Relating COVID-19 risk indices to population density in Gauteng

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Gauteng City-Region Observatory (GCRO)

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Introduction

Key strategies to manage the COVID-19 pandemic include social distancing, preventative hygiene and socio-economic support packages. In South Africa, these measures are easier to implement and quantify in some areas than in others. The GCRO's March 2020 Map of the Month highlighted how different parts of Gauteng might experience different risks according to two indices of risk factors when facing the challenges of the COVID-19 pandemic. Although the March 2020 Map of the Month considered household crowding as one of the variables in the indices, it did not explore the influence of population density in detail. It is important to do so since population density has a particularly significant impact on one's ability to maintain adequate social distance and provide suitable assistance to residents, like providing enough medical care and keep basic services working.

In addition to household crowding that was considered in the March 2020 Map of the Month, population density beyond the household level will have a critical influence on the management of COVID-19 pandemic. The purpose of the following data visualisations is (1) to examine how population density in Gauteng might affect strategies to mitigate the spread of COVID-19, and (2) to assess how population density influences vulnerability to the health and social impacts during the pandemic and broader shutdown in the province.

Population density and risk factors to *spreading* COVID-19

The first index presented in the March 2020 Map of the Month focuses on the risk factors that undermine maintaining social distance and preventative hygiene. In order to consider how this index interacts with population density, Map 1 groups all wards in Gauteng into four categories according to their position above or below the provincial average risk levels and provincial average population density per ward.

These include:

(1) wards that have lower than average risk and lower than average population density (dark blue),

(2) wards that have lower than average risk but higher than average population density (light blue),

(3) wards that have higher than average risk but lower than average population density (orange), and

(4) wards that have higher than average risk and higher than average population density (red).

The position of all the wards with respect to the averages are also represented graphically in Figure 1.

Population density and risk factors to *spreading* COVID-19

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Wards with higher than average risk and population density (red wards) are mostly wards in and around townships, for example Mamelodi, Ivory Park, Soweto, Katlehong and Tsakane. The higher risk and higher density mean that a large number of residents might require support in these areas; thus the capacity of nearby facilities (like healthcare facilities) and services (like refuse removal) will have to be adjusted to accommodate increased demand. The red wards could be targeted as priority areas for short-term interventions.

Centrally-located residential areas and many middle class suburbs tend to have both lower than average risk and population density (dark blue wards). These wards are also less reliant on public healthcare facilities and public transport (two important elements of the index).

Peripheral wards tend to have lower than average population densities but higher than average risk levels (orange wards). The higher than average risk is mostly due to informal living conditions and relatively poor access to service infrastructure in these wards. However, because the population density of the ward is low, this should be carefully interpreted against the ward-specific population distribution in order to target interventions appropriately because the population that is most at risk is likely concentrated in one or two small parts of the larger ward. A more detailed perspective is provided in Map 3, below. There are very few wards with lower than average risk levels and higher than average population density (light blue wards). However, the dynamics in these light blue wards are important in at least two respects. Firstly, valuable lessons could be drawn from the reasons why their average risk is lower than other surrounding wards - like how to manage household crowding or provide better basic infrastructure. Secondly, these wards will require careful monitoring in case COVID-19 infections do appear in order to mitigate the effects of density.

Population density and risk factors to *spreading* COVID-19

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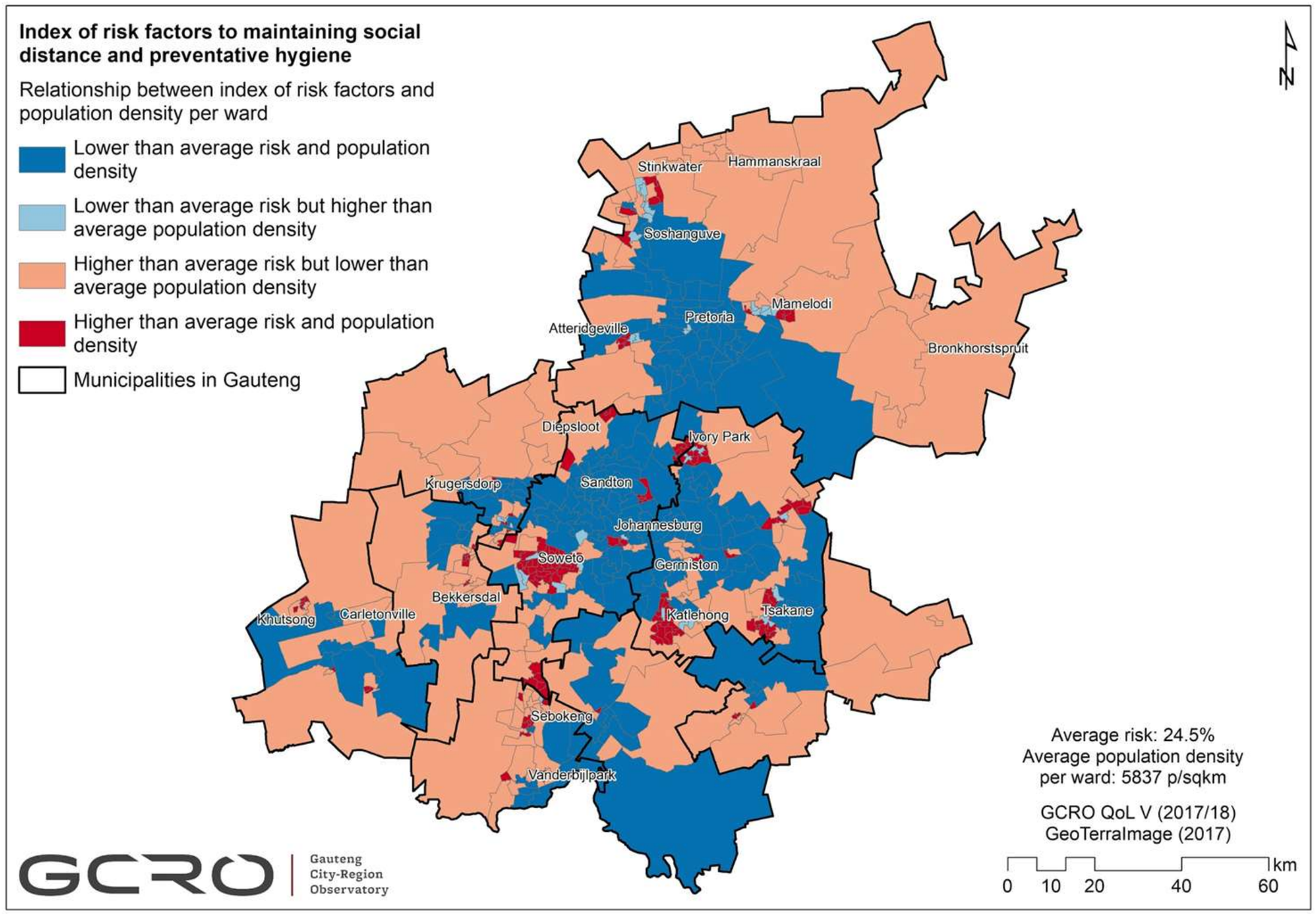
Map 1: Index of risk factors to maintaining social distance and preventative hygiene related to population density per ward in Gauteng



Population density and risk factors to *spreading* COVID-19

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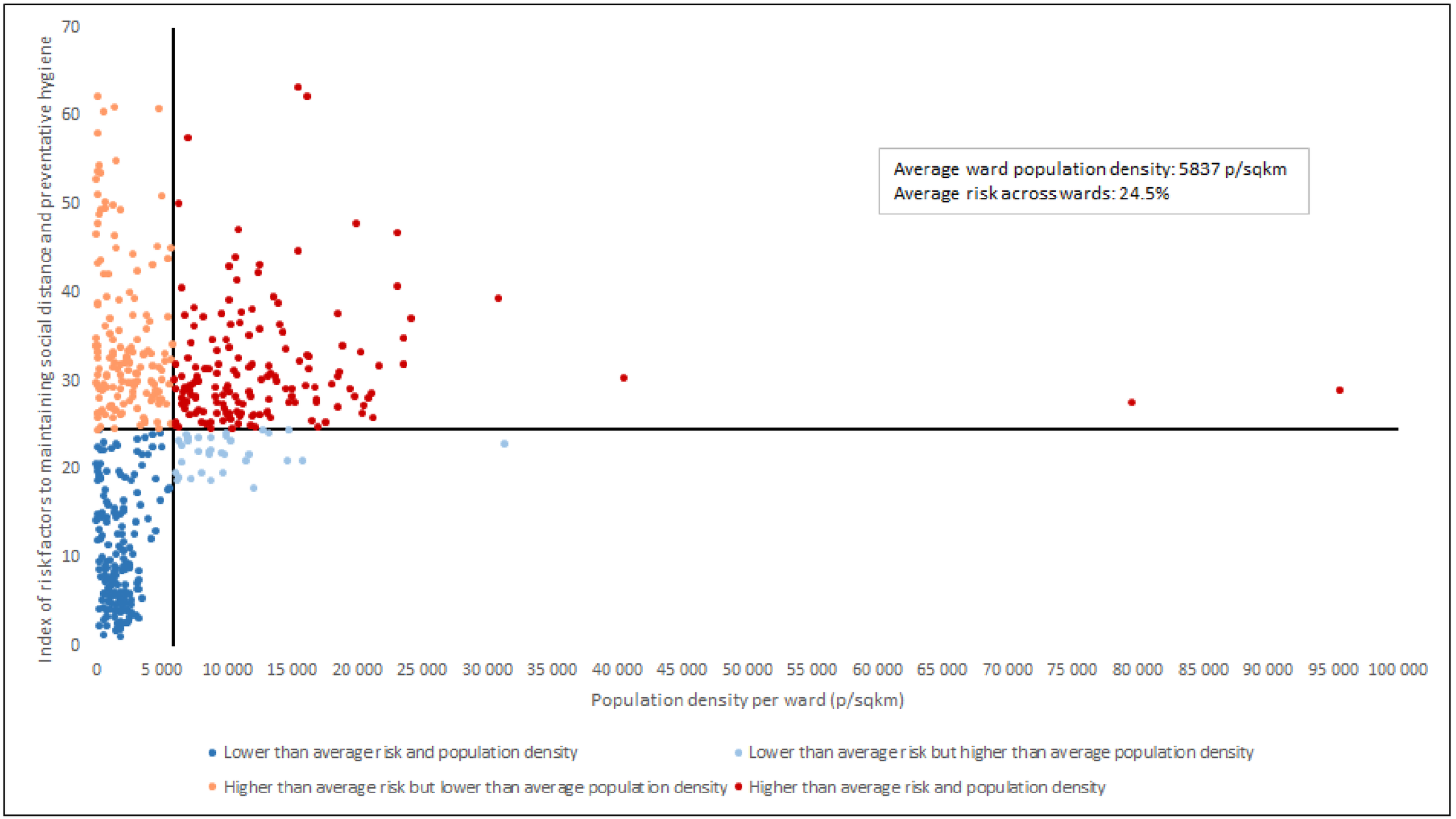
We can also take a closer look at how wards are distributed with respect to average population density and average risk (Figure 1). Wards with higher than average risk and population density are dispersed across the upper right quadrant of the graph (red dots), indicating that some wards have much higher than average levels of risk and much higher than average population density. This is often the conditions that are found in townships in Gauteng, as mapped above. It is also evident that the wards with lower than average risk and population density tend to have risk levels that are well below the provincial average, as indicated by the cluster of dark blue dots in the lower left quadrant of Figure 1.

The wards with lower than average risk but higher than average population density (light blue dots) also tend to be positioned very close to the provincial averages - further indicating that these need to be monitored closely. Many of the wards with higher than average risk levels and lower than average population density (orange dots) have very low population densities, as indicated in the upper left quadrant of the graph. This further signifies how important it is to identify exactly where the vulnerable settlements are located in each ward.

Outliers can be explored in more detail in the supplementary data file on the COVID-19 project page.

Population density and risk factors to *spreading* COVID-19

Figure 1: The relationship between the index of social distance and preventative hygiene risk factors and population density per ward



Population density and risk factors to the *impact* of COVID-19

The second index presented in the March 2020 Map of the Month combined risk factors that increase health and social vulnerability during an outbreak or broader shut down. Map 2 divides all wards in Gauteng into four groups in the same way as Map 1 to relate population density to the health and social vulnerability risk factors.

The position of all the wards around the averages are also represented graphically in Figure 2. The average health and social vulnerability (38.7%) is somewhat higher than the average of the first index of risk factors (24.5%), indicating the widespread challenges that might be faced during an outbreak or broader shutdown. However, the risk and the ability to cope with an outbreak is not spread evenly across the Gauteng province.

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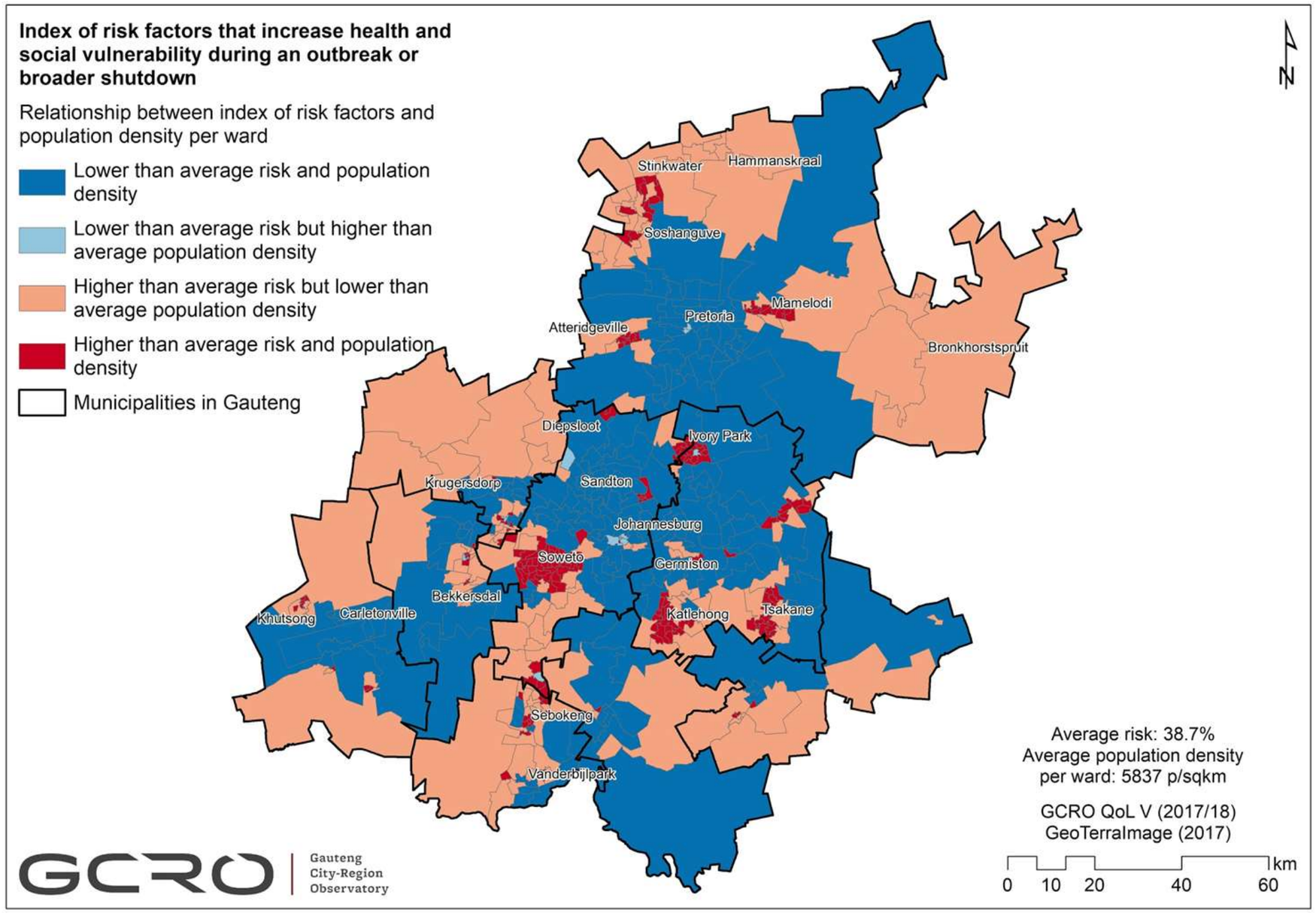
In Map 2 below, wards with higher than average risk and population density (red wards) are again mostly located in and around townships, such as Soshanguve, Diepsloot, Alexandra (east of Sandton), Sebokeng and others. And again, centrally-located residential areas and many middle class suburbs tend to have lower than average risk and population density (dark blue wards) but there are more wards included in this category than in Map 1. This is most likely influenced by the relatively higher socio-economic status of residents in these wards. Peripheral wards still tend to have lower than average population densities but higher than average risk levels (orange wards), but there are fewer wards that fall into this category than the equivalent category in Map 1. There are only a few wards with lower than average risk and higher than average population density (light blue wards).

Population density and risk factors to the *impact* of COVID-19

Map 2: Index of risk factors to health and social vulnerability related to population density per ward in Gauteng



Population density and risk factors to the *impact* of COVID-19

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Comparing Map 1 and Map 2, various interesting patterns become evident. For example, the light blue ward south-west of Diepsloot (which is also the ward which includes Cosmo City) has an above average population density. However, while it has an above average level of risk in the first index (social distance and preventative hygiene), it has a below average level of risk in the second index (health and social vulnerability). This suggests that there are some specific socio-economic characteristics in this area that reduce the average health and social vulnerability of residents.

In this ward (Ward 79800100 in Johannesburg), the estimated population density is 6 097 people per square kilometre and about 3% of respondents had poor or very poor health status, 30% had some form of medical insurance, only 28% face potential hunger risk, only 21% experienced concerning pre-existing health conditions in their household, 19% are able to save money relatively easily and only 4% failed to find healthcare when they previously needed it. These are the factors that reduce the average health and social vulnerability of the ward, but there may still be many households who remain vulnerable.

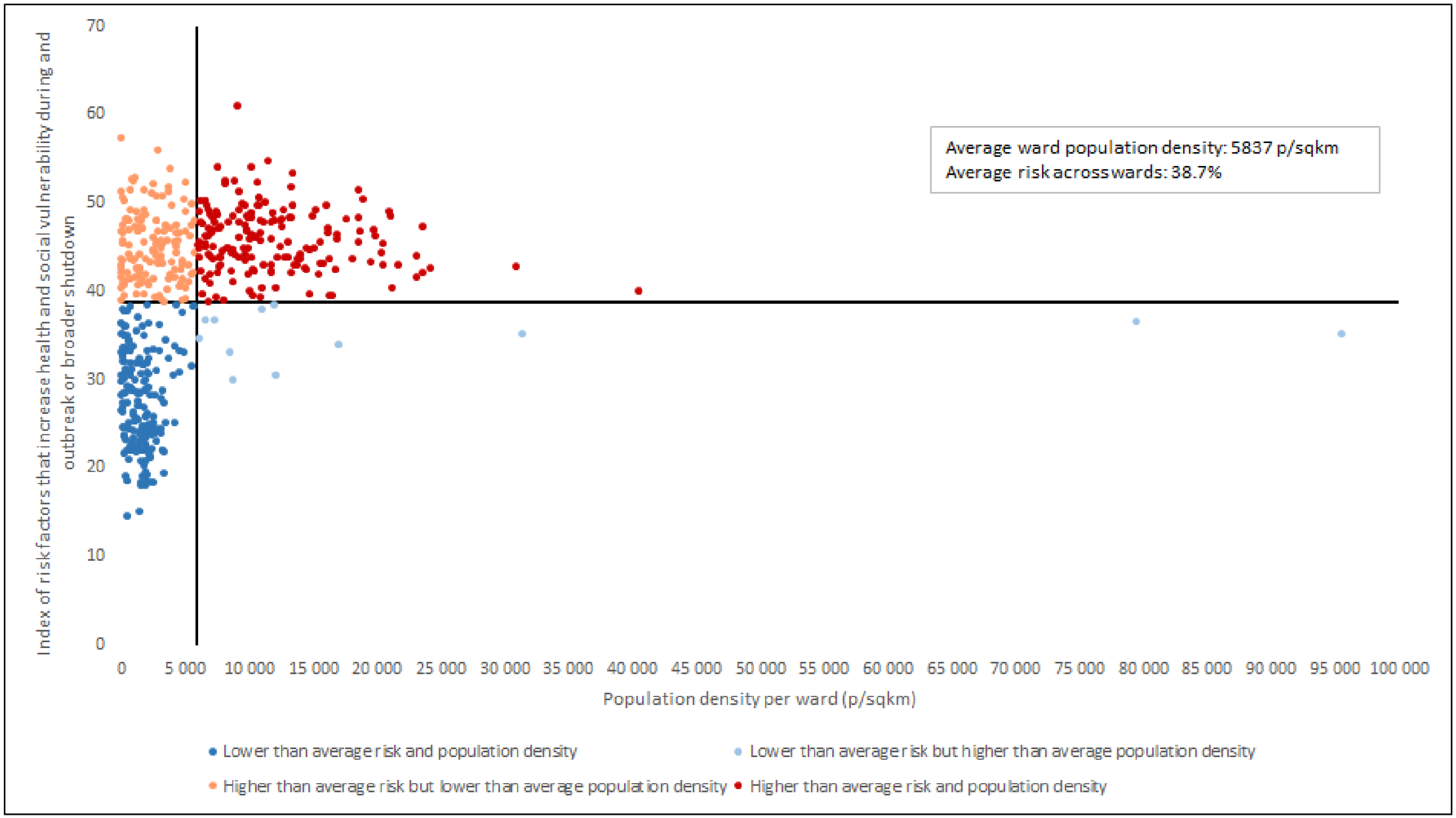
The opposite is true in some wards, such as in Soshanguve, Mamelodi, Soweto, Katlehong and Tsakane. In these wards, the risk for spreading COVID-19 is relatively low, but the risk for the impact of COVID-19 is relatively high. This indicates a situation where the risk of spreading COVID-19 is uneven within some areas but the risks associated with the impact of COVID-19 in these areas are distributed more evenly. In other words, because the socio-economic status and the availability of a safety net for residents varies, it means that within a ward the risk of spreading might be relatively low but the impact of COVID-19 could still be harsh. Considering this against population density helps us to understand how many people within different areas might need additional support.

In Figure 2, it is evident that the distribution spread is smaller than the distribution presented in Figure 1. This distribution is more clustered around the average population density and average risk and there are fewer outliers than the first index which makes it more difficult to identify where to focus efforts in response to these risks.

Outliers can be explored in more detail in the supplementary data file on the COVID-19 project page.

Population density and risk factors to the *impact* of COVID-19

Figure 2: The relationship between the index of health and social vulnerability risk factors and population density per ward



Population density and the 100 wards most at risk

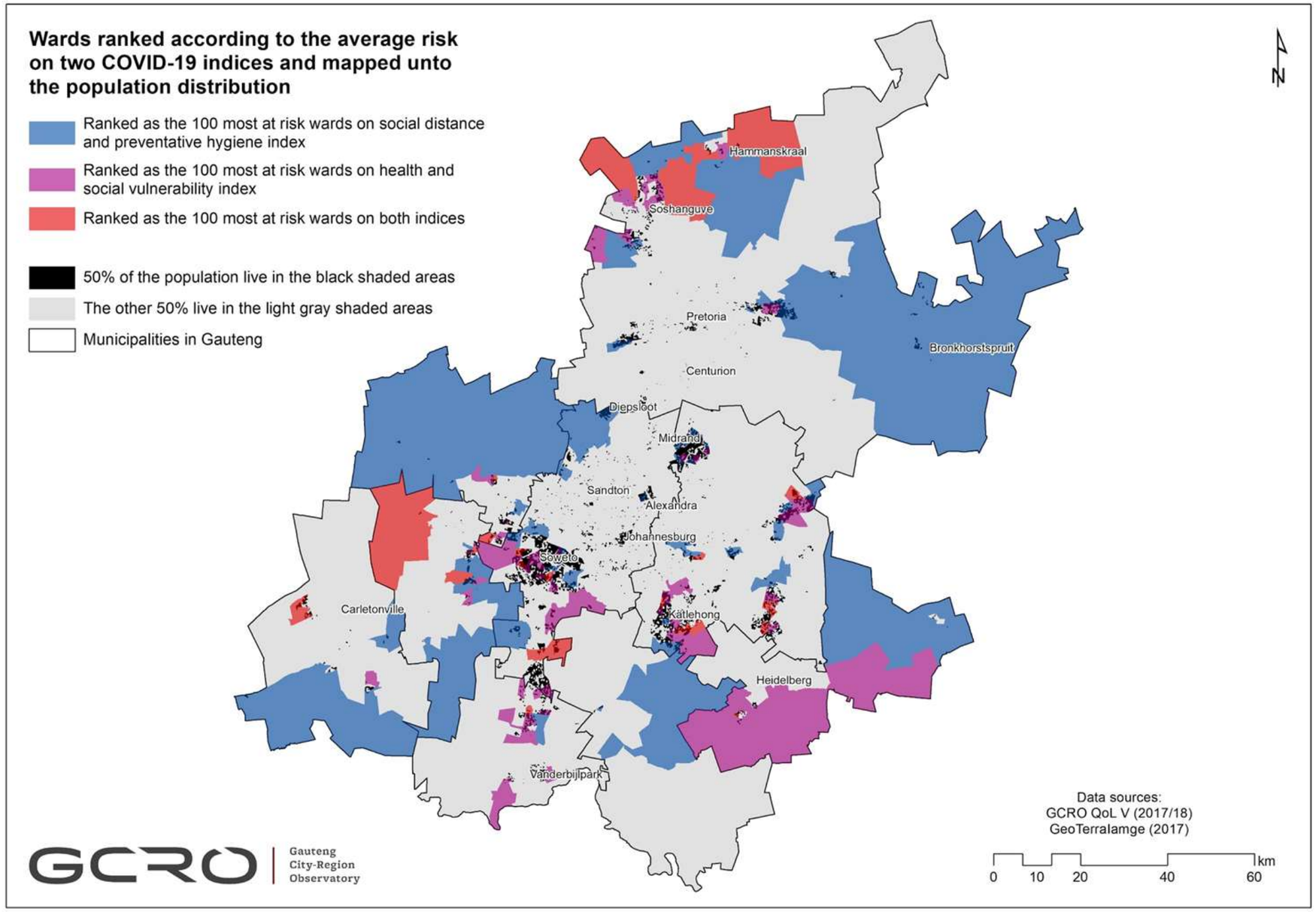
Using the GCRO's two COVID-19 risk indices we extracted the 100 wards with the highest average risk in each index and overlaid these wards on the Enumerator Areas (EAs) in Gauteng where about 50% of the population live (Map 3). The black shaded EAs on the map show where 50% of Gauteng's population lives. In other words it shows where the densest settlements in the province are located. The shaded wards are those most at risk on either the social distance and preventative hygiene index (blue wards) or on the health and social vulnerability index (pink wards) or on both indices (red wards).

It could be expected that areas with higher concentrations of the population would also have higher than average levels of vulnerability. On Map 3 it is evident that most of the areas where 50% of the population live coincide with a ward that is ranked as one of the 100 most at risk wards on at least one index, if not both. The only exceptions include the Pretoria and Johannesburg CBDs and certain parts of townships.

Further, Map 3 helps to understand how populations are concentrated in some of the large wards in Gauteng. For example, in wards in northern Gauteng, near Hammanskraal, it is evident that the population in those wards are likely to be concentrated in a few small areas of the larger ward. Just north of Carletonville is a ward that is in the top 100 wards on both indices (highlighted in red), but the population that is at risk is likely located in one or two informal settlements, as indicated by the one cluster of very dense EAs in the ward. This analysis highlights the average level of risk at a ward-level, and while an entire ward might be shaded a specific colour, it is important that spatially targeted interventions take the sub-ward level context into consideration to ensure that they are directed towards the appropriate individual settlements within each ward.

Population density and the 100 wards most at risk

Map 3: The 100 most at risk wards related to where 50% of the Gauteng population live



Technical notes

- The data used to create the scatter plots (Figure 1 and Figure 2) can be explored in more detail by downloading the relevant Excel document from the "Responding to the COVID-19 pandemic in Gauteng" project page.
- All population figures are from modelled population data per EA as of 2017 and was sourced from GeoTerraImage.
- To create the 50% population distribution, EAs are ranked from high to low according to their population density and with the proportion of the total population in each EA we are then able to identify the EAs which are home to 50% of the population.