis of this study are frequently based on interpolation between the utilized cross-sections on five-year intervals in the period 1991-2016. Interpolated data should be interpreted with caution and has mainly been carried out to facilitate visual interpretations of developments over time. The analysis was limited to 6 cross sections to reduce the time spent on computation of indexes for bespoke neighborhoods on 6 scales (5 scales of bespoke neighborhoods and administrative areas).

In the section *'Conceptualizing the Neighborhood'* the potentials of integrating terrain and mobility in bespoke neighborhood analysis was described in relation to recent implementations of friction filters in the Equipop Flow software (Östh & Turk 2020). However, running the Equipop Flow software entailed a too high computational load for the analyses envisaged in this thesis. In combination with time constraints, it was decided to instead use the regular Equipop software.

From an epistemological perspective, the proposed research relates to a positivist stance towards social sciences. The research relies on quantitative data in the form of numerical abstractions of reality to produce generalized conclusions about segregation over time and space. From a qualitative perspective, it could perhaps be more interesting to investigate segregation with an interpretivist epistemology to expose individuals' complex and dynamic experiences and understandings of segregation. This is essentially a limitation of the proposed research, given that individuals may relate to and experience the concept of segregation differently from what quantitative abstractions of reality might suggest. It should therefore be concluded that the results of this study do not represent a complete account of segregation as a social phenomenon, it is rather to be perceived as an attempted quantitative interpretation of segregation over time. While the choice of a quantitative method can be criticized from ontological and epistemological perspectives, it can be argued that it is difficult if not impossible not to rely on abstractions of reality in a macro analysis which aims to investigate how segregation has developed over time in Stockholm County.

Results & Analysis

This chapter will present and discuss the results of this study with frequent reference to estimate scores which are displayed in graphs to illustrate segregation developments over time. The first section describes and discusses segregation trends in relation to estimates based on the dissimilarity index. The second section highlights segregation trends over the study period based on the isolation index and the relative isolation index. This section also includes a comparison of findings with previous studies using the same indices. The third section will visualize segregation trends over time with percentile plots to highlight trends related to the overall populations varying exposure to individuals at risk of poverty. The fourth and final section will provide brief comment and discussions of the cartographic illustration of location quotients 1991-2016.

Socio-economic segregation estimated by the Dissimilarity Index

Results of the analysis based on the dissimilarity index which has been calculated for bespoke neighborhoods and SAMS areas for the period 1991-2016 in Stockholm County are illustrated below in *figure 7*. The graph is complemented by comments and discussions on relevant findings. The discussion also highlights potential errors which are viable to consider when the dissimilarity index is applied to bespoke neighborhood data.

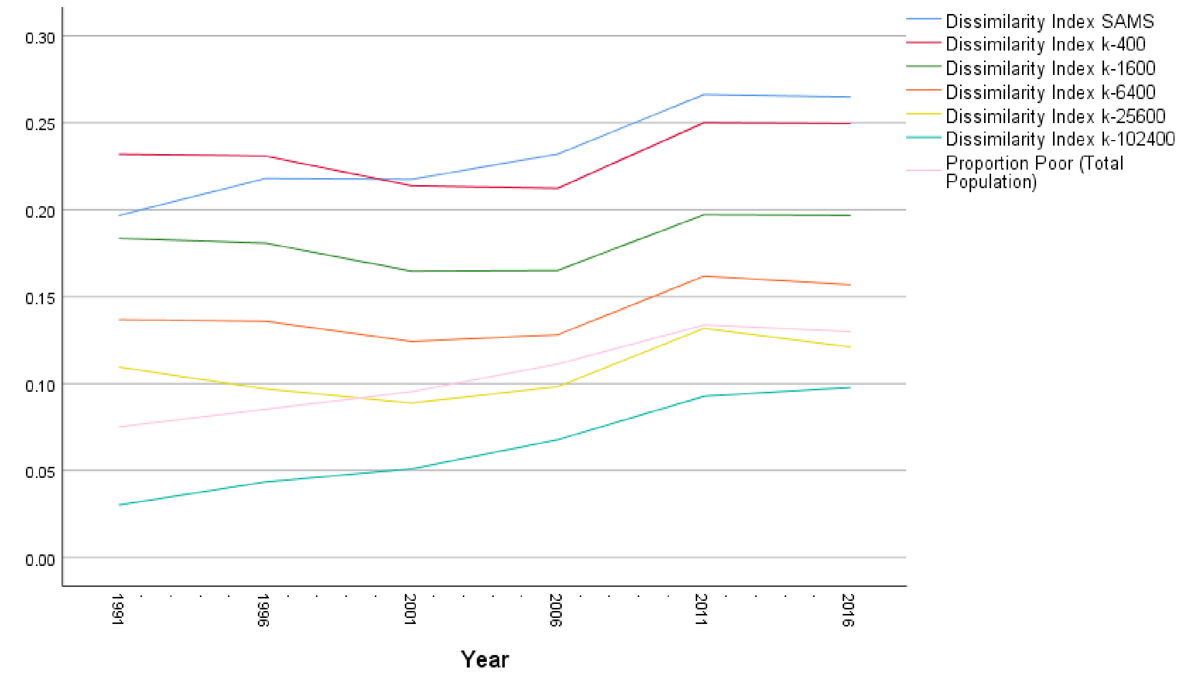


Figure 7 – Graph illustrating the dissimilarity index for SAMS areas and bespoke neighborhoods (k-400-102.400) for the years 1991 through 2016.

As can be seen in *figure 7* above, the dissimilarity index for bespoke neighborhoods consisting of the nearest 400, 1.600, 6.400 and 25.600 neighbors similarly indicate trends of decline in the years 1991-2001, stagnation 2001-2006, increase in 2006-2011 and stagnation/slight decline 2011-2016. Measurements on larger scales however, as can be seen in the curve illustrating the dissimilarity index for bespoke neighborhoods of k - 102.400 nearest neighbors, indicates increasing – but relatively low - levels of segregation throughout the study period. On this scale the dissimilarity index increased consistently from about 0.03 in 1991 to almost 0.10 in 2016. Similarly, the trend line for the dissimilarity index for SAMS-areas indicates increasing levels of segregation throughout the study period with relatively constant estimates during the intervals 1996-2001 and 20011-2016. For SAMS areas and bespoke neighborhoods of k= 400-25.600 nearest neighbors the dissimilarity index peaked in 2011. Measurements for 2011 estimate that the dissimilarity index ranges from about 0.27 for SAMS areas, 0.25 for k-400 nearest neighbors, 0.20 for the k-1600 nearest neighbors to about 0.13 for the k-25.600 nearest neighbors. Interestingly, Haandrikman (2019) study reported significantly higher dissimilarity values of 0.39 for the k-1600 nearest neighbors in 2011. Since, Haandrikman's (2019) study was limited to areas in a 25km perimeter around the Stockholm city epicenter, this discrepancy might indicate that segregation of individuals at risk of poverty is more apparent in the immediate surroundings of Stockholm compared to the more rural outskirts. Marcińczak et. al (2015) suggest – for socio-economic segregation - that dissimilarity index values below 0.2 should be interpreted as low levels of segregation whereas values over 0.4 should be interpreted as high levels of segregation. While it may be problematic to rely on any arbitrarily defined categorical interpretation of these estimates, I find it viable to interpret the observed estimates by this categorization to facilitate interpretations. Interpreting the results of this study based on this range, the dissimilarity index estimates for 2011 indicate moderate levels of segregation for SAMS areas and bespoke neighborhoods of k-400 nearest neighbors, while measurements on larger scales of k-25.600 – 102.400 nearest neighbors indicate relatively low levels of segregation.

Overall, the dissimilarity index for SAMS areas increased from about 0.20 in 1991 to 0.26 in 2016. One of the main differences perceivable in the graph in *figure 7* is that while the dissimilarity index for bespoke neighborhoods of k-400 – 25.600 nearest neighbors indicate decreasing levels of segregation 1991-2001, the dissimilarity index for SAMS areas and bespoke neighborhoods of k-102.400 nearest neighbors indicate increases during the same time period. While differences between measurements performed on different scales are expected in this type of analysis, the differences seen in the trends for the dissimilarity index for SAMS areas and bespoke neighborhoods of k-1.600 nearest neighbors is more surprising since they refer to a comparable scale. This discrepancy therefore provides a relevant example of contrasting trends depending on the analytical method of bespoke neighborhoods versus administrative units. While this discrepancy is apparent for the dissimilarity index, results for the isolation index illustrated in *figure 8* below illustrate homogeneous trends for estimates based on SAMS-areas and bespoke neighborhoods of the k-1.600 nearest neighbors.

A potential explanation for the analytical discrepancies discussed above might be related to issues which are evident when reflecting on the mathematical properties of the dissimilarity index in relation to the results of bespoke neighborhood analysis. As has been previously described in the background chapter, the bespoke neighborhood method calculates proportions for relative surroundings of varying k-number of nearest neighbors for all cells in the data structure. The results therefore consist of gridded data which describe relative surroundings for each cell whereas these relative surroundings overlap for neighboring cells. The mathematical function $\left(\frac{x_i}{X_T} - \frac{y_i}{Y_T}\right)$ which estimates deviations from evenness across cells is based solely on this population data which describes the relative surroundings for each cell. Consequently, calculations of the dissimilarity index on bespoke neighborhood data will be based on a model which assumes that the population for the whole study area is significantly larger the original dataset since the population data for bespoke neighborhoods which include relative surroundings overlap multiple times. The dissimilarity index will therefore be based on a model of the population which differs significantly from the initial data structure. For bespoke neighborhoods with relatively large k-value thresholds the dissimilarity index will be calculated on a model which assumes an enormous population size. To illustrate this issue, the total values X_T and Y_T for the year 2016 are listed below in *table 4* to provide a concrete illustration of this issue.

Table 4. Bespoke aggregates of X & Y 2016

Threshold Value	Sum Population
X k-400	1 070 353
X k-1600	3 791 308
X k-6400	15 536 505
X k-25 600	63 898 210
X k-102 400	255 025 886
Y k-400	8 123 725
Y k-1 600	28 138 212
Y k-6 400	106 254 656
Y k-25 600	415 889 470
Y k-102 400	1 657 016 549

Table 4 – illustration of X_T and Y_T for all bespoke neighborhood sizes for the year 2016. X_T and Y_T refer to aggregates of individuals at risk of poverty and individuals not at risk of poverty for corresponding k-value across all grid cells.

The fact that dissimilarity index calculations on bespoke neighborhood data is based on models of the total population which are significantly larger than the original dataset is not an issue per se since the dissimilarity index returns a percentual share ranging between 0-1. However, one could question the legitimacy of this calculation since it no longer can be considered a neutral reflection of the population in the actual contexts. To illustrate this argument, *table 5* below illustrates relative proportions of people at risk of poverty based on the initial data as well as aggregates on k-levels 400-102.400 for the year 2016. It is apparent that proportions of individuals at risk of poverty differ slightly across estimates based on the initial data and various k-levels. Consequently, one could question the viability of calculations of the dissimilarity index on bespoke neighborhoods data since it is based on a population account which deviates from the initial data.

Table 5. Proportion poor based on bespoke aggregates 2016

2016	
Proportion Poor (Total Population)	12.99%
Prop. Poor Aggregate for k-400	11.64%
Prop. Poor Aggregate for k-1600	11.87%
Prop. Poor Aggregate for k-6400	12.75%
Prop. Poor Aggregate for k-25600	13.32%
Prop. Poor Aggregate for k-102400	13.38%

Table 5 – Estimates of proportion poor 2016 based on the initial data as well as bespoke neighborhoods on various k-levels (400-102.400).

Socio-economic segregation estimated by the Isolation Index

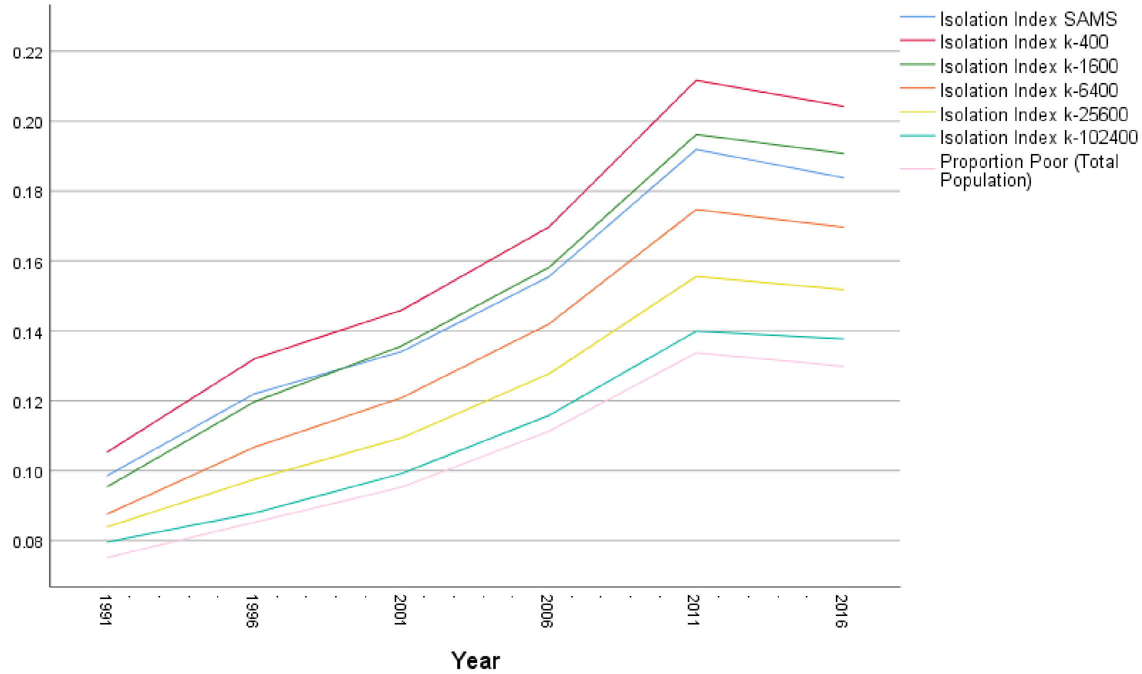


Figure 8 – Isolation Index 1991-2016 for SAMS areas and bespoke neighborhoods of the nearest k= 400 – 102.400 nearest neighbors.

Figure 8 illustrates the isolation index for SAMS areas and bespoke neighborhoods on 5 different k-levels. The figure shows that the isolation index increased on all scales throughout the study period, except for in the final cross-section 2016 which entails a slight decline since 2011 across all scale levels. Additionally, in accordance with previous research, the isolation index tends to return higher values for lower k-values (Haandrikman et. al 2019). For k-400 it returns the highest values while the value of the isolation index for larger k-values are significantly closer to the overall proportion of people at risk of poverty. Consequently, this indicates that the segregation of people at risk of poverty is perceivable to some extent on all scales, while it is more apparent when estimated on smaller scales. Unlike the results for the dissimilarity index, it is apparent that the isolation index values for k-1600 and SAMS areas is roughly equivalent for all years. This is perhaps expected since the mean population size for SAMS areas is close to 1600 for all years, ranging from 1238 in 1991 to 1778 in 2016 as seen in *table 2*.

Calculations of the isolation index for bespoke neighborhoods are not subject to extensive methodological concerns as is the case for the dissimilarity index, as previously discussed. For the dissimilarity index, issues were apparent since the formula requires all mathematical operations to refer to the estimates of relative surroundings. For the isolation index, the calculation $\left(\frac{x_i}{X_T}\right)$ can instead refer to local cell values where it returns the relative share of individuals at risk of poverty present in corresponding cell as a share of all individuals at risk of poverty across all cells. Thereafter, this value is multiplied by $\left(\frac{x_i}{t_i}\right)$ which describes the relative share of individuals at risk of poverty as a proportion of the total population. In the analysis of administrative areas $\left(\frac{x_i}{t_i}\right)$ refers to the local ratio in corresponding SAMS area, whereas it in the analysis of bespoke neighborhoods refer to proportions of relative surroundings on different scales represented by ratios on various k-levels.

The graph in *figure 8* indicates that the isolation index is positively correlated with the overall proportion of people at risk of poverty in Stockholm County across all measurements. This is expected since it is an inherent trait of this index which has been discussed previously in the chapter on segregation estimates. Due to this correlation it is difficult to ascertain if the increases seen in *figure 8* are due to increasing levels of segregation or due to the increasing share of individuals at risk of poverty. To highlight segregation trends over the study period 1991-2016 irrespective of changes in the overall proportion of individuals at risk of poverty, the relative isolation index is illustrated below in *figure 9*.

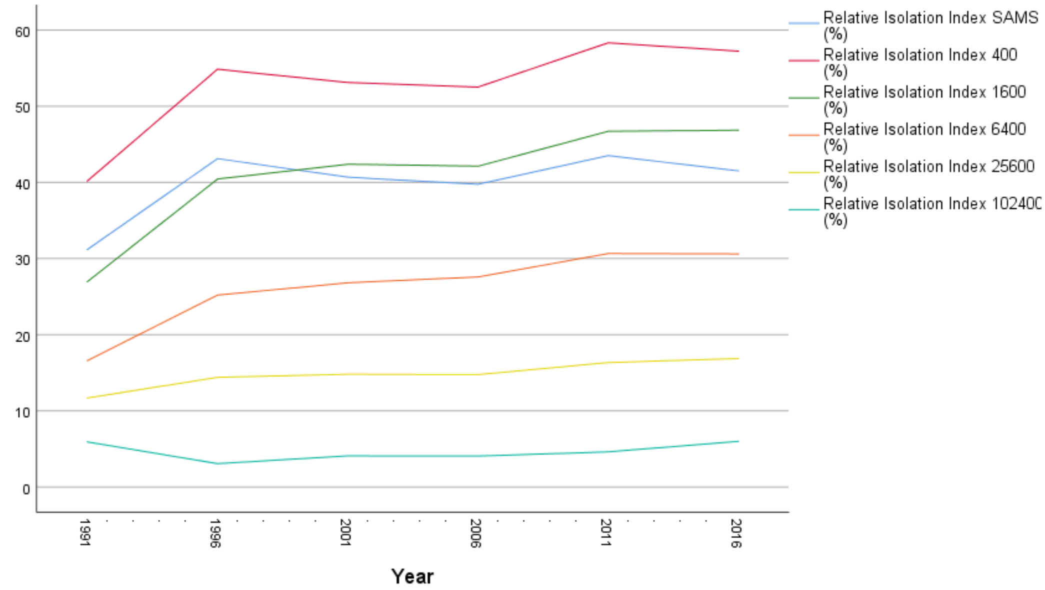


Figure 9 – Relative Isolation Index 1991-2016 for SAMS areas and bespoke neighborhoods on k-levels 400-102.400.

In accordance with the results for the isolation index, the relative isolation index returns lower values on higher scales. With a few exceptions, the relative isolation index indicates increasing levels of segregation 1991-2011 and decreasing or stagnating levels 2011-2016. For SAMS areas and bespoke neighborhoods on all scales except for the largest (k-102.400), the most apparent increases are perceivable 1991-1996 and 2006-2011. This is an interesting result since these specific timeframes coincide with two major financial crises in Sweden 1990-1994 and 2007-2008, the formed has been discussed previously in the theoretical background chapter. These results could perhaps suggest that these financial crises have had implications for processes of socio-economic segregation on neighborhood scales of immediate surroundings, local neighborhoods, and city districts.

On the other hand, the curve which illustrates the relative isolation index on the regional scale (k-102.400) differs from the patterns perceivable on smaller scales. Variance over time is relatively small in absolute terms on the regional level, ranging from 3-6 percent. In relative terms however a decrease from 6 to 3 % is quite large since it corresponds to a 50% relative decrease. On the regional scale, the relative isolation index decreased from about 6% in 1991 to about 3% in 1996. This is an interesting result since the highest increases of the relative isolation index on all other scales 1991-1996 coincide with the largest decreases on the largest scale. Consequently, estimations of segregation based on the relative isolation index suggest that segregation trends have differed significantly on regional scales (k-102.400) in comparison with assessments made on smaller scales (k-400 – 6.400). Furthermore, the graph in *figure 9* suggests that segregation of individuals at risk of poverty on the regional scale has increased slightly from 1996 and throughout the study period. In 2016, the relative isolation index for the k-102.400 nearest neighbors therefore indicated comparable levels of segregation as in 1991.

In *figure 10* below results of the analysis based on the relative isolation index for SAMS areas and bespoke neighborhoods of the nearest 400, 1600 and 6400 nearest neighbors are compared with the reference studies Andersson & Kährik (2016) and Östh et. al (2014). It is apparent that all the estimates presented in *figure 10* increase consistently throughout the period 1991-2010. Additionally, the relative isolation index scores of this study are relatively large as compared to the reference studies, especially so for SAMS-areas and smaller bespoke neighborhoods. It is however apparent that the results of this study indicate slightly increasing trends over time while the results of the reference studies entail more drastic increases, especially so considering the drastic increasing relative isolation index scores of Östh et al's (2014) study.

A potential explanation for the dramatic increases of the relative isolation index seen in Östh et. al's (2014) study and the relatively subtle increases of corresponding estimates of this study might be due to differing estimates of the overall proportion of individuals at risk of poverty over time. Östh et. al's (2014) study estimate the overall proportion of individuals at risk of poverty to 14% in 1995 and 13% in 2010 which indicate a slight overall decline. Contrastingly, this study estimates that the overall proportion of individuals at risk of poverty in Stockholm County to about 8% in 1996 and about 13% in 2011. Potential explanation for this discrepancy could be; *i)* that this study is limited to individuals above 25 years of age whereas similar limitations are not mentioned for Östh et. al's (2014) study, *ii)* due to differing estimates of income, this study is based on individual equalized disposable household income while Östh et. al's (2014) study seems to be based on individual disposable income. Furthermore, comparing the results with the relatively low estimates of Andersson & Kährik (2016) study might indicate that the segregation of individuals in the lowest income quintile is less apparent compared to individuals at risk of poverty in Stockholm County.

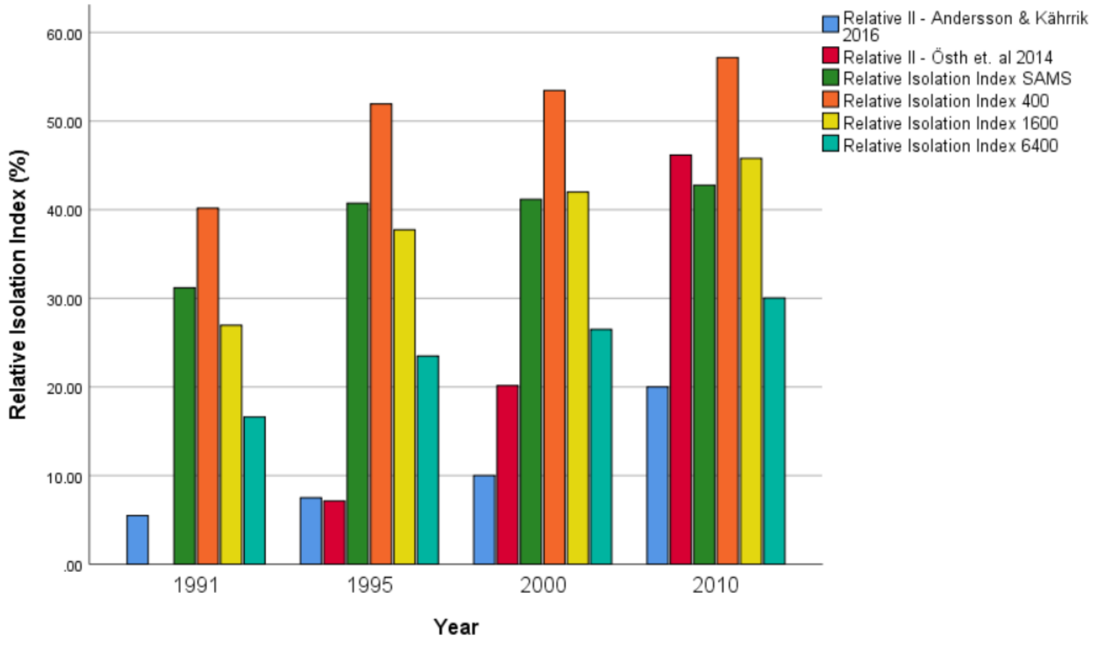


Figure 10 – Bar chart illustrating the relative isolation index of individuals at risk of poverty based on SAMS-areas and bespoke neighborhoods of the nearest 400, 1.600 and 6.400 nearest neighbors. Corresponding results for Andersson & Kährik's (2016) study of the bottom quintile income earners based

on SAMS areas and the isolation index, and Östh et. al (2014) study of individuals at risk of poverty based on bespoke neighborhoods of the 400 nearest neighbors. [234]

Based on the comparative results in *figure 10*, it can be concluded that the results of this study confirm previous findings of increasing levels of segregation of relatively low-income earners over the period 1990-2010. It is however more difficult to find uniform indications of the strength of this trend based on the results of these three studies.

The analysis above has highlighted segregation trends based on the mean intergroup exposure of individuals at risk of poverty based on the isolation index and relative isolation index for both administrative areas and bespoke neighborhoods of the nearest k = 400 – 102.400 neighbors. In other words, using the isolation index segregation is estimated by measuring to what extent individuals at risk of poverty are exposed to or isolated from the majority population. From another perspective, it is arguably relevant to investigate the extent to which the overall population is exposed to individuals at risk of poverty and how the relative exposure varies across the study population at large. Analyses using the isolation index will therefore be complemented by an analysis of percentile plots in the following section to illustrate the varying exposure of the overall population of Stockholm County to individuals at risk of poverty. Furthermore, the conventional percentile plots will be complemented with relative percentile plots which describe longitudinal developments over the study period 1991-2016.

Socio-Economic segregation visualized by Percentile Plots

In the following subsections percentile plots will first be illustrated in *figure 11* for five bespoke neighborhood scales of k= 400-102.400 nearest neighbors. In *figure 11* six graphs are merged into one figure to illustrate varying exposure across scales for corresponding years in the study period 1991-2016. Since the overall proportion of individuals at risk of poverty has changed significantly over time, additional percentile plots will be used to highlight developments over time. To illustrate developments over time, the percentile plots have been relativized by estimating percentile plots in relation to the overall proportions of individuals at risk of poverty for the corresponding year; in these figures they should be interpreted as deviations from the overall proportion expressed in percentages. The relative percentiles plots are illustrated in *figures 12a – 12e*. The relative percentile graphs are shown for the initial cross section 1991 and the final cross section in 2016. The amount of data has been reduced to facilitate visual interpretation of developments over the whole study period.

---

[2] *The isolation index scores in Andersson & Kährik's (2016) and Östh et. al's (2014) study have been converted to relative scores by the researcher to facilitate comparisons.*

[3] *Since these studies utilize different cross sections the comparison above is based on some linear interpolation.*

[4] *Data for the year 1991 was not available for Östh et. al's (2014) study which investigated only two cross-sections, 1995 and 2010.*

Percentile plots for k-values 400- 102.400 by year

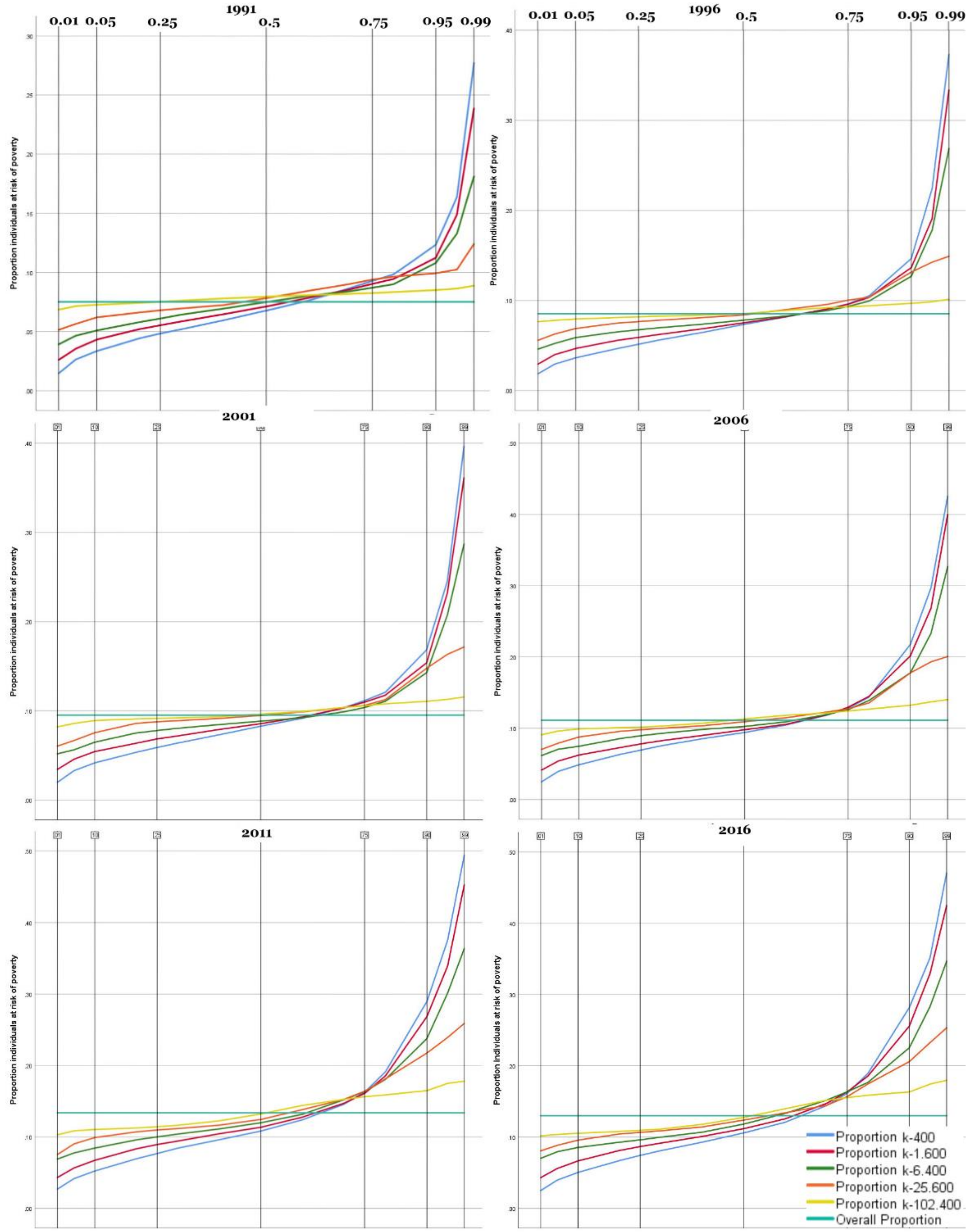


Figure 11 – Six graphs illustrating percentile plots for bespoke neighborhoods of 400- 102.400 nearest neighbors. The y-axis refers to proportions of individuals at risk of poverty whereas the x-axis refers to cumulative percentages of 0.01, 0.05, 0.25, 0.5, 0.75, 0.95 and 0.99, as percentages of the overall study population. The overall proportion of individuals at risk of poverty for the corresponding year is illustrated with a horizontal turquoise line to provide a point of reference.

The percentile plots illustrated in *figure 11* should be interpreted in relation to the horizontal turquoise line describing the overall proportion of individuals at risk of poverty for the corresponding years. To interpret the lines, one should consider the extent to which they deviate from the turquoise line which represent the overall proportion for corresponding year. Stronger deviations should be interpreted as an indicator of higher levels of segregation since it suggests that the variance among the overall population's exposure to individuals at risk of poverty is high.

Visual assessment of the graphs in *figure 11* suggest that the variance of the proportion of individuals at risk of poverty is larger for small k-value thresholds. The variance or deviation from the overall proportion of poor is correspondingly smaller for measurements on larger scales, especially so for bespoke neighborhoods of k-102.400 nearest neighbors. This is an expected result since both the isolation index and the dissimilarity index indicated lower levels of segregation for neighborhoods consisting of the k= 102.400 nearest neighbors.

The percentile plots in *figure 11* are quite difficult to interpret in terms of longitudinal developments. This is partly because several scales are visualized simultaneously which results in crowded graphs, and partly due to the fact that the overall proportions differ over time which has implications for longitudinal comparisons. However, it is apparent in the graphs for 2011 and 2016 in *figure 11* that the percentile plots for k = 102.400 deviate more from the overall proportion in comparison to the graphs for previous years. This could be interpreted as an indicator of increasing levels of segregation of individuals at risk of poverty on large scales since the highest and lowest percentiles differ significantly more from the overall proportion in the last two cross sections compared to previous years. This observation will be discussed further in relation to *figure 12e* below where the relativized percentile plots for bespoke neighborhoods of k = 102.400 nearest neighbors for 1991 and 2016 is illustrated in greater detail.

Percentile plots 1991 & 2016 by k-value

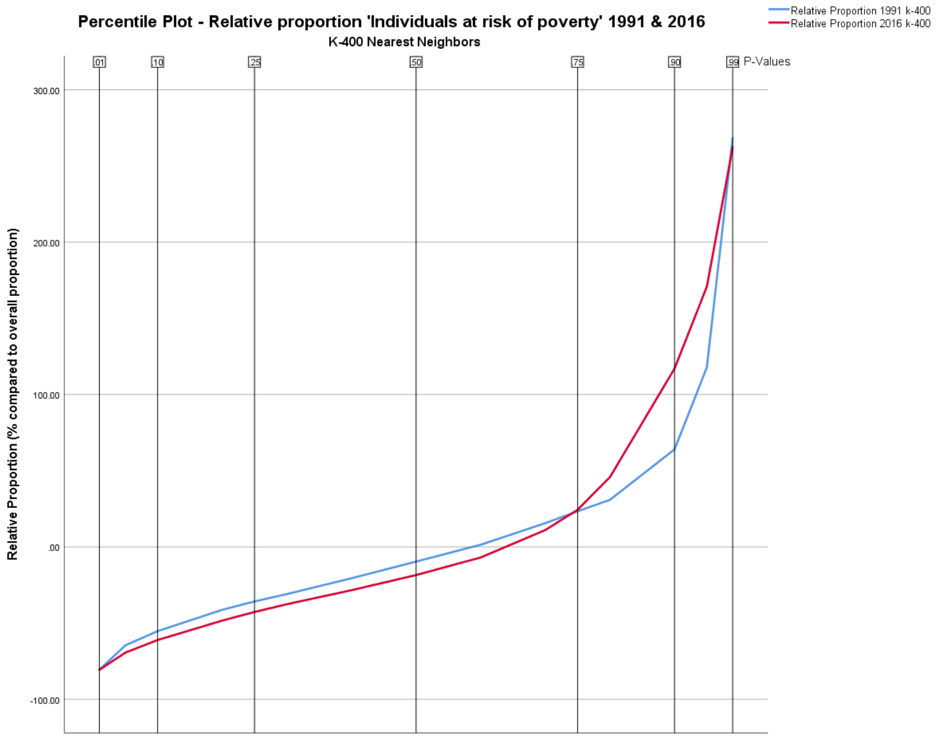


Figure 12a – Relativized percentile plot for the k = 400 nearest neighbors 1991 & 2016. [5]

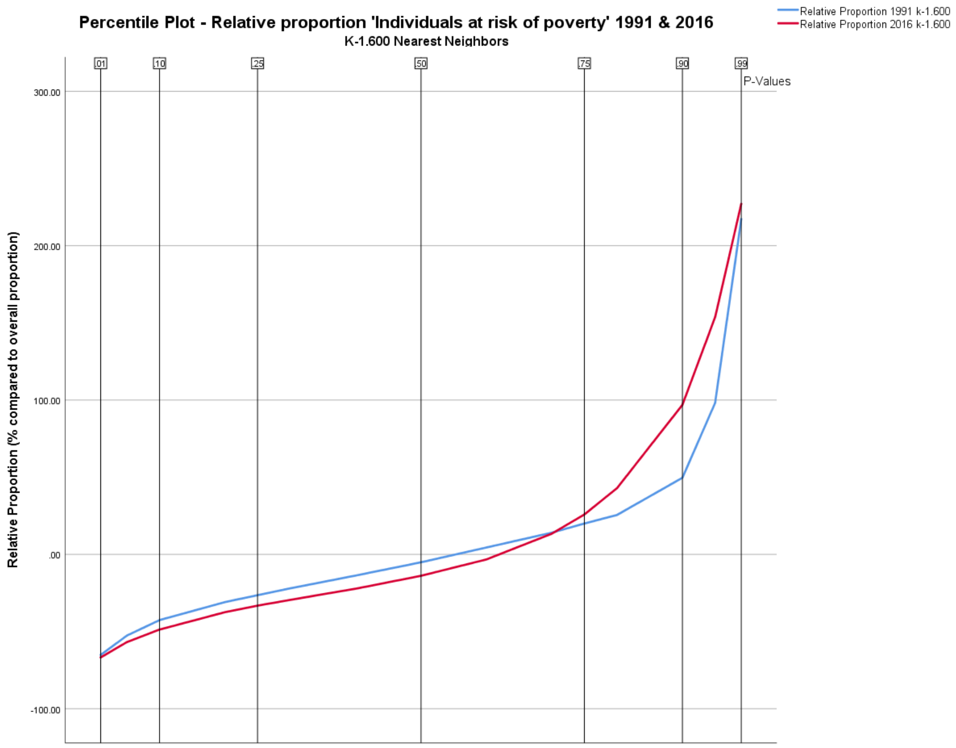


Figure 12b – Relativized percentile plot for the k=1.600 nearest neighbors 1991 & 2016.

---

[5] *The graphs in figures 12 a-e refer to deviations from the overall proportion expressed in % where 0 % refers to the overall proportion of individuals at risk of poverty for corresponding year.*

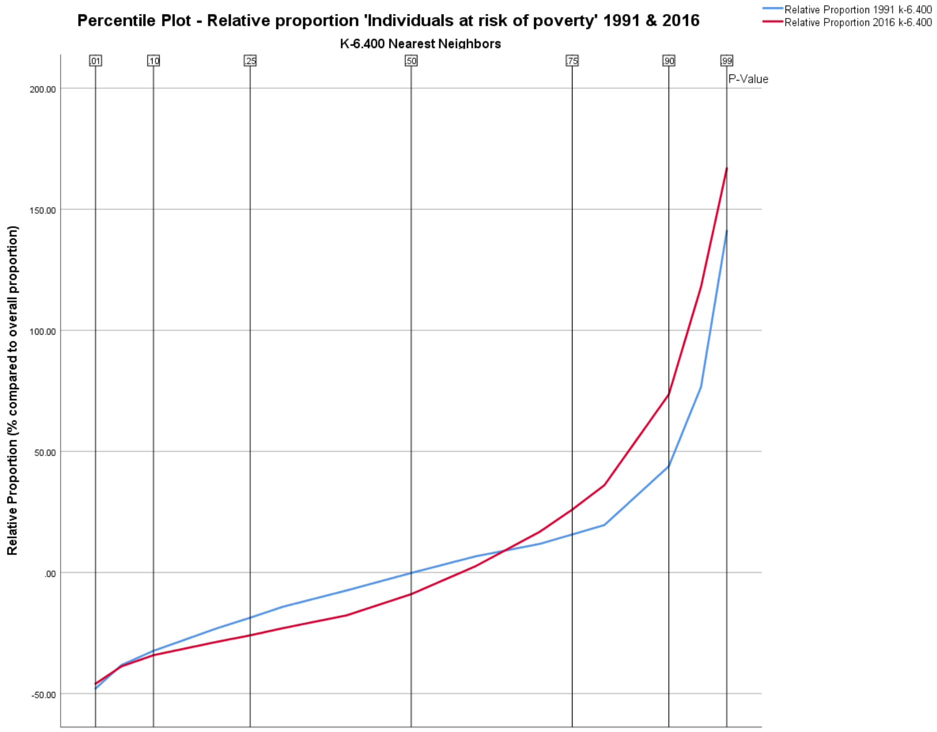


Figure 12c – Relativized percentile plot for the k=6.400 nearest neighbors 1991 & 2016.

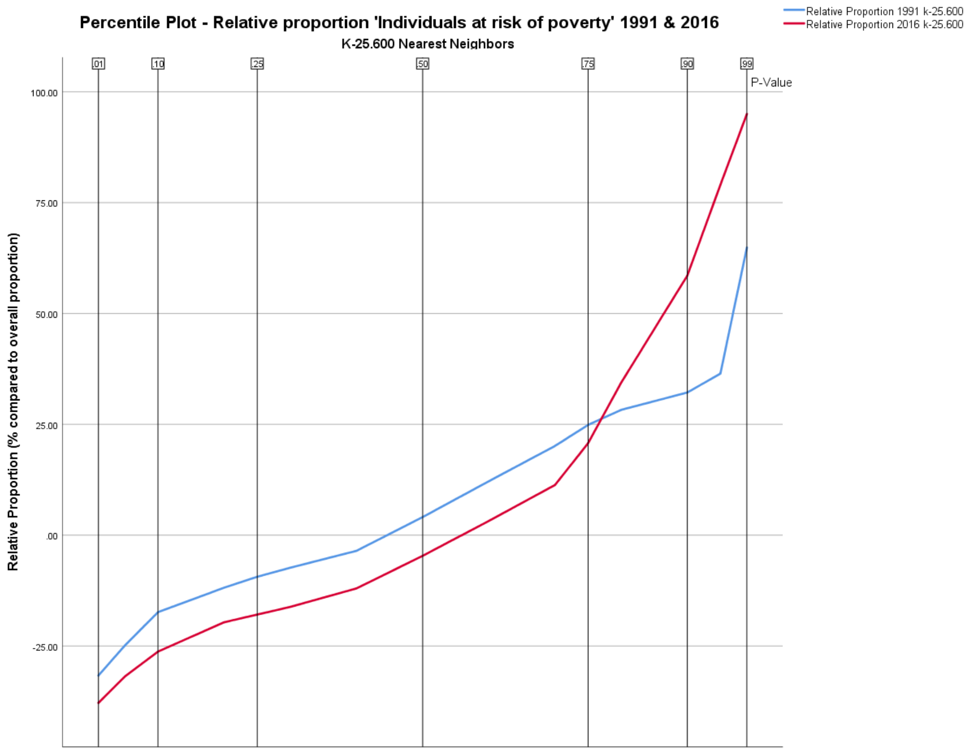


Figure 12d – Relativized percentile plot for the k=25.600 nearest neighbors 1991 & 2016.

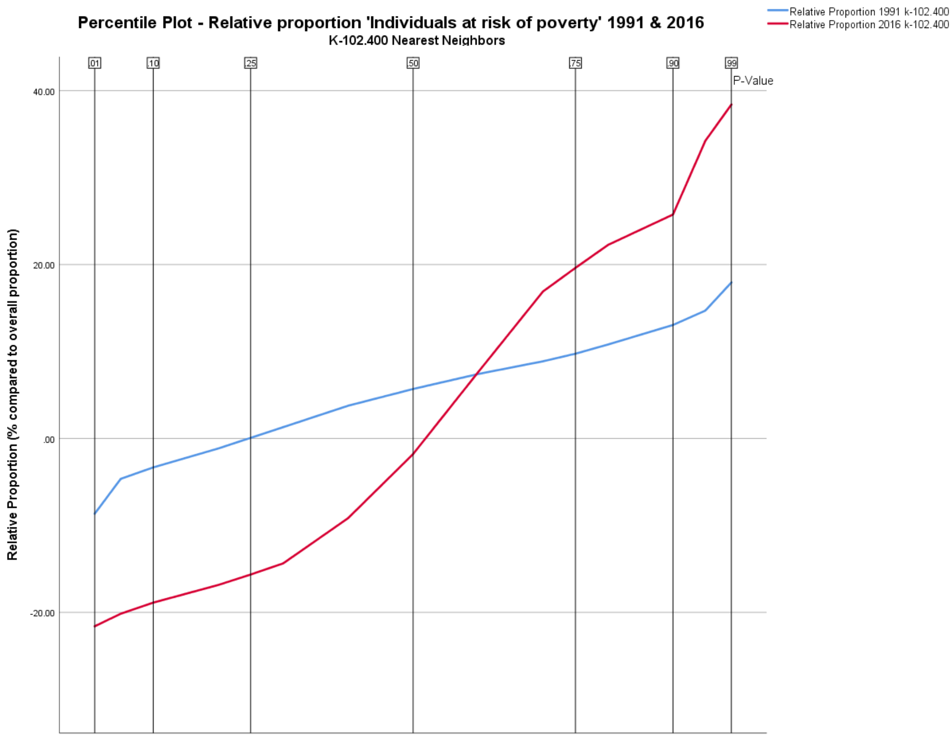


Figure 12e – Relativized percentile plot for the k =102.400 nearest neighbors 1991 & 2016.

The percentile plots for k-values 400 – 6.400 in 1991 and 2016 seen in *figure 12a-c* indicate that the top 25% individuals in terms of exposure to individual at risk of poverty (0.75 percentile) are relatively more exposed to individuals at risk of poverty in 2016 compared to 1991. The lines are significantly steeper around the 0.75 percentile mark in 2016 compared to corresponding plots for 1991. This suggests that a significantly larger share of the population lived in neighborhoods which were relatively overexposed to individuals at risk of poverty in 2016 compared to 1991.

Comparisons of the percentile plots for 1991 and 2016 for the k values 400 and 1600 *(figure 12 a & b*) suggest that there are few differences between the highest and lowest percentiles of the population in terms of relative over-/under- exposure to individuals at risk of poverty (see percentile scores 0.01 and 0.99). The percentile plots highlight that the relative over- and under- exposure to individuals at risk of poverty for the lowest and highest percentiles of the population was similar in 2016 as in 1991 for neighborhood scales of the nearest 400 and 1600 individuals. Conversely, differences in terms of exposure of the lowest and highest percentiles are more apparent in figures *12 d* & *e*. Results illustrated in these figures suggests that differences in terms of relative under- and over- exposure are more apparent when they are estimated based on larger bespoke neighborhood scales. Figures *12 d & e* refer to bespoke neighborhood scales of the nearest 25.600 & 102.400 nearest neighbors where the top and bottom percentile in terms of exposure to individuals at risk of poverty (percentile 0.99 and 0.01) were relatively more exposed to individuals at risk of poverty in 2016 compared to 1991. In 2016, the 99th percentile lived in neighborhoods where the relative proportion of individuals at risk of poverty among the nearest 102.400 neighbors were about 38% higher than the overall proportion. In 1991, corresponding statistics for the 99th percentile was about 18%. Corresponding statistics for the 1st percentile was about -22% in 2016 compared to about -8% in 1991. Similar but less pronounced discrepancies are perceivable in *figure 12d* for bespoke neighborhoods of the nearest 25.600 individuals. Consequently, results of these percentile plots suggest that large-scale neighborhoods population composition in terms of individuals at risk of poverty deviate significantly more from the overall proportion in 2016 compared to 1991. Consequently, this result suggests that the segregation of individuals at risk of poverty has increased 1991-2016 on the neighborhood scales of the nearest 25.600 and 102.400 individuals.

Spatial patterns highlighted by Location Quotients

Trends of socio-economic segregation 1991-2016 have been illustrated by mapped location quotients which are attached in the appendix. These maps illustrate location quotients calculated for bespoke neighborhoods of the nearest 1.600 neighbors compared to the overall proportion of individuals at risk of poverty in Stockholm County for corresponding year. Illustrations in these maps are based on centroid of the 250x250m / 1000x1000m grid cells. Grid cells with location quotients values below 0.85 are illustrated in shades of blue which indicates significant under-representation of individual at risk of poverty amongst the nearest 1600 neighbors. Correspondingly values above 1.20 are illustrated in shades of red to highlight significant over-representation. Values in between 0.85 and 1.20 will be referred to as even representation which refers to non-significant deviations from the overall metropolitan proportion of individuals at risk of poverty. These threshold values are based on Brown & Chung's (2006) definition of appropriate threshold values. These maps will be commented briefly in this section to highlight relevant examples of segregation developments in relation to specific localities. This discussion will mainly exemplify developments based on findings in central Stockholm with brief examples of economically marginalized suburbs, as well as central Södertälje with surroundings.

In 1991 representations of individuals at risk of poverty in central Stockholm were relatively close to the overall metropolitan proportion. Most grid cells in central Stockholm had an even or slight over-representation of individuals at risk of poverty in 1991. Contrastingly, in 2016 most grid cells in central Stockholm refer to slight under-representation. Furthermore, in Vasastan and Kungsholmen a significant share of the grid cells indicates moderate or high under-representation of individuals at risk of poverty in 2016. These developments could perhaps be related to processes of tenure conversions since a large share of the rental stock in central Stockholm has been converted to tenant-owned apartments in the post 1990s context.

In Skärholmen, most grid cells indicate slight over-representation in 1991 whereas location quotients for 2016 indicate moderate- or high- levels of over-representation. Similar tendencies are perceivable in trends for Fisksätra and Rågsved. Consequently, one could assume that these areas are increasingly over-exposed to individuals at risk of poverty in 2016 as compared to 1991. Developments over time in Rinkeby, Tensta and Botkyrka are less pronounced however since these areas already experienced significant over-representation of individuals at risk of poverty in 1991.

Contrasting to the trends seen for central Stockholm, the location quotients maps for Södertälje highlight trends of increasing over-representation of individuals at risk of poverty. In 1991, grid cells indicate mixed neighborhood types in central Södertälje since grid cells indicated a mixture of even and low- and moderate- levels of over- and under- representation. Additionally, in 1996 a significant share of the grid cells in central Södertälje indicate moderate or high under-representation of individuals at risk of poverty. In 2016 however, grid cells in western Södertälje indicate increased clustering of neighborhoods which are moderately or highly over-represented in terms of individuals at risk of poverty. Additionally, in 2016 central Södertälje was mainly characterized by grid cells with even or slight over-representation of individuals at risk of poverty. Simultaneously, neighboring areas such as Nykvarn, Ekeby and Rönninge has come to be increasingly characterized by moderate- or high- levels of underrepresentation of individuals at risk of poverty. Consequently, this finding might suggest that individuals at risk of poverty in Södertälje were increasingly clustered and concentrated in central areas in 2016 as compared to 1991, whereas the opposite trend is perceivable for some neighboring localities. One should consider, however, that since the overall proportions of individuals at risk of poverty has almost doubled in the period 1991-2016 areas which are defined by even or slight under-representation in 1991 might be defined as moderate or highly under-represented in 2016. From this perspective increasing levels of under-representation in specific localities could be due to increases in the proportion of individuals defined as at risk of poverty in Stockholm County as a whole rather than due to changes in the population composition at the local level.

Conclusions

This study has investigated the segregation of individuals at risk of poverty in Stockholm County 1991-2016 using multiple estimates and measurement techniques. The conclusions will provide a comprehensive summary of the results of this study in relation to the initial research questions in consecutive order; *i)* How can patterns of segregation be described by using the dissimilarity index, the isolation index, percentile plots, and location quotients? ii) How have patterns of socio-economic residential segregation developed in Stockholm County over the period 1991-2016? How do these findings relate to previous research that found increasing levels of socio-economic segregation during the same period? iii) To what extent are segregation indices such as the dissimilarity index and isolation index affected by methods based on administrative areas or bespoke neighborhoods? The study is thereafter concluded with suggestions for further research.

In this study, the *dissimilarity*- and *isolation- index* have been estimated based on individualized bespoke neighborhoods on multiple scales as well as data aggregated to administrative (SAMS) units. The *dissimilarity index* has been used in this study to appreciate segregation levels in terms of *evenness* based on administrative units and bespoke neighborhood data. Methodological complexities of calculating *the dissimilarity index* based on bespoke neighborhood data has raised some concerns for the compatibility of these two methods. Furthermore, the *isolation index* has been used to highlight trends of socio-economic segregation in terms of intergroup exposure. The *isolation index* has been relativized and expressed in relation to overall proportions of individuals at risk of poverty for corresponding year to compensate for changes in population composition. The *relative isolation index* has been used to highlight developments over time irrespective of changes in overall population compositions of individuals at risk of poverty. *Percentile plots* have been used to visually illustrate the overall populations varying exposure to individuals at risk of poverty over time. The analysis of *percentile plots* has been based on visual interpretations by the researcher in contrast to the condensed scores produced by *the isolation index* and *dissimilarity index* estimates. Similarly, *location quotients* have been used to highlight developments in relation to specific localities based on cartographic illustrations.

Overall, the results of this study are in line with previous research findings which have indicated increasing levels of segregation of low-income earners 1990-2010. These results have been reaffirmed by this study which indicate increasing levels of segregation 1991-2011 across most employed measurements. However, results for the more recent years 2011-2016 suggest that trends of increasing levels of segregation has stagnated or even declined in recent years. Results of this study based on the *dissimilarity index* for SAMS areas and *the relative isolation index* for *bespoke neighborhoods* of the nearest 400, 1.600 and 6.400 neighbors indicate that the most significant segregation increases of individuals at risk of poverty took place in 1991-1996 and 2006-2011. Interestingly these two time periods coincide with the financial crisis of the early 1990s and 2007-2008. This finding might indicate that these events could have implications for processes of socio-economic segregation in this context. Furthermore, estimates of the *relative isolation index* in this study have been high compared to the results of previous studies, especially for the period 1990-2000. Consequently, these results might indicate that the segregation of the poor defined as individuals at risk of poverty is more pronounced than corresponding measures based on the bottom quintile income earners. Furthermore, the results of this study suggest that increases in segregation levels over the period 1991-2011 are less pronounced compared to the relatively rapidly increasing trends which has been found in previous research (Andersson & Kährik 2016; Östh et. al 2014).

While results across measurements have been consistent for bespoke neighborhoods on relatively small scales, discrepancies have been apparent for measurements on the regional scale. Estimates of the *relative isolation index* on the regional scale has indicated increasing levels of socio-economic segregation for large scale neighborhoods 2011-2016, as well as relative decreases in the period 1991-2011 which are especially due to significant decreases in estimates for the period 1991-1996. Consequently, these results have highlighted diverging segregation trends over the study period for bespoke neighborhood on smaller local scales and the regional neighborhood scales. Similar discrepancies have been apparent in the results of the *relative isolation index* and *percentile plots* on the regional scale. P*ercentile plots* have indicated that segregation has increased significantly on the regional scale 1991-2016 since the highest and lowest percentiles of individuals live in regional scale neighborhoods which deviate significantly more from overall proportions of individuals at risk of poverty in 2016 as compared to 1991. These results were reaffirmed by overall increases in estimates based on the *dissimilarity index* 1991-2016 on the regional scale. Estimates based on *the relative isolation index* have however indicated similar levels of segregation in 2016 compared to those in 1991 on the regional scale. This discrepancy could be explained by the fact that *the isolation index* is based on mean intergroup exposure condensed into an overall score while *percentile plots* highlight variance in the overall population's exposure to individuals at risk of poverty which is interpreted visually by the researcher.

Further discrepancies have been apparent in segregation trends estimated by the *dissimilarity index* for bespoke neighborhoods and administrative areas. Discrepancies in the results have been particularly apparent in diverging trends for the period 1991-2006. Estimates based on *administrative SAMS-units* have indicated increasing levels of segregation during this period whereas the analysis based on *bespoke neighborhoods* contrastingly indicate decreases for the same period. Differences in results of the analysis based on administrative areas and bespoke neighborhoods were less apparent in the analysis based on the *relative isolation index*. Estimates of the *relative isolation index* based on SAMS areas and bespoke neighborhoods of the nearest 400, 1600 and 6400 nearest neighbors indicate similar trends throughout the whole study period 1991-2016 except for slight discrepancies in trends estimated for the period 1996-2001. The bespoke neighborhood analysis has been useful in this study to highlight and investigate segregation trends on multiple scales simultaneously using *the isolation index, percentile plots,* and *location quotients.* However, discrepancies in the results for the *dissimilarity index* and the methodological issues related to calculations of *the dissimilarity index* on bespoke neighborhood data has raised concerns for the compatibility of *the dissimilarity index* and bespoke neighborhood data.

For further research, this study suggest that segregation analysis based on bespoke neighborhood data is most compatible with analysis based on *the isolation index, percentile plots,* and *location quotients.* To avoid methodological complexities related to varying overall group compositions over time, it could be advisable to investigate income deciles or quintiles rather than utilizing quantitative definitions of subpopulations which differ significantly over time. Additionally, the author suggests for replications of this type of longitudinal study based on multiple estimates focusing on the segregation of the economically affluent. Results of such research would be interesting to consider since previous research have found significantly higher levels of segregation of the economically affluent as compared to individuals at risk of poverty. Finally, the author suggests for further research of correlations between tenure forms and housing policies and segregation levels in local contexts. Such studies could contribute to the segregation research field by highlighting potential explanations for the perceived increases in segregation of individuals at risk of poverty 1991-2011.

List of References

Aldén L. & Hamarstedt M. (2016). Boende med konsekvens – en ESO-rapport om etnisk bostadssegregation och arbetsmarknad. Rapport till Expertgruppen för studier i offentlig ekonomi 2016:1. Finansdepartementet. Available at: https://eso.expertgrupp.se/rapporter/20161-boende-med-konsekvens-en-eso-rapport-om-etnisk-bostadssegregation-och-arbetsmarknad/

Amcoff, J. (2012). Hur bra fungerar SAMS-områdena i studier av grannskapseffekter? : En studie av SAMS-områdenas homogenitet. *Socialvetenskaplig tidskrift*, 19(2), 93–115. Retrieved from http://urn.kb.se.ezp.sub.su.se/resolve?urn=urn:nbn:se:uu:diva-188530

Andersson, R., & Kährik, A. (2016). Widening gaps : Segregation dynamics during two decades of economic and institutional change in Stockholm. In Socio-Economic Segregation in European Capital Cities. : East meets West. (pp. 110–131). London.

Andersson, R., & Magnusson Turner, L. (2014). Segregation, gentrification, and residualisation: from public housing to market driven housing allocation in inner city Stockholm. *International Journal of Housing Policy*, 14(1), 3–29. https://doi.org/10.1080/14616718.2013.872949

Åslund, O. (2005) Now and forever? Initial and subsequent location choices of immigrants. *Regional Science and Urban Economics* 2005:35, pp 141 – 165.

Biterman, D. (2010). Social Rapport 2010. Socialstyrelsen. Available at: https://www.socialstyrelsen.se/globalassets/sharepoint-dokument/artikelkatalog/ovrigt/2010-3-11.pdf.

Biterman, D.; Franzen, E. (2007) Residential segregation (Chapter 6*) International journal of social welfare.* 16(1), 127-162.

Brown, Lawrence A. and Chung, Su–Yeul (2006). Spatial segregation, segregation indices and the geographical perspective. *Population, Space and Place* 12, 125–143. Doi: 10.1002/psp.403.

Böhlmark, A. & Willén, A. (2020). Tipping and the Effects of Segregation. *American Economic Journal: Applied Economics* 12(1): 318–347.

Cortese, C. F, Falk, F. R. & Cohen, J. K. (1976). Further Considerations on the Methodological Analysis of Segregation Indices. *American Sociological Review* 41 (August), 630-637.

Eurostat. (2020). People at risk of poverty or social exclusion. Retrieved from: https://ec.europa.eu/eurostat/web/products-datasets/-/t2020_50&lang=en

Fowler C. S. (2016) Segregation as a multiscalar phenomenon and its implications for neighborhood-scale research: the case of South Seattle 1990–2010, *Urban Geography*, 37:1, 1-25, DOI: 10.1080/02723638.2015.1043775

Grundström, K. & I. Molina (2016) From Folkhem to lifestyle housing in Sweden: segregation and urban form, 1930s–2010s, *International Journal of Housing Policy*, 16:3, 316-336, DOI: 10.1080/14616718.2015.1122695

Haandrikman, K., Costa, R., Malmberg, B., Rogner, A. F., Sleutjes, B. (2019). Socio-economic Segregation in European Cities A Comparative Study of Brussels, Copenhagen,Amsterdam, Oslo and Stockholm. ResSegr Working Paper 2019:1. Available at: https://www.residentialsegregation.org/working-papers.

Hansen K. Y. & Gustafsson J-E. (2016) Causes of educational segregation in Sweden – school choice or residential segregation, *Educational Research and Evaluation*, 22:1-2, 23-44, DOI: 10.1080/13803611.2016.1178589

Hennerdal, P. & Nielsen, M. M. (2017) A Multiscalar Approach for Identifying Clusters and Segregation Patterns That Avoids the Modifiable Areal Unit Problem, *Annals of the American Association of Geographers*, 107:3, 555-574, DOI: 10.1080/24694452.2016.1261685

Kain, J. F. (1968) Housing Segregation, Negro Employment, and Metropolitan Decentralization. *Quarterly Journal of Economics*, [s. l.], v. 82, n. 2, p. 175–197, 1968. DOI 10.2307/1885893.

Malmberg, B., Nielsen, M. M., Andersson, E., & Haandrikman, K., 2016. Residential Segregation of European and Non-European Migrants in Sweden: 1990-2012. ResSegr Working Paper 2016:1. Available at: https://www.residentialsegregation.org/working-papers.

Marcińczak, S., Tammaru, T., Novák, J., Gentile, M.,Kovács, Z., Temelová, J., Valatka, V., Kährik, A. & Szabó, B. (2015) Patterns of Socioeconomic Segregation in the Capital Cities of Fast-Track Reforming Postsocialist Countries, *Annals of the Association of American Geographers*, 105:1, 183-202, DOI: 10.1080/00045608.2014.968977

Massey, D., & Denton, N. (1988). The Dimensions of Residential Segregation. *Social Forces, 67*(2), 281-315. doi:10.2307/2579183

Musterd D, S. (2005) Social and Ethnic Segregation in Europe: Levels, Causes, and Effects. *Journal of Urban Affairs*, [s. l.], v. 27, n. 3, p. 331–348, 2005. DOI 10.1111/j.0735-2166.2005.00239.x.

Nielsen, M. M., & Hennerdal, P. (2017). Changes in the residential segregation of immigrants in Sweden from 1990 to 2012 : Using a multi-scalar segregation measure that accounts for the modifiable areal unit problem. *Applied Geography*, 87, 73–84. https://doi-org.ezp.sub.su.se/10.1016/j.apgeog.2017.08.004

Nielsen, M. M. & Hennerdal, P. (2019) Segregation of Residents with Tertiary Education in Sweden from 1990 to 2012, *The Professional Geographer*, 71:2, 301-314, DOI: 10.1080/00330124.2018.1518719

Openshaw, S. (1984). The modifiable areal unit Problem: Concepts and techniques in modern geography no 38. Norwich: Geo Abstracts Ltd.

Österberg, T. (2013). The increasing importance of place: neighbourhood differences in metropolitan Sweden, 1990–2006, *China Journal of Social Work*, 6:3, 244-261, DOI:10.1080/17525098.2013.840662

Östh, John ; Amcoff, Jan and Niedomysl, Thomas (2014) Demografisk rapport 2014:09 In Befolkningsprognos 2014-2023/45. Retrieved from http://lup.lub.lu.se/record/4812562

Östh, J. & Türk, U. (2020). Integrating infrastructure and accessibility in measures of bespoke neighbourhoods. In S. Musterd (Ed.), Handbook of Urban Segregation, 202 (pp. 378–394). Cheltenham, UK: Edward Elgar Publishing.

Park, R. E., Burgess, E. W., & McKenzie, R. D. (1925). The city. Chicago, Illinois: The University of Chicago Press

Reardon, S., & O'Sullivan, D. (2004). Measures of Spatial Segregation. *Sociological Methodology*, 34, 121-162.

Statistics Sweden (SCB) (2016). Longitudinell integrationsdatabas för Sjukförsäkrings- och Arbetsmarknadsstudier (LISA)1990–2013. Bakgrundsfakta Arbetsmarknad och Utbildning 2016:1. Örebro: Statistics Sweden.

Stockholm Stad. (2018). Översiktsplan för Stockholm Stad. Availiable at: https://vaxer.stockholm/tema/oversiktsplan-for-stockholm/

Strömgren, M., Tammaru, T., Danzer, A. M., van Ham, M., Marcińczak, S., Stjernström, O., & Lindgren, U. (2014). Factors shaping workplace segregation between natives and immigrants. *Demography*, 51(2), 645–671. https://doi-org.ezp.sub.su.se/10.1007/s13524-013-0271-8

Tammaru, T., Musterd, S., Ham, M. & Marcińczak, S., (2016). A Multi-factor Approach to Understanding Socio-economic Segregation in European Capital Cities. In Tammaru et. al (2016). Socio-Economic Segregation in European Capital Cities : East Meets West. Abingdon, Oxon : Routledge. .

Wimark, T. (2018). Boendesegregation I Sverige – En Översikt av det Aktuella Forskningsläget. Bostad 2030, Rapport 5. Available at: http://media.bostad2030.se/2018/05/Rap-5-Boendesegregation-i-Sverige_final.pdf

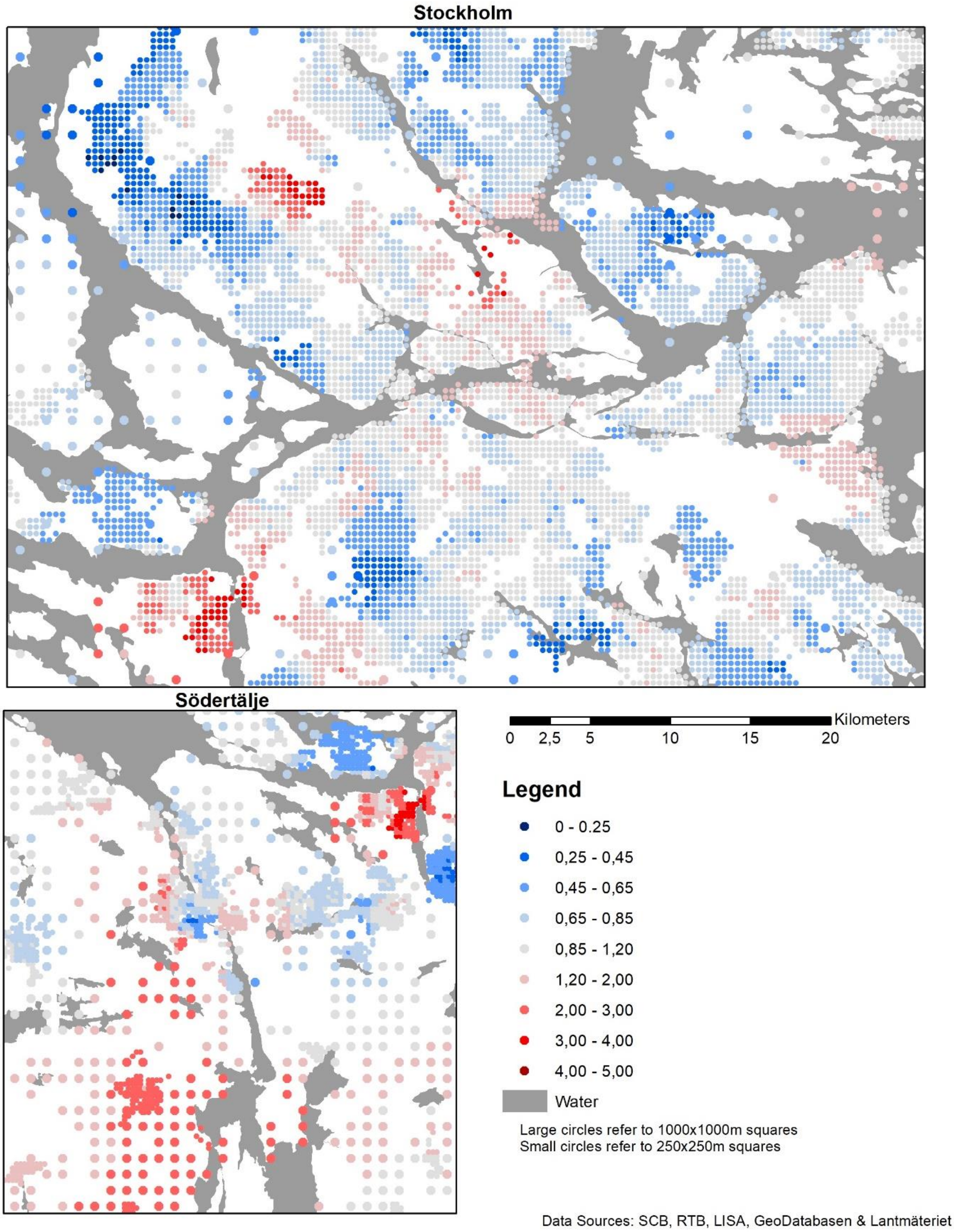
Wimark, T., Andersson, E. K. & Malmberg, B., (2020). Tenure Type Landscapes and Housing Market Change: A Geographical Perspective on Neo-liberalization in Sweden. *Housing Studies*, 35:2, 214-237, DOI: 10.1080/02673037.2019.1595535

Vogiazides, L. (2018). Exiting distressed neighbourhoods: The timing of spatial assimilation among international migrants in Sweden. Population, *Space and Place*. 2018; 24:. https://doi-org.ezp.sub.su.se/10.1002/psp.2169

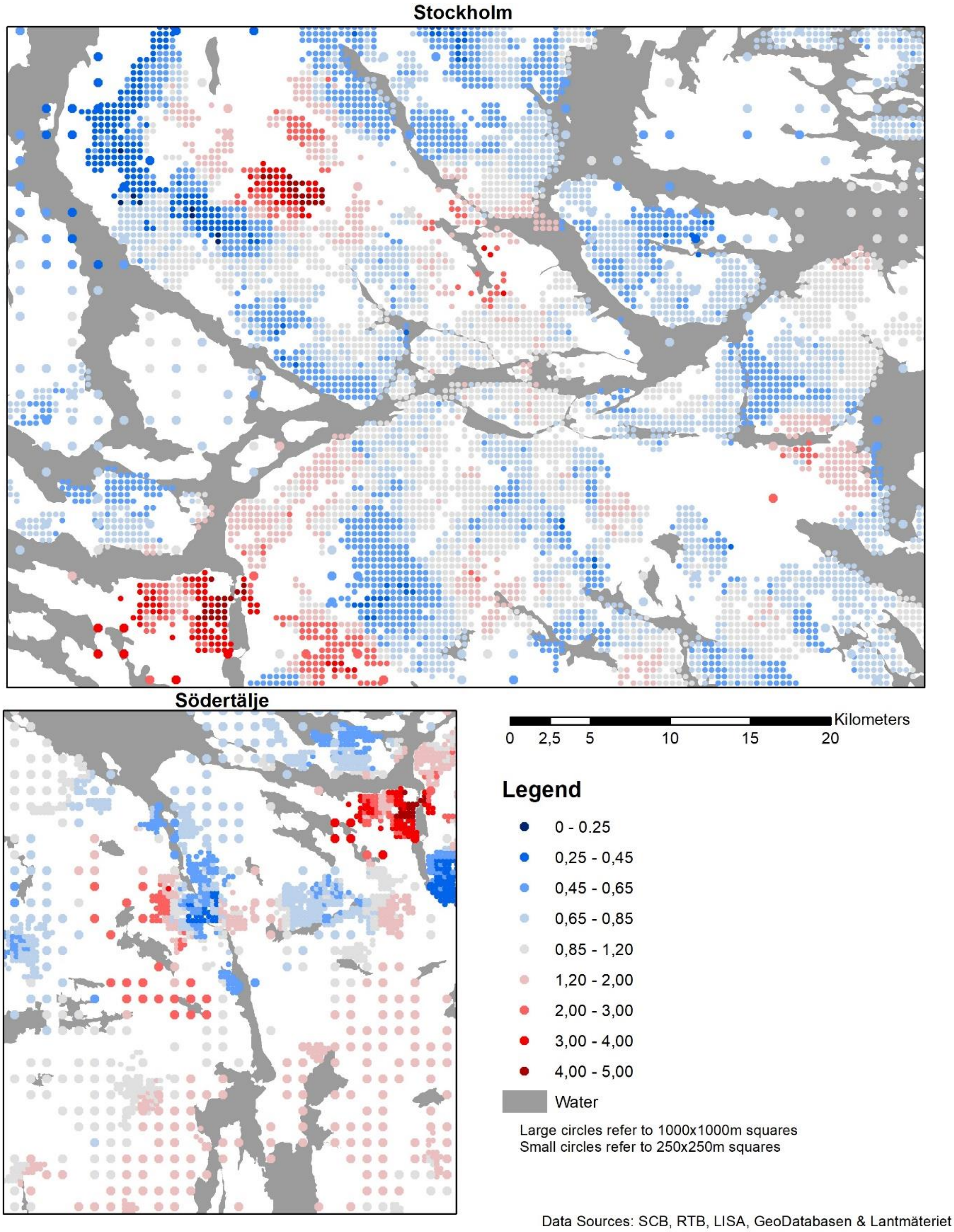
Wong, D. W. (2009). Modifiable Areal Unit Problem. *International Encyclopedia of Human Geography*, Elsevier, 2009, Pp. 169-174, https://doi.org/10.1016/B978-008044910-4.00475-2

Yao, J., Wong, D.W., Bailey, N. and Minton, J. (2019), Spatial Segregation Measures: A Methodological Review. *Tijds. voor econ. en Soc. Geog*., 110: 235-250. doi:10.1111/tesg.12305

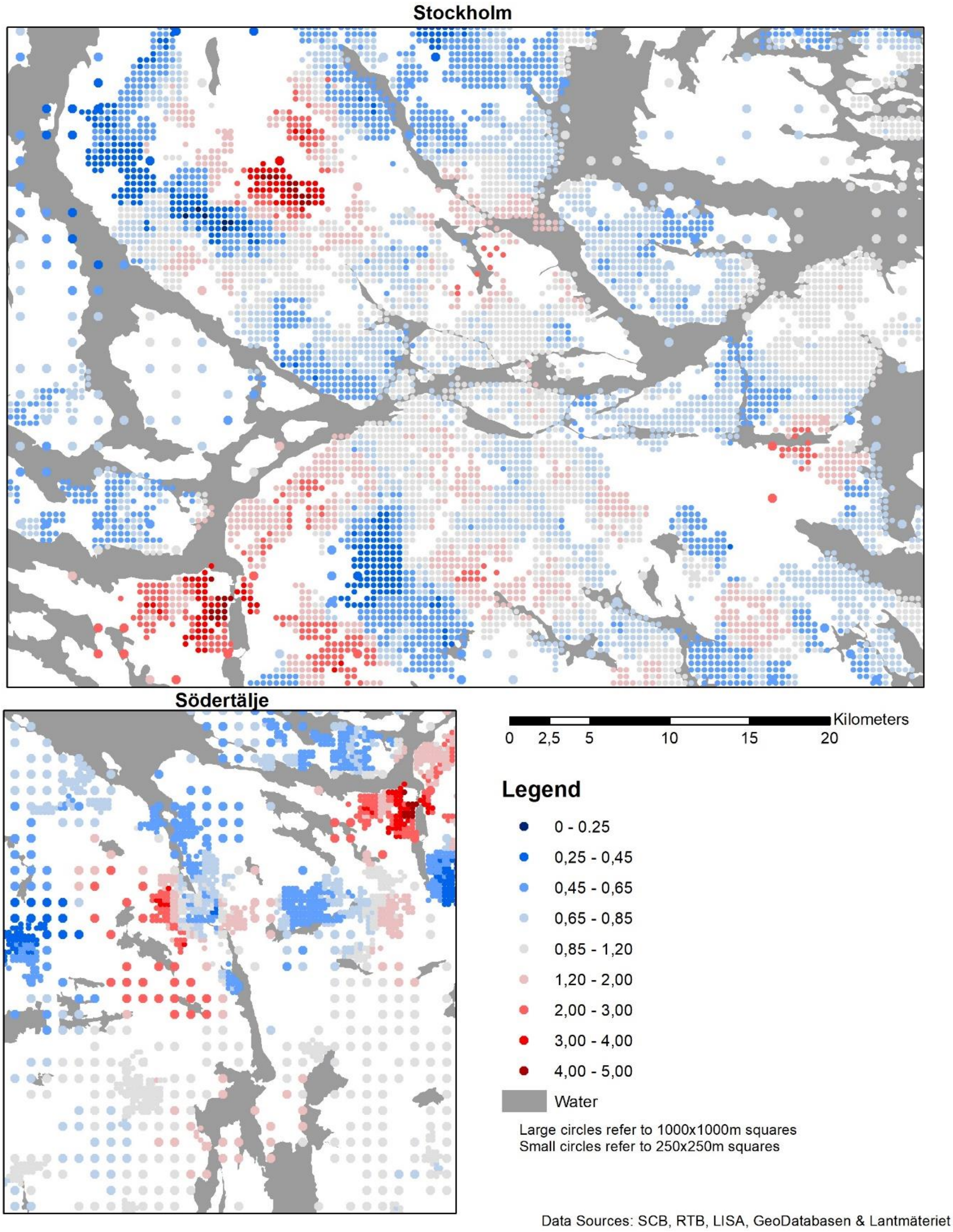
Appendixes



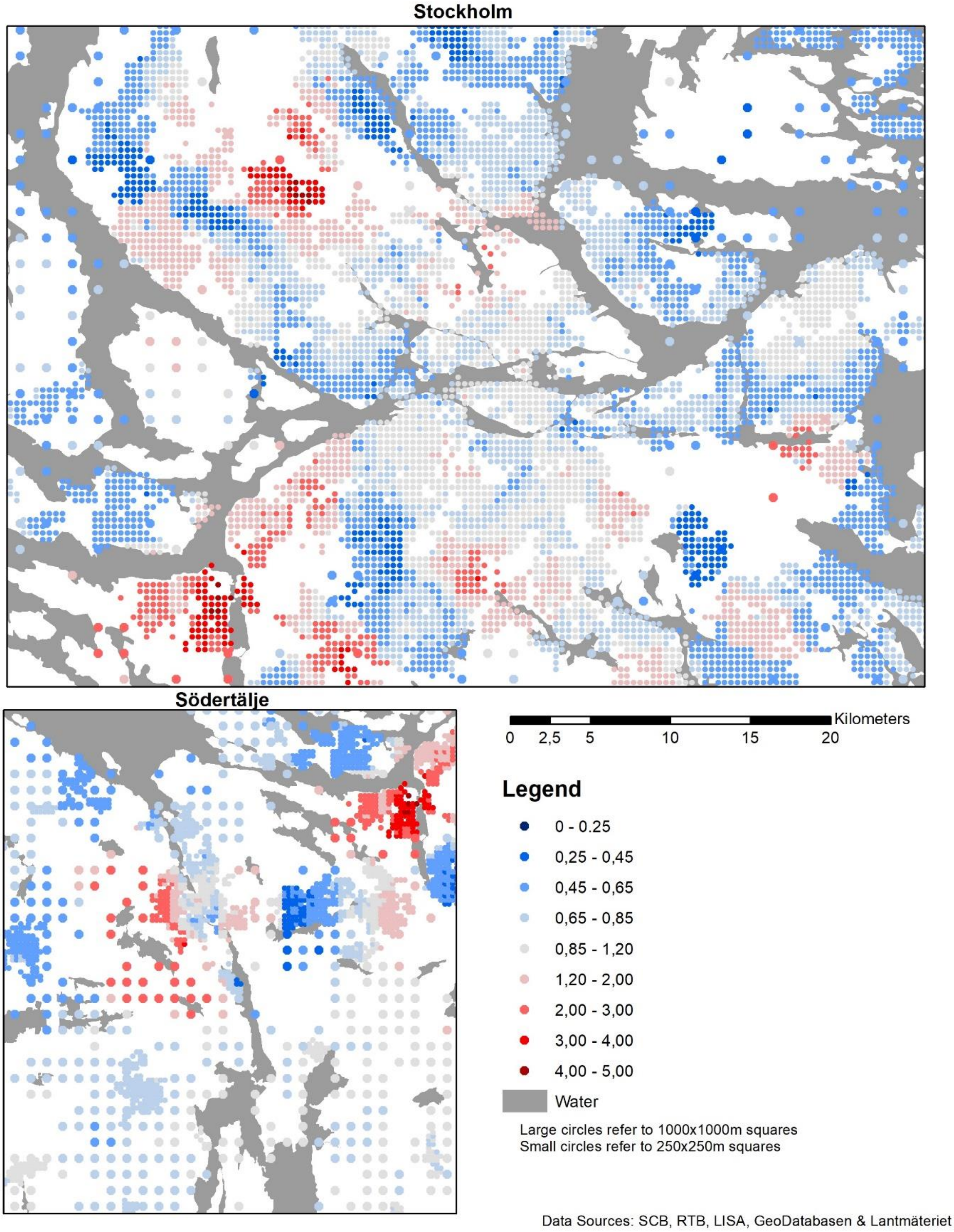
Map 1 - Location quotients of the population at risk of poverty 1991, k=1600.



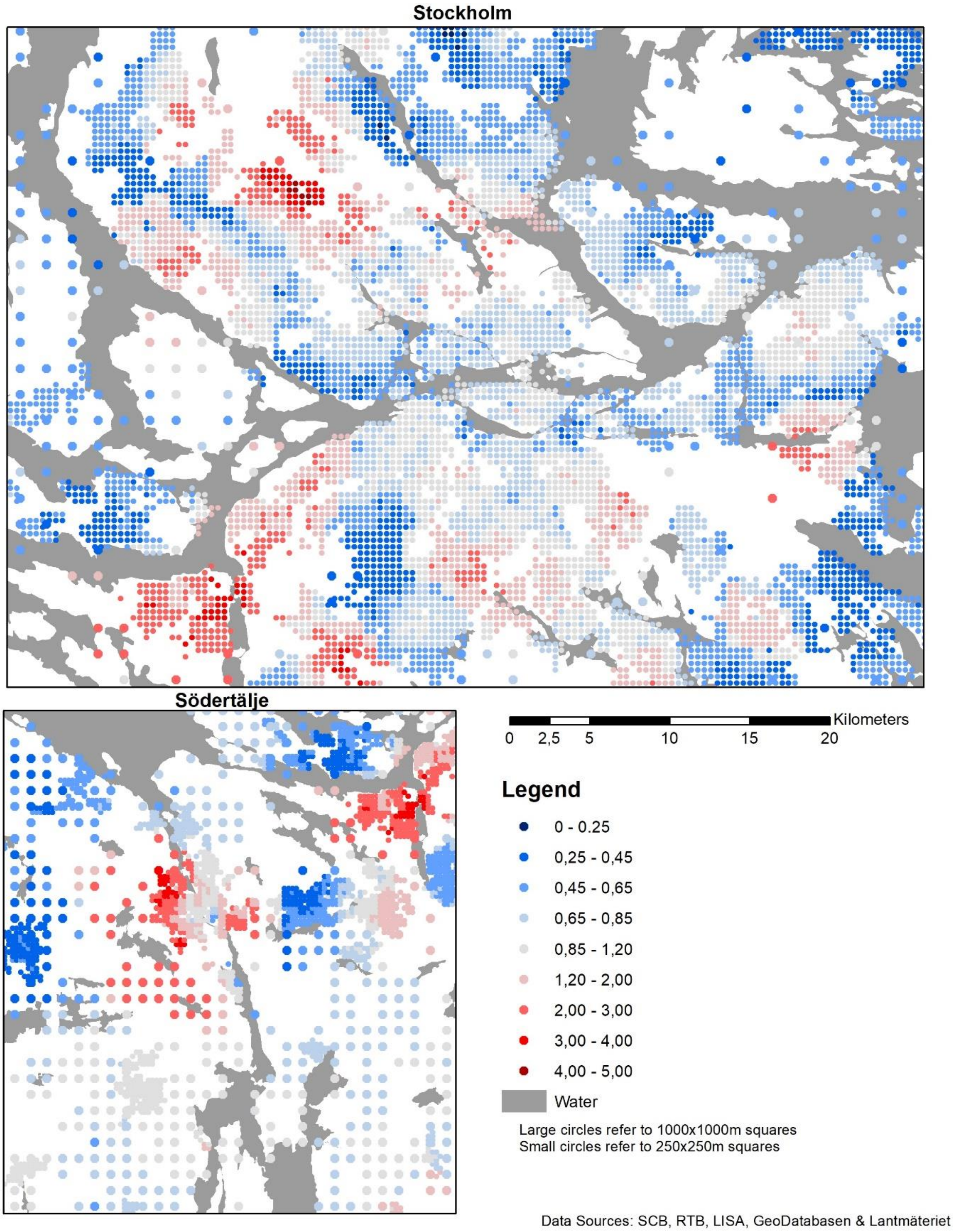
Map 2 - Location quotients of the population at risk of poverty 1996, k=1600.



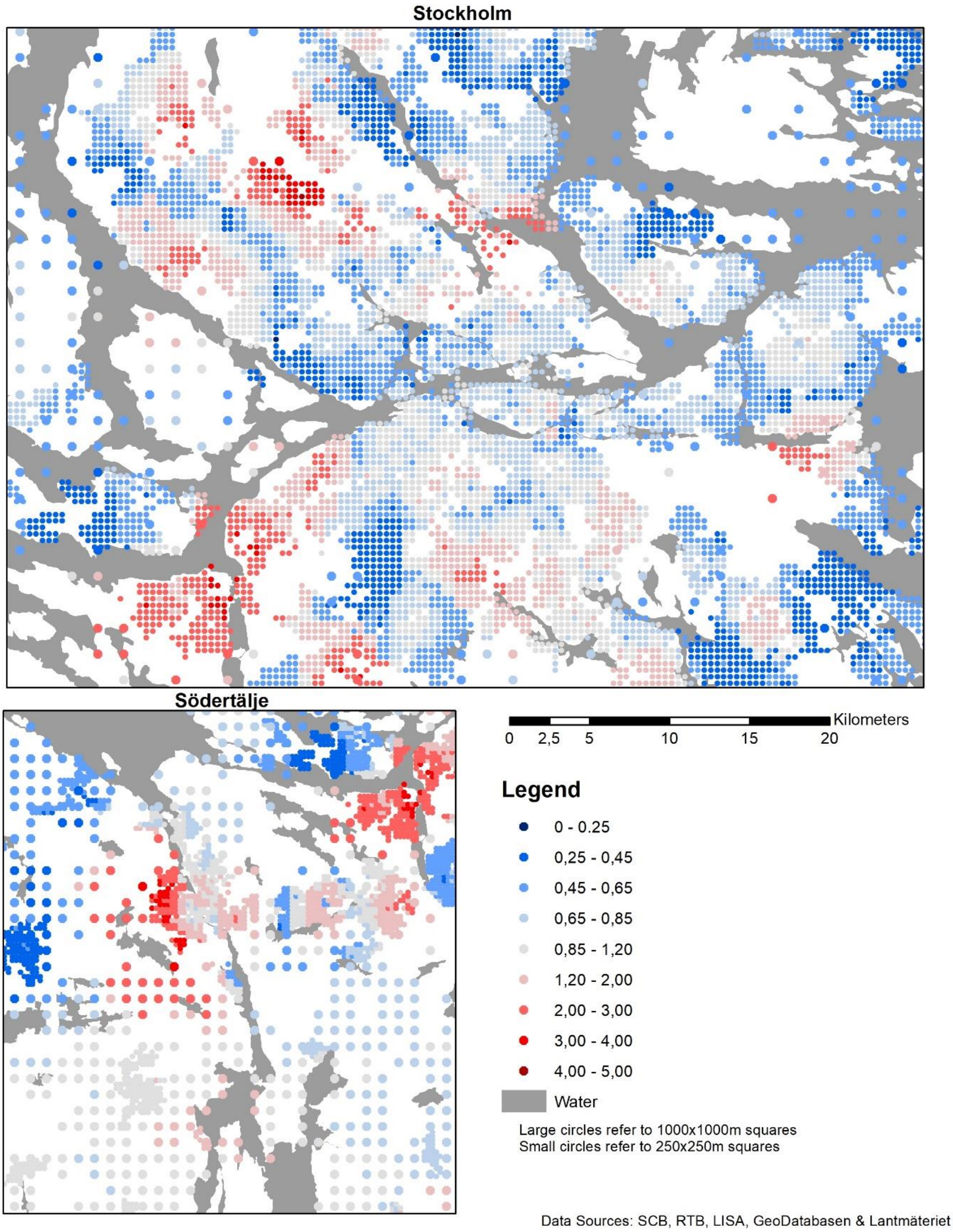
Map 3 - Location quotients of the population at risk of poverty 2001, k=1600.



Map 4 - Location quotients of the population at risk of poverty 2006, k=1600.



Map 5 - Location quotients of the population at risk of poverty 2011, k=1600.



Map 6 - Location quotients of the population at risk of poverty 2016, k=1600.

Stockholms universitet/Stockholm University
SE-106 91 Stockholm
Telefon/Phone: 08 – 16 20 00
www.su.se