Visualising "the vulnerable": Understanding vulnerability to COVID-19 in relation to the South African COVID-19 Vulnerability Index (SA CVI)

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Abstract

This study investigates the definition of "vulnerability" in the visualisation and underpinning index of Stats SA's South African COVID-19 Vulnerability Index (SA CVI)'s data visualisation dashboard. The paper establishes definitions of vulnerability in relation to literature before COVID-19, research in the time of the pandemic, and in relation to data visualisation. The discussion finds that while the pandemic is widely perceived as a "health crisis", South African vulnerability to this pandemic is mostly constituted by factors that fall outside of normative "health" concerns – beyond "straightforward" medical, biological and epidemiological factors. Instead, South African vulnerability to COVID-19, and the "health" of its citizens in this context, are largely to be understood as systemic, socio-economic, and necropolitical conditions. It is found that these conditions have not been generated by the pandemic but have rather been exposed by it.

Keywords

pandemic, data feminism, data visualisation, precarity, necropolitics

INTRODUCTION

Vulnerability indices offer governments, policy makers, and other stakeholders a measure of the extent to which populations are exposed to specific hazards. These hazards can range from ecological disasters to the outbreak of diseases.[1] Since the outbreak of COVID-19 in December 2019, various platforms have devised such indices through which to communicate and represent the vulnerability of populations to this pandemic. These platforms visualised complex data sets, indicating to governments and health institutions, as well as to broader publics, which regions, communities and circumstances were deemed vulnerable to the threat of the novel coronavirus. Models of the outbreak of the virus, the curves of its global infection rates, hotspots of local outbreaks and other data visualisations of complex information related to the virus supported science communication at a time of unprecedented global need (Bowe et al., 2020; Dixon et al., 2021; Ponjavić et al., 2021). These visualisations, representing everything from deaths, recovery, and containment related to COVID-19, have been used to communicate the dangers and spread of the pandemic, as well as safety and prevention measures. However, it is crucial to critically consider whether these visualisations convey an objective notion of vulnerability – data feminism, as a theoretical perspective, emphasises this attempt. Data feminism and its focus build on the seminal work of Haraway (1988) in questioning objectivity in science knowledge. The field promotes the investigation

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1   Such an index is usually a composite of various indicators and is represented as a numerical value, usually with a minimum and maximum to indicate different degrees or stages of vulnerability.

of objectivity in data visualisations to understand the ways in which these visualisations reveal, reflect, and are vehicles of power relations (D'Ignazio & Klein, 2019:10, 15). Critically considering the definition and visualisation of vulnerability during a pandemic may therefore reveal and reflect power relations in any given society that are often overlooked, but made visible, during a time of crisis.

In December 2020, during the second wave of COVID-19 infections in South Africa, the local statistics agency, Statistics SA (Stats SA), launched a visualisation platform, the South African COVID-19 Vulnerability Index (SA CVI) and its accompanying online VIndex Dashboard (Stats SA, 2020b). The purpose of this dashboard is to visualise and communicate the vulnerability of South African publics to the effects of the pandemic. The index uses data from the 2011 South African census to communicate localised risk factors. This was done in order to visually represent the vulnerability of South African citizens to the virus and to map the geographical distribution of vulnerability and areas of its potential highest concentration.

Research has shown that the intersections of the novel coronavirus pandemic as a health crisis with socio-economic contexts and disparities cannot be ignored (Butler, 2020; Dawson, 2020; Žižek, 2020), both globally and in South Africa (Broadbent, 2020a; Broadbent, 2020b). Social and economic inequalities across South African communities arguably impact on and are reflected in how vulnerability is understood and communicated. In a South African context, an analysis around definitions and visualisations of vulnerability, as seen on the SA CVI platform, could contribute to ongoing attempts to understand how such definitions function, and their relationship to the vast socio-economic disparities in this country.

This paper attempts to outline this health crisis in South Africa to highlight power relations (Foucault, 1980) that are related to seemingly "value-free" knowledge in the form of data-driven definitions and representations of vulnerability in this country. Moreover, this paper attempts to provide an academic reflection on the "objective" data behind the SA CVI definitions and visualisations of vulnerability. This may help to understand these definitions and representations as potentially reflective of broader societal contexts in South Africa. Within this overarching aim, this paper finds answers to the following research questions:

- How is vulnerability defined in theory in 1) literature before the COVID-19 pandemic; 2) research in the time of the novel coronavirus; and 3) in relation to data and data visualisation?
- How is vulnerability defined in the underpinning index of and visually represented in the data visualisation of the SA CVI?
- What are potential visual and social impacts of these definitions, as determined from the SA CVI, and how do this platform and these impacts relate to the theory reviewed in answer to the first research question?

The discussion section of this article centres on a critical discourse analysis with a semiotic focus. This paper aligns itself with Fowler's (1981) understanding of critical discourse analysis, not as flagrant fault-finding, but as a method that provides a "careful analytic interrogation of the ideological categories, and the roles and institutions ... through which a society constitutes and maintains itself and the consciousness of its members" (Fowler, 1981:25). A critical discourse analysis, with a focus on highlighting how objects of text[2] constitute or produce the social world (Bryman, 2012:528), helps this study to explore not just the relevant visual elements of the SA CVI, but also how the other aforementioned objects of text help to constitute and make sense of definitions and visualisations of vulnerability during the time of COVID-19. The semiotic focus of discourse analysis in this study is crucial – it affords a focus on the semiotic

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2 The notion of 'objects of text' derives from a semiotic understanding of text and its constituent elements (signifiers and signifieds), and builds on the work of Bryman (2012) and Fowler (1981) regarding objects and their relation to knowledge and processes of constructing meaning. This paper approaches all visual aspects, as well as linguistic and statistical elements in data visualisations included in the discussion, as objects of text, i.e., as objects constituted by text, consisting of their own sets of underlying elements that function to construct meaning and significance.

aspects of data visualisations, statistics, guidelines, and official communications in relation to broader socio-political concerns, accentuating these understandings as context specific.

UNDERSTANDING VULNERABILITY

The concept of "vulnerability" has been increasingly referred to in scholarly writing since the late 1980s and early 1990s, specifically in literature on natural disasters (Delor & Hubert, 2000:1561), and has since been explored and applied in other fields too. Delor and Hubert (2000) review typologies of vulnerability, including definitions of the term in relation to crime, racial harassment, and mental health. Other authors (Ligon & Schechter, 2003; Glewwe & Hall, 1998) analyse vulnerability in relation to household welfare and macroeconomics, respectively. Hufschmidt's (2011) comparative analysis of six vulnerability models, outlines two prominent schools of thought around vulnerability. The first is the human ecologist school that views vulnerability as a "human adjustment to natural hazards" (Hufschmidt, 2011:623). The second, the structural perspective, provides a critique of the first and "focuses on the social, economic, cultural and political context people live in and their everyday living condition" (Hufschmidt, 2011:625).

Researchers agree that vulnerability is difficult to define – Hufschmidt argues that this is because standardising and operationalising vulnerability is a challenge (2011:637), while Adger contends that the challenge is finding suitable metrics for vulnerability (2006:274). Adger argues that "vulnerability is a dynamic phenomenon often in a continuous state of flux" (2006:274). Delor and Hubert also maintain the "potentially changeable nature of vulnerability, whether over time, relational areas, or networks, or even according to the social context in the broad sense" (2000:1564), troubling a straightforward understanding of this complex term and its implications. From another perspective, Jackson and colleagues (2012) comment on the power of language when discussing vulnerability. They claim that "using 'vulnerable' or 'vulnerability' as a descriptor can obscure the strengths people bring to challenging situations" (Jackson et al., 2012:142), and argue for adjustments in the language of scholarly work on the topic.

This study is located in these complex perspectives and implications of defining vulnerability. Therefore, in acknowledging the contingent nature of vulnerability, this literature review makes a distinction between understanding vulnerability before COVID, during COVID, and in relation to data and data visualisation.

A pre-COVID typology of vulnerability

Mackenzie, Rogers and Dodds (2014) identify two broad responses in defining vulnerability. The first response, "inherent vulnerability" (Lange et al., 2013:336), is described as "the capacity to suffer that is inherent in human embodiment" (Mackenzie et al., 2014:4). This implies that vulnerability is an inescapable part of "being human". On the one hand, this view highlights the animal nature of the human body and its susceptibility to be injured and affected by its surroundings (MacIntyre, 1999; Nussbaum, 2006). On the other hand, it highlights the human body as a social one; since it is shaped and potentially affected by social relations with other human beings, the body is "vulnerable to the actions of others and dependent on the care and support of other people" (Mackenzie et al., 2014:4). Butler argues that "there are no invulnerable bodies" (Butler, 2009:34), and that "the body is a social phenomenon: it is exposed to others, vulnerable by definition" (Butler, 2009:33). In this perspective the human body as unavoidably vulnerable is thus marked by environmental, corporeal and social relationships – vulnerability does not necessarily stem from these relationships but is an essential part of human existence.

A second way of understanding vulnerability is described by Mackenzie, Rogers and Dodds (2014) as an emphasis on external context; this is called "situational vulnerability" (Lange et al., 2013:336). This response entails approaching "vulnerability as ontological [since] it focuses on the contingent susceptibility of particular persons or groups to specific kinds of harm or threat by others" (Mackenzie et al., 2014:6). Lange, Rogers and Dodds expand on this classification, using it to refer to "'the personal, social, political, economic or environmental situation of a person or social group'. Situational sources of vulnerability may be intermittent and short-term, or enduring" (2013:336).   Aligning themselves with a similar perspective on vulnerability as context-specific, Peter and Friedland (2017) argue that "vulnerability is the result of many intersecting individual, social, and political factors, only an up-close knowledge of

specific individuals would allow for vulnerability to be accurately determined" (Peter & Friedland, 2017:112).

These two responses to vulnerability, as described above, are inter-related, and many theorists use the one in order to delineate and define the other. Hurst (2008) contends that views on vulnerability as a "universal expression of the human condition" (Hurst, 2008:191-192), in their claims of universality, do not sufficiently account for circumstantial influences. Luna (2009) also critiques writings associated with the first response, saying that they coincide with "the tendency to treat vulnerability as a label fixed on a particular subpopulation" (Luna, 2009:121). Instead, Luna maintains an understanding of "layers of vulnerability" (2009:121) to show how persons or groups deemed vulnerable "may not be per se vulnerable or essentially vulnerable, but they might be rendered vulnerable" (2009:122) by means of "personal, social, political, economic, or environmental" factors (Lange et al., 2013:336). This means that even before the interference of conditions that increase being vulnerable, these groups may have been rendered vulnerable by social, economic or political contexts – a preceding state only exacerbated, not brought about, by said hazardous circumstances. Butler (2016) refers to this preceding state of being vulnerable as "precarity" (Butler, 2009; Butler, 2016), and says that this state is made visible by societal infrastructure, or lack thereof, but not necessarily made possible by such a presence or failure (Butler, 2016:12-13).

Understanding vulnerability in COVID times

It became crucial to re-examine and redefine vulnerability in the face of the global COVID-19 crisis (The Lancet, 2020:1089). While those vulnerable to the health threat of COVID-19 may have been straightforwardly understood as the elderly, those living with compromised immunity or comorbidities, the homeless or the underhoused, The Lancet states that "the risks of sudden loss of income or access to social support have consequences that are difficult to estimate and constitute a challenge in identifying all those who might become vulnerable" (2020:1089). The editorial shows that considering being vulnerable in the time of COVID has to account for "people from a gradient of socioeconomic groups that might struggle to cope financially, mentally, or physically with the crisis" (The Lancet, 2020:1089). Vulnerability in COVID times can therefore not be understood as only a corporeal matter, but one that is certainly dependent on context and not limited only to aspects of health.

Due to the global outbreak of the novel coronavirus, ways of being vulnerable that may have become normalised in pre-COVID discourse are now magnified and perpetuated by vulnerability in relation to health at this time. At the same time, these preceding vulnerabilities exacerbate COVID as a health crisis in that the economic effects of the pandemic on the poor, and the social effects of the pandemic on the socially marginalised, have repercussions for access to health services and the national and global control of the spread of the virus. In a 2020 study, Mukumbang and colleagues discuss how COVID-19 aggravated preceding vulnerabilities in the lives of asylum seekers, refugees and undocumented migrants in South Africa, referring to this state of preceding vulnerability as "silent inequality" (Mukumbang et al., 2020:3). The findings of Mukumbang and colleagues are supported in a 2020 study by Kiaghadi and colleagues who confirm that beyond medical and socio-economic conditions, other factors like the exposure to environmental pollutants, exposure to areas contaminated with hazardous waste material, past exposure to harmful pathogens and pollutants due to natural disasters, and behavioural and lifestyle factors impact on the uneven distribution of vulnerability related to COVID (Kiaghadi et al., 2020:2). Kim and Bostwick (2020) come to a similar conclusion in their study on how COVID-19 has disproportionately affected poor, highly segregated African American communities in Chicago. What is highlighted in these studies about vulnerability around COVID is that the intersection of the novel coronavirus pandemic, as a health crisis, with socio-economic disparities and a range of preceding precarities trouble any easy distinction and definition of vulnerability in COVID times. Vulnerability in this context may perhaps best be understood as located in a complex network of these disparities and precarities, both made visible (preceding vulnerabilities) and made possible (vulnerability to COVID as a health threat) only in and through this complex non-linear network structure.

Data and data visualisation in relation to vulnerability

Butler's recent work (2020) covers precarity, the mourning of death, and the loss of life and its representation in graph and number format in the context of the COVID-19 pandemic (Butler, 2020). Butler makes these connections to interrogate how the socio-economic positions that relate to perceptions of someone's humanness, and the value of human lives lost to COVID, translate into data visualisation and eventual public reactions to death by means of such visualisations. For Butler (2020), preceding precarities and social inequalities are written into and may be accessed through both the representation of and the reaction to such data visualisations.

Gray (2020) studies data visualisation of statistics on war, death and violence, saying that an "emotional distance" (2020:315) seemingly works to establish a sense of objectivity in this kind of visual representation (Gray, 2020). This author shows that "'quantification is a technology of distance,' which aims to support objectivity by attempting to produce 'knowledge independent of the particular people who make it'" (Gray, 2020:315). Gray expands on this idea to highlight another way in which data visualisation is exclusionary, in the context of representing death at a clinical visual-numeric distance, writing that this kind of visual practice sets up a "misleading sense of immediacy" (Gray 2020:324) that "leads attention away from social, cultural, and political processes" involved in the making of such data visualisation (Gray, 2020:324). Butler refers to this kind of representation as the "sanitisation of death" (Butler, 2020), building on Mbembe's writing on necropolitics (Mbembe, 2003). It may be argued that data visualisations set up a false sense of immediacy, one that is fleeting and creates and perpetuates an aesthetic and transfixing distance between the audience and those whose deaths are represented in these visualisations. This means that the audience is removed from the lives now visually represented as deaths, and from the process of dying. It furthermore means that the audience is removed from the "social, cultural, and political processes" (Gray, 2020:324) involved in data visualisation too, and from the socio-economic and cultural conditions and necropolitical power exercised over those whose lives and deaths are represented in numbers and graphs.

Robertson and Travaglia (2020) apply Mbembe's necropolitics to COVID times and to vulnerability in this moment. They argue that "clearly some people are more at risk than others, clearly people who were vulnerable before are even more so now. Some of that vulnerability is a consequence not of their individual or social health categorisation ... but due to our prevailing necropolitics and unexamined positions in respect of those necropolitical arrangements" (Robertson & Travaglia, 2020). The place and potential of data and data visualisation in the perpetuation of vulnerability in the context of COVID-19 lie in their attempts at objectivity and the implications of clinical distance bound to this decontextualised representation. The visual field that is decontextualised and disembodied does not acknowledge the context or lived experience of vulnerability – this is lost through both the measuring of information and content as well as the aesthetic form of representation. The ensuing clinical distance smooths over experiences of the vulnerable, exercises necropolitical power even in this kind of representation of death, and risks the possibility that the lives behind the numbered and graphed deaths may not be grasped in their entirety.

THE STATS SA SOUTH AFRICA COVID-19 VULNERABILITY INDEX (SACVI)

This section reviews Stats SA's SA CVI dashboard, making reference to specific examples (see Figure 1, for instance). These examples do not necessarily represent the entire dashboard, but aim to clarify the format and function of this platform.
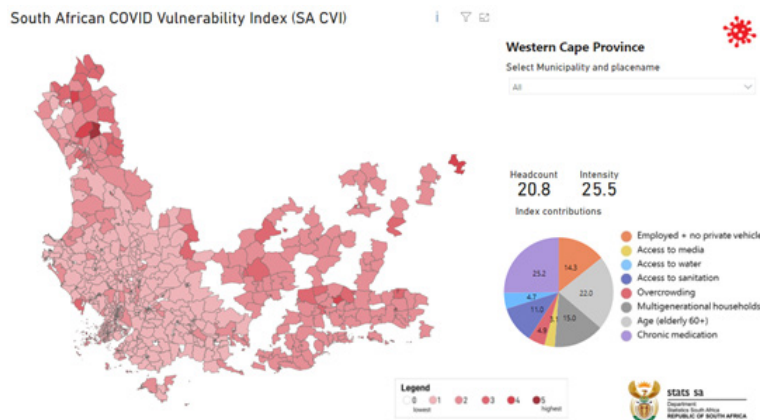

Figure 1: Stats SA, South African COVID-19 Vulnerability Index (SA CVI): Western Cape Province, 2020. [Online screenshot].

(Stats SA, 2020b).

South African COVID-19 Vulnerability Index (SA CVI): Index

The main page of Stats SA's outline of the SA CVI describes this index as measuring certain COVID-19 related risk factors by using a "natural counting approach to determine the headcount of vulnerable individuals within a population as well as measure their level of simultaneous vulnerability determining intensity" (Stats SA, 2020a) in relation to the novel coronavirus. The aim of the index is described as the identification of individuals and populations subjected to multiple risks in order to understand which regions and populations are potentially most vulnerable to the spread of COVID-19 (Stats SA, 2020a). Stats SA states: "'Vulnerability' in this context refers to the demographic and socioeconomic factors that affect the resilience of individuals and communities, and represent those more likely to be adversely affected when COVID-19 manifests itself" (Stats SA, 2020a). The examples listed as typically "vulnerable groups" are people who live in poverty or in "deprived conditions" (Stats SA, 2020a) that may impact on their hygiene and sanitation, people living in crowded conditions and informal settlements, impacting their ability to socially distance themselves from others, and people living in multigenerational households with extended families in a single dwelling (Stats SA, 2020a).

The SA CVI draws on eight indicators of risk to determine a composite marker of vulnerability to contracting COVID-19, and where regions of potentially highest risk are. Where no relevant data are available, proxy indicators are used – employment status and access to private vehicle transport are used as a proxy indicator for the likelihood of using public transport or car-pooling (risk of shared transport and standing in queues), and whether an individual uses chronic medication is used as a proxy indicator of health status. The eight indicators appear under four themes of vulnerability, and have equal weighting in determining the final index. The four themes (population, household services, household composition, and health), the rationales for using these specific eight risk indicators, and the cut-offs in determining their measure of vulnerability are summarised in Table 1.

Table 1: Eight risk indicators, rationales, and cut-offs of the South African COVID-19 Vulnerability Index (Stats SA, 2020c).

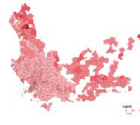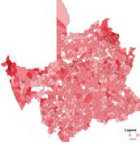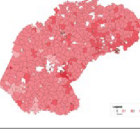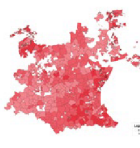| Themes of vulnerability	Risk indicator	Cut-off	Rationale
Population	Employment status and access to private vehicle transport (proxy).	If someone is employed *and* does not own a car.	Indicates a likelihood of using public transport or car-pooling to and from work.
	Access to media (television, cell phone, Internet, radio).	If someone does not own a television, radio, cell phone, or has no access to the Internet.	Indicates an unlikeliness of understanding the spread of COVID-19.
Household services	Access to running water (within 200 meters from dwelling).	If someone does not have access to piped water within the dwelling.	Indicates an unlikeliness of easy access to water for hygiene purposes.
	Access to sanitation (toilets within the dwelling).	If someone does not have access to toilet facilities in the dwelling.	Indicates a likelihood of using shared or public toilet facilities.
Household composition	Overcrowding (more than three people per room).	More than three persons per functional room in the dwelling.	Indicates a likelihood of sharing rooms – a health risk to others if one person is infected.
	Multigenerational households.	Children (0-15 years) and elderly (60+) people live together in a single household.	Indicates a likelihood of children as inadvertent carriers infecting others in the dwelling.
Health	Age (over 60 years).	If someone is 60 years and older.	Indicates a likelihood of population at risk of fatality if infected.
	Use of chronic medication (proxy).	If someone uses chronic medication.	Indicates a likelihood of individuals having co-morbidities.

Identifying the *vulnerable* in the index is done by means of the vulnerability cut-offs (see Table 1). These cut-offs represent the "proportion of minimum deprivation a person must experience in order to be identified as vulnerable" (Stats SA, 2020d: 4). Vulnerability is defined here as "the weighted sum of deprivations" (Stats SA, 2020d: 9). A composite index is derived from the eight risk indicators, after which the intensity of vulnerability is measured by determining the number of themes or risk indicators an individual is vulnerable to. In this instance, "intensity" is defined as "the average proportion of indicators in which multi-dimensionally vulnerable persons are deemed vulnerable" (Stats SA, 2020d: 9). The final Vulnerability Index (VIndex) score is computed as the intensity of vulnerability multiplied by headcount, where "headcount" is defined as "the proportion of persons that are considered to be multi-dimensionally vulnerable" (Stats SA, 2020d: 9). The VIndex score is ranked from 0 to 5, with 0 calculated as being the least vulnerable, and 5 the most (see Figure 1).

South African COVID-19 Vulnerability Index (SA CVI): Data visualisation

SA CVI uses an interactive dashboard, since "a static map product would not allow for effective data analysis at such a small spatial area of EA [enumeration area] or placename" (Stats SA, 2020d: 11). This choice was made for the optimal visualisation of the vulnerability index, headcount, intensity of vulnerability, and a breakdown of vulnerability by the eight risk indicators as previously discussed. The SA CVI launch page provides an overview of the function and aims of the index and its dashboard visualisation. There is an interactive map on the right-hand side of this page that serves as a link to the dashboard's broadest possible visualisation, vulnerability per province. When selecting a province, a new tab opens with the relevant breakdown and visualisation as selected – see Figure 1 for a screenshot of the Western Cape at a glance. This new tab provides a breakdown of the province map with EAs indicated as smallest geographical areas, coloured to correlate with the VIndex legend, at the bottom right to middle (0-5), which indicates overall vulnerability in reds of proportionally increasing shades of darkness, ranging from white to dark deep red. This dashboard view provides further options for visual information; these include being able to see vulnerability scores on municipal and EA level, the headcount and intensity measures (20.8 and 25.5 respectively for the Western Cape), and a pie chart visualising which of the eight risk indicators contribute most to the vulnerability visualised. The headcount indicates that for the area selected, 20.8% of people are vulnerable to some extent, and the intensity indicates that these individuals accounted for in the headcount are vulnerable in 25.5% of the eight risk indicators used to compile the index. In the Western Cape, chronic medication (25.2%) and age (22%) are the greatest risk contributors to vulnerability. These breakdowns on the right (headcount, intensity, and index contributions) are a constant feature on the dashboard, and their numbers change according to the area selected to always show the information relevant to the accompanying map.

Table 2 provides a summary of the headcount, intensity and top three index contributors and their percentages (from highest to lowest), as visualised per province. The table also provides a small indication of the mapping and colouring distribution of vulnerability per province. By implication, the lighter and closer to white an area is coloured, the less vulnerable the whole area is to the spread of COVID-19; the darker the red, the higher the area's overall average vulnerability to the disease. These vulnerabilities provide an at-a-glance perspective at provincial level, but can be zoomed in on the dashboard for a more close-up understanding at municipal and EA level.

Table 2: South African COVID-19 Vulnerability Index: Per province breakdown of the main parameters of the index (Stats SA, 2020b).

Province	Headcount (%)	Intensity (%)	Top 3 index contributors (%; highest to lowest)	Mapping and colouring
Western Cape	20.8	25.5	Chronic medication (25.2); Age (22); Multigenerational households (15).	
Northern Cape	33.0	26.4	Access to sanitation (20.8); Chronic medication (17.7); Multigenerational households (15.6).	
Eastern Cape	53.9	28.4	Access to sanitation (26.4); Access to water (17.2); Multigenerational households (16.8).	
Free State	26.4	25.9	Access to sanitation (19.6); Chronic medication (19.2); Multigenerational households (19).	
KwaZulu-Natal	41.2	27.5	Access to sanitation (23.4); Multigenerational households (18.3); Chronic medication (13.8).	
Mpumalanga	38.6	27	Access to sanitation (28.1); Multigenerational households (18.2); Employed + no private vehicle (12.6).	
Gauteng	16.6	25.4	Chronic medication (22.4); Age (20); Employed + no private vehicle (16.6).	
North West	40.8	27.6	Access to sanitation (26.4); Multigenerational households (16.5); Chronic medication (14.5).	
Limpopo	52.2	27.6	Access to sanitation (36.2); Multigenerational households (18.9); Access to water (15.2).	

DISCUSSION

The headcount and intensity scores of the SA CVI perhaps unintentionally create a distance, through statistical measuring as a "technology of distance" (Gray, 2020: 315), between the audience and the data visualised. However, it seems that the platform's pie chart and breakdown of scores by risk indicators help to provide a more holistic understanding of South Africa's vulnerability to COVID, the underlying contributors to this vulnerability, and how this vulnerability might be classified in relation to the theoretical typologies discussed earlier. Of the eight risk indicators that underpin the SA CVI, arguably only two, namely age and the chronic use of medication (as a proxy for health), coincide with what Lange, Rogers and Dodds categorise as "inherent vulnerability" (2013: 336). The other six indicators all fall outside the body of the individual, but constitute and are maintained by the body politic. As such, this source relates to what Lange, Rogers and Dodds refer to as "situational vulnerability" (2013: 336). It may be said that these six risk indicators do not constitute an "innocent" situational vulnerability, but perhaps one that rather coincides with what Lange, Rogers and Dodds call "pathogenic vulnerability" (2013: 336). This categorisation is a subtype of situational vulnerability, but one that arises from "dysfunctional social or personal relationships. These relationships are often characterized by prejudice, abuse, neglect or disrespect, or from political situations characterized by injustice, persecution or political violence" (Lange et al., 2013: 336).

Violence continues to plague South African communities – violence both subjective and objective (Žižek, 2008), including but not limited to prevailing xenophobia (prejudice), unequal access to service delivery and basic sanitation (neglect and disrespect), and the societal systems (systemic violence) and use of language (symbolic violence) that prop up and justify more subjective forms of violence – and all this is made *visible*, not *possible* (Butler, 2016), by the pandemic.

As previously discussed, a classification of vulnerability in COVID times cannot be thought of as a linear process and solution but has to be approached as a complex non-linear network of constituting factors. Furthermore, the states of *being vulnerable* need to be understood as both "occurrent (immediate and present) [and] dispositional (latent or background)" (Lange et al., 2013: 336) at the same time. These two states of vulnerability coincide during this time in a complex interrelationship for which uncomplicated descriptions will not suffice. This appears to be true of the South African instance as highlighted by the SA CVI. In South Africa, this complexity is heightened by traces of past discourse that constitute and exaggerate many of the dispositional factors that intensify occurrent vulnerabilities in the time of COVID. While the continuing effects of South Africa's colonial and apartheid pasts in terms of urban planning (Bickford-Smith, 1995; Houssay-Holzschuch and Teppo, 2009; Marks and Bezzoli, 2001; Nuttall and Mbembe, 2008), public commemoration (Coombes, 2003; Gurney, 2017; Guyot and Seethal, 2007; Marschall, 2009), and its education system (Akala, 2018; Jansen, 2019; Schmahmann, 2016), have been widely documented, the COVID-19 pandemic highlights these effects in relation to health. This is true not merely of the individual body, as a straightforward understanding of COVID as health crisis would signify, but more in relation to the body politic and a connotative reading of its health not as medical, biological or epidemiological, but rather systemic, socio-economic and necropolitical (Mbembe, 2003).

In Table 2 it is seen that the combination of chronic medication (as a proxy for health) and age constitute the highest contributing pair of risk indicators towards vulnerability only in the Western Cape and in Gauteng. These two provinces are densely populated – see the red zones in Figure 2, Map 1, based on 2011 census data – but other risk factors are outweighed by the only two tied to corporeal vulnerability. While the other provinces in the country are subjected to conditions resulting in mostly situational and pathogenic vulnerabilities, both dispositional and occurrent, residents of the Western Cape and Gauteng have the "privilege" of being vulnerable mostly because of an occurrent and essential human bodily condition, making them subjects of, not subject to, vulnerability. According to 2020 economic statistics, Johannesburg (capital of Gauteng) and Cape Town (capital of Western Cape) are the two richest cities in South Africa, at total wealth of $209bn and $112bn respectively (Business Tech, 2020). The economic conditions of these two provinces and urban areas are read in and through the SA CVI data visualisations and impact on the distribution and type of vulnerability in these provinces.
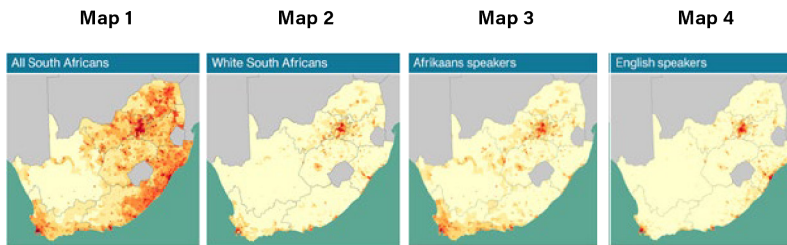
| Map 1 | Map 2 | Map 3 | Map 4 |

Figure 2: South Africa Gateway, Distribution of South Africa's population: All South Africans; White South Africans; Afrikaans; English, 2019. [Online screenshot - composite].

(Alexander, 2019)

Braidotti (2020) states that the normative understanding of *the human* prevailing since modernity in western discourse, including South African apartheid ideology, has been characterised as "masculine, white, Eurocentric, practicing compulsory heterosexuality and reproduction, able-bodied, urbanized, speaking a standard language" (Braidotti, 2020: 466). While some of these characteristics cannot be read in the above maps and their overlap with the SA CVI, there is an intersection regarding the distribution of the race (Figure 2, Map 2), the language (Figure 2, Maps 3 and 4) and the urbanity of individuals in privileged socio-economic milieus. This overlap allows for a connotative reading of the privileged position, in terms of race and socio-economic status, that inherent vulnerability (health and age), in a mostly occurrent state, comes to signify in COVID times. This connotative reading highlights that the peoples and populations historically marginalised in South Africa by definitions of *the human*, that coincide with Braidotti's description, are the communities most vulnerable to COVID-19, especially as a consequence of poor sanitation and a lack of access to basic running water – conditions that Lange, Rogers and Dodds (2013) refer to as "dysfunctional" on social or personal levels (2013: 336).

Furthermore, drawing on Table 2, the visualisations and the statistics per province perhaps give a skewed perspective on the intensity of vulnerability and the headcount at risk on municipal and EA levels. There are areas with a headcount of a 100 – for instance, Utrecht (EA 52510022) in the Amajuba municipality in KwaZulu-Natal has a headcount of 100% and an intensity measure of 43.8%. The division of risk indicator contributions in this EA are equally shared by access to sanitation, access to water and multigenerational households (28.6%). These details get lost in the focus on provincial level and are visually absorbed by patches of white or lighter shades of red – see the screenshots included in Table 2. If red functions as a signifier of danger and vulnerability in this context, with a high level of vulnerability signified by dark red, an understanding of vulnerability in this regard may also be absorbed and visually discouraged. In provinces like the Northern Cape and the Free State, the red patches (across all shades) are more equally distributed in the visual mapping. This is in contrast to provinces like the Eastern Cape, KwaZulu-Natal and Limpopo that visually read as discontinuous, perhaps extending this quality to the viewer's understanding of vulnerability in the area too. When making connections between visualisation and cognition, it may be argued that this visual absorption of dark red minimises the visual impact of the much more intensely vulnerable EAs that are visually overshadowed by discontinuity in the mapping at provincial level. A visual effect of this discontinuous provincial mapping may both facilitate and explain a misunderstanding of vulnerability as discontinuous, especially when the risk factors involved do not form part of the viewer's immediate experiences and surroundings in COVID times.

The SA CVI positions itself as providing government officials, policy makers and science communicators with datasets to assist in interventions and communication efforts in the fight against COVID-19 (Stats SA, 2020a; Stats SA, 2020d). This platform defines vulnerability as layered and impacted on by a variety of factors and influences. This results in a seemingly stable denotative meaning of the dashboard and its "objective", evidence-based, and "factual" representations of vulnerability in the time of COVID-19 in order to assist measures to control the spread of the disease. The stability of this denotative reading is disrupted when considering whose interests are served in this positioning, whose interests are negated,

and exploring the possible consequences of this positioning.

In South Africa, only 37% of the population has access to the internet through either a mobile phone or a computer, and "North West and Limpopo have the lowest access to internet at home, at 3.6% and 1.6% respectively" (Hanekom, 2020). When considering the intersections of vulnerability, as seen on the SA CVI, with access to smartphones and mobile internet services, it may be argued that these representations can predominantly not be accessed by those vulnerable to the pandemic (Alsop, 2021; GSMA, 2020). Instead, the platform and its representations are accessible to those already in positions of socio-economic privilege, as signified by access to a smartphone or computer and internet services to view these platforms. Furthermore, the platform is accessible to those with privileged cultural capital (Bourdieu, 2018) that data literacy and data visual literacy signify (D'Ignazio & Bhargava, 2020), and those in positions of political power that have the "right to kill, to allow to live, or to expose to death" (Mbembe, 2003: 12). By implication, the interests of those in already precarious positions, outside of power and privileges, are negated. Instead, they are subjected to representations that deny them agency, and dehumanise them through the capacity of data to create "emotional distance" (Gray, 2020: 315) between the audience of data visualisations and the actual lives and conditions of those visualised.

Powell (2020) writes that "while consuming this [COVID-19-related] data and its messages, we have been distracted from how management, control and prediction through data consolidate power in ways that exacerbate inequality" (Powell, 2020). While this inequality may precede "data and its messages", data serve to enhance the function of power in ways that respond to Foucault's writing on power, knowledge and discourse (1980). One of the dangers when interacting with data science-related texts such as these is to disregard these texts as products of and vehicles for broader power structures, and instead interact with them as objective and transparent artefacts that represent (scientific) truth. These kinds of interactions with and interpretations of data visualisations entrench beliefs that these visualisations are able to show facts in a straightforward way. This study on the visualisation of vulnerability on the SA CVI platform shows that these kinds of assumptions are naïve and disregard the layers of possible meaning and implication that a simple focus on the surface of a data visualisations ignores.

Powell (2020) discusses the emergence of a "mediated folk epistemology" promoted by data visualisations around COVID-19, especially the well-known image and metaphor of the curve that needed to be flattened during this time. While this kind of visual representation provided publics around the world with a way to grasp and make sense of an infection of unprecedented reach and proportions, this image of the curve came to signify the disease itself, instead, flattening the complexities of the pandemic and drawing attention away from other information and vital aspects by means through which to understand the pandemic. The visualisations on the SA CVI platform, although more varied and complex than a mere curve, are also in danger of creating this socio-visual effect. A visual field that is disembodied, decontextualised and overly simplified does not acknowledge the context or lived experience of vulnerability. The lived realities behind vulnerability in this context are compromised by means of both the measuring of information and content, and the aesthetic form of representation. The sense of clinical distance that is seemingly written into and implied by the SA CVI platform arguably smooths over experiences of *the vulnerable* in that it continues to allow for necropolitical power to be exercised over the already precarious, and furthermore risks the possibility that the lives rendered vulnerable behind the numbered and graphed deaths may not be grasped in their entirety.

CONCLUSIONS

This paper explored definitions of vulnerability in a South African context during the time of COVID-19. These definitions of vulnerability were accessed through the indices and data visualisations of the South African COVID-19 Vulnerability Index (SA CVI). This paper found that data and their visualisations, functioning like a language *and* consequently as a social practice, have palimpsestic links to their surrounding historical and ideological contexts. Furthermore, the previous section showed that both past and present social relations may be read and accessed via the SA CVI platform.

Two main conclusions may be drawn from this work. First, while the novel coronavirus pandemic is

widely perceived as a health crisis, this study showed that South African vulnerability to this pandemic is mostly constituted by risk factors that fall outside the realm and consequences of normative health, but pertain to socio-economic conditions that have been exposed by COVID but not generated by this disease. Second, this paper illustrated that the predominant state of vulnerability in this time is not necessarily occurrent (immediate) but dispositional (latent), and affected by risks that are enabled by discursive traces from South Africa's colonial and apartheid histories that continue to disrupt the present. As a result, the focus of the SA CVI, as located in COVID-19 as a health crisis, is complicated, since as this paper showed, this pandemic is not to be straightforwardly understood as a matter of purely medical, biological and epidemiological health, but one in which health is defined as systemic, socio-economic, and necropolitical.

This paper has three main limitations. The first is the limitation imposed by the theoretical frameworks used to discuss the platform. An understanding of sources and states of vulnerability applied in the discussion was predominantly based on two main sources (Lange et al., 2013; Mackenzie et al., 2014); had other typologies and sources been used, other implications and results may have been formulated. The second limitation pertains to the paper's focus on one platform only. Accessing a greater variety of data visualisation platforms that indicate South African and global communities' vulnerability to COVID may provide more nuanced results. The third limitation extends to the aspects of vulnerability as accessed through the SA CVI platform – discussing this platform in relation to other aspects may broaden an understanding of its function as more complex than the current study accounts for. Future research can use this paper as a foundation on which to elaborate other typologies and experiences of vulnerability in the time of COVID-19, as well as extend the discussion to be applied to multiple platforms and consider further aspects than those reported on in this paper.

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