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Making Informal Settlements 'Visible' Through Datafication: *A Case Study of Quarry Road West Informal Settlement, Durban, South Africa*

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2019

Abstract

Can datafication increase the 'visibility' of informal settlements in South Africa, in the context of a national and local state that holds both progressive and repressive approaches towards informal settlements? This case study explores a datafication process that has been in place for five years in an informal settlement in Durban, which has been established through an inclusionary, participatory data collection and production process.

It examines how and when the data moves in the information value chain, and the implications this movement has for achieving rights-based, instrumental, structural and distributive justice. It argues that procedural and rights-based justice can be achieved to a certain extent through the construction of an inclusionary datafication process. However, instrumental, structural and distributive justice is dependent on how the interventionist and developmental state of South Africa engages with the data, and whether it takes it up in a meaningful way, thus enabling it to lead to fundamental shifts in discourses, approaches and practices towards informality.

The results reveal that the 'governance and knowledge platforms' that are built through the datafication process are more important and powerful at first, than the actual data itself. However, informal settlers and other data intermediaries, who have learnt how to engage data to secure the 'right of informal settlers to the city', have begun to use the data in interesting ways, acting as champions, and re-shaping citizens' relations with the state. While this does not secure tangible changes in informal settlements, it begins to shift discourses and power relations, which is critical to informal settlement upgrading.

A. Introduction

This case study focuses on the role that urban datafication, including participatory mapping, is playing in building social and environmental justice in Quarry Road West informal settlement, Durban, South Africa. Quarry Road West informal settlement, which comprises approximately 1083 households, is located on the Palmiet River, in the urban core of Durban (see Figure 1). Researchers from the School of Built Environment and Development Studies, University of KwaZulu-Natal (UKZN), Durban, and 'mapmakers' from Quarry Road West informal settlement have established a five year partnership within the Palmiet Catchment Rehabilitation Project (PCRP) as part of an action research project, to improve quality of life in the settlement. The PCRP is a pilot project of the uMngeni Ecological Infrastructure Partnership (UEIP), which focuses on improving water security in the uMngeni Catchment using ecological infrastructure (Sutherland & Roberts 2014). The researchers and mapmakers are co-constructing a range of data and maps at the local scale, producing knowledge on the settlement and its governance. This datafication of the settlement has the goal of improving the living environment of residents through informal settlement upgrading, supporting social learning, river rehabilitation, climate adaptation, and the building of resilience (Martel & Sutherland 2019; Mazeka et al 2019; Sim et al 2019; Vogel et al 2016; Williams et al 2019).

The university researchers and mapmakers continually reflect on 'if, how and why' this data contributes to, and shapes, the well-being, resilience and development of the community and whether it has helped to build state-citizen relations, which have emerged as being critical to 'good' urban governance in Durban (Martel & Sutherland 2019; Mazeka et al 2019). Has this long-term, participatory and time-consuming data production process supported the transformation of the community and addressed development deficits in any way? Has it shaped city decision making with respect to the relocation or upgrading of the settlement and service provision within it? And has it contributed to shifting broader city discourses around the 'rights' and 'place' of informal settlers in the city? The case study therefore reflects on whether 'data justice for development' is emerging through the Quarry Road West datafication project, and if so, whose interests does it serve. It identifies the levers of change in the datafication project, which have led to development outcomes. It also reflects on the barriers and structural constraints in achieving a higher level of data justice. Heeks & Shekhar's (2019) model of data justice is used as a framework to assess data justice in the Durban case study. This model is expanded to include governance and 'critical moments' as additional elements of data justice, based on evidence from the Quarry Road West informal settlement datafication project.

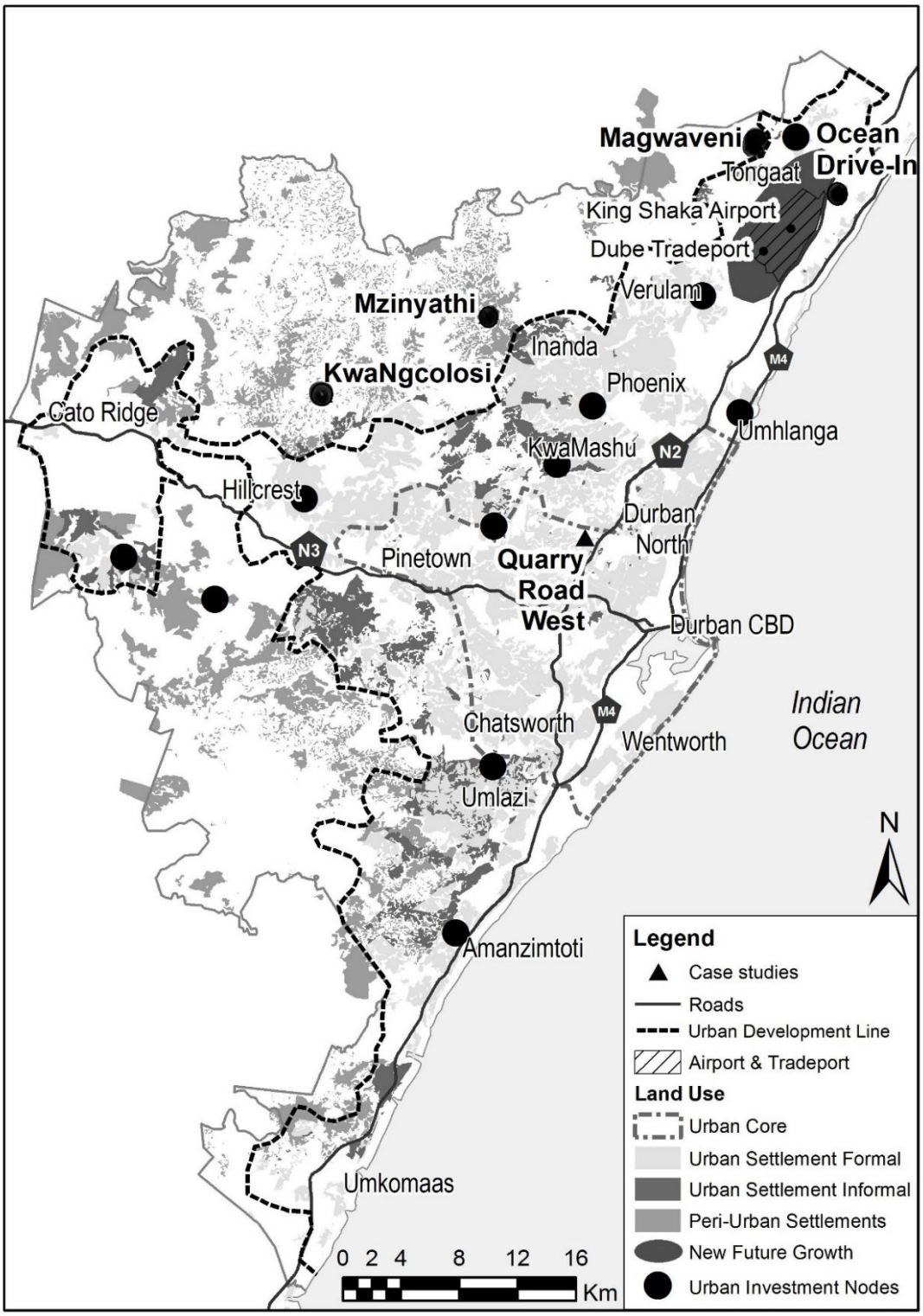


Figure 1: The location of Quarry Road West informal settlement within the urban core of Durban (eThekwini Municipality) (map produced by Eduaction in 2019)

The case study provides a critical reflection on the form and level of data justice achieved through the participatory methodologies that have been employed in the settlement to date. It explores the way in which the data has been produced and travelled between the community, the university and the municipality, in most instances through 'bridges' or 'data

intermediaries' (Heeks & Shekhar 2019), informing community adaptations, as well as municipal responses. The case study therefore explores:

- how the process of co-constructing and producing data is leading to greater social and environmental justice (procedural justice);
- if and how the data has been used to improve quality of life in the informal community and if it has shaped municipal decisions and responses to informal housing (instrumental justice);
- the power relations produced both by the data production process and the data collected, with an emphasis on the role of bridges or data intermediaries (structural data justice);
- to what extent making the settlement more 'visible' has shifted discourses about informal housing in the city, particularly in terms of informal settlers' 'rights to the city' (rights-based justice);
- who has benefited and who has lost through the datafication process (distributive justice).

Given that relatively few analyses of real-world initiatives of data justice for development have been undertaken (Heeks & Shekhar 2019), this case study makes a contribution by both providing an empirical case of emerging data justice in an African city, and by expanding Heeks & Shekhar's (2019) model to include two other elements that shape data justice in cities in the South, namely governance and 'critical moments'. It has also broadened the understanding of rights-based justice in the model.

B. Background

B1. Datafication for Development

Development depends on data or information for decision making (Heeks & Shekhar 2019; Milan & Treré 2017; UN-Habitat 2017). However, the production of, and control over data used for development has predominantly been in the hands of scientists and experts, who have provided data to the state and non-state actors for decision making through administrative rationalism (Dryzek 2012). According to Dryzek (2012:75) "administrative rationalism emphasizes the role of the expert rather than the citizen or producer/consumer in social problem solving, and stresses social relationships of hierarchy rather than equality or competition". However, data is now making its way into decision making through multiple actors and multiple pathways. This is a result of the democratisation of decision making through the shift from government to governance, the development of the network society (Castells 2000; Hajer & Wagenaar 2003), and the growing volume, velocity, variety and visibility of data, as a result of the digital technologies of the 21st century (Heeks 2018). This is leading to the 'datafication of development', which is the growing presence, use and impact of data in social processes, leading to opportunities for increased developmental impact through new forms of data streams being produced, shared and translated at different scales (Heeks & Shekhar 2019; Mazeka et al 2019; Spratt & Baker 2015; Taylor & Broeders 2015). The production, sharing and use of data is particularly important for the urban poor, who to date have been largely excluded from data production processes in

cities in the South, due to their perceived and constructed illegibility, informality and lack of power.

In focusing on the power of datafication in supporting development, it is critical to differentiate between big data, digital data and 'local' or community-produced data. Taylor (2017) argues that datafication tends to focus on digital data or the data people emit through the technologies that citizens, the private sector and the state employ to both participate in and be accountable to society. However, what happens to development, if the data emitted by people does not focus on or address the challenges of urban poverty, marginalisation, and informality in the city? Large numbers of the urban poor do not emit digital data on a regular basis. For example, the contribution of informal settlers to state coffers through payment for rates and services is often limited or non-existent, as their presence in the city is seldom digitally recorded, and they do not pay for services through formal administrative systems, as services in informal settlements are often free or illegally obtained. The urban poor are connected to digital systems of data collection through smart phone technology and the use of the internet, but this is often intermittent due to the cost of, and hence their lack of access to, data. As Milan & Treré suggest (2017: 3019), "the underprivileged, the silenced, the subaltern, and the "have nots," whose presence outdoes geographical boundaries, often remain in the blind spot" and hence they remain invisible.

At the same time, datafication has provided institutions and corporations, whose interest it is to manage and govern people, with new 'technologies of rule' and hence power (Li 2007). This can lead to development when undertaken in a socially transformative manner, but it can also produce greater inequality and marginalisation in spaces where human rights are most fragile (Heeks & Shekhar 2019; Milan & Treré 2017). Taylor & Broeders (2015) argue that big data and its processes of informational capitalism serves the interest of the elite or those in power, rather than securing socially-just development interventions. This leads to a geography of disempowerment as datafication recognises, makes visible and benefits some, while excluding and making others invisible and illegal, as they attempt to claim their 'right to the city' from the 'bottom of the data pyramid' (Arora 2016; McQuillan 2015). Does datafication support individuals and communities with different histories and geographies including diverse racial, class, legal and socio-cultural conditions? Or does it reproduce these inequalities?

A point of departure in responding to these questions is to reflect of who is doing the collecting of the data, for what purpose and how. The advent of digital technologies has increased the production of data on cities, as new forms and streams of data in decision making have emerged and are impacting on urban development particularly through the discourses and practices of the 'smart cities' agenda (Heeks 2018). Cities are now being mapped using remote sensing, sensors that record environmental data, and by tracking mobile phone use, which generates new patterns of life in the city (Lokanathan et al 2016; Willis 2017). In all these cases, technology is producing the data to support decision making for development with experts controlling both the production and use of data. Datafication therefore has the potential to support development through increased knowledge and understanding of citizens' needs and everyday lived worlds; through ensuring efficiency in decision making; and in supporting evidence-based and more transparent development (Samarajiva et al 2015; van Veenstra et al 2014).

However, there is a growing body of literature which critically reflects on the datafication of the city, arguing that the way in which data is collected is not fair or equal; that the use of data does not always achieve just outcomes and that some benefit more than others from this process (Baud 2016; Milan & Treré 2017; Taylor & Richter 2015). This has led to the call for pro-equity data initiatives (PEDIs), where new forms of data sets and data flows are being created to draw the poor and marginalised into the decision-making processes of the city through open data and community-based mapping (Chakraborty et al 2015; Heeks & Shekhar 2019; Willis 2017). This approach is supported by a well-established body of knowledge on the value and practices of participatory community-based mapping; an important tool in participatory research which emerged in the 1960s (Brown & Kyttä 2014; Chambers 2006; Elwood 2006; Mazeka et al 2019; Rambaldi et al 2006). According to Rambaldi et al (2006), community-based maps act as vehicles for (spatial) learning, discussion, information exchange, analysis, decision making and advocacy and they facilitate communication between insiders (the community) and outsiders (researchers, government officials). The mapping process also has the potential to transform power relations as a result of the empowerment that takes place when communities are engaged in the mapping of their settlements (Lydon 2003; Mazeka et al 2019; Piccolella 2013).

Community-based mapping has been supported through the dissemination of spatial information technologies such as global positioning systems (GPS), (open source) geographic information systems (GIS) and open access to spatial data through the internet (Chambers 2006). This has opened up a new range of possibilities for 'participatory GIS', through which local community members record attributes of their community relevant to them in locally-scaled maps (Gaillard et al 2013; Mazeka et al 2019). Participatory community-based data collection and mapping produces different forms of data and data streams to those produced through digital technologies, as the data collected is 'localised' and 'embedded' and is produced through collaborative processes that draw on local knowledge and experience. This data can be digitised through the use of GPS and GIS, leading to its inclusion in digital data analysis.

This case study explores the datafication of an informal settlement in Durban through participatory data practices, produced through a community-university partnership, which is attempting to enhance data justice for development. It therefore aims to address the call to analyse real-world data production initiatives in the global South, to reflect on how new data streams and datafication are influencing and shaping development at the local scale (Heeks & Shekhar 2019; Sengupta et al 2017; Spratt & Baker 2015; Taylor & Broeders 2015). Evaluative frameworks are required to determine to what extent data initiatives for the urban poor in cities in the South are leading to greater social justice and transformation (Heeks & Shekhar 2019). Heeks & Shekhar's (2019) model for data justice for development is employed to critically analyse the datafication process which is emerging in Quarry Road West informal settlement in Durban.

B2. A Framework to Assess Data Justice for Development

Heeks & Shekhar (2019) have developed a model, or applied data justice framework, which explores five dimensions of data justice (see Figure 2). In developing their model and drawing on the data justice literature, they have highlighted three critical elements of data

justice. First, it must be critical and must support procedural, instrumental and rights-based justice. Second, the way data is produced, flows and is used, determines its transformative potential far more than the technology used to produce, process and display it. Third, the socio-political context within which the 'data assemblage' is produced, including the discourses, institutions, social relations and material resources of that context, will shape data-related outcomes (Heeks & Shekhar 2019). The case study presented here reflects the importance of these three elements of data justice.

Heeks & Shekhar's (2019) model of the data system for datafication focuses on the different forms of justice that emerge out of and support the information value chain, which reflect the steps through which data is transformed into development outcomes.

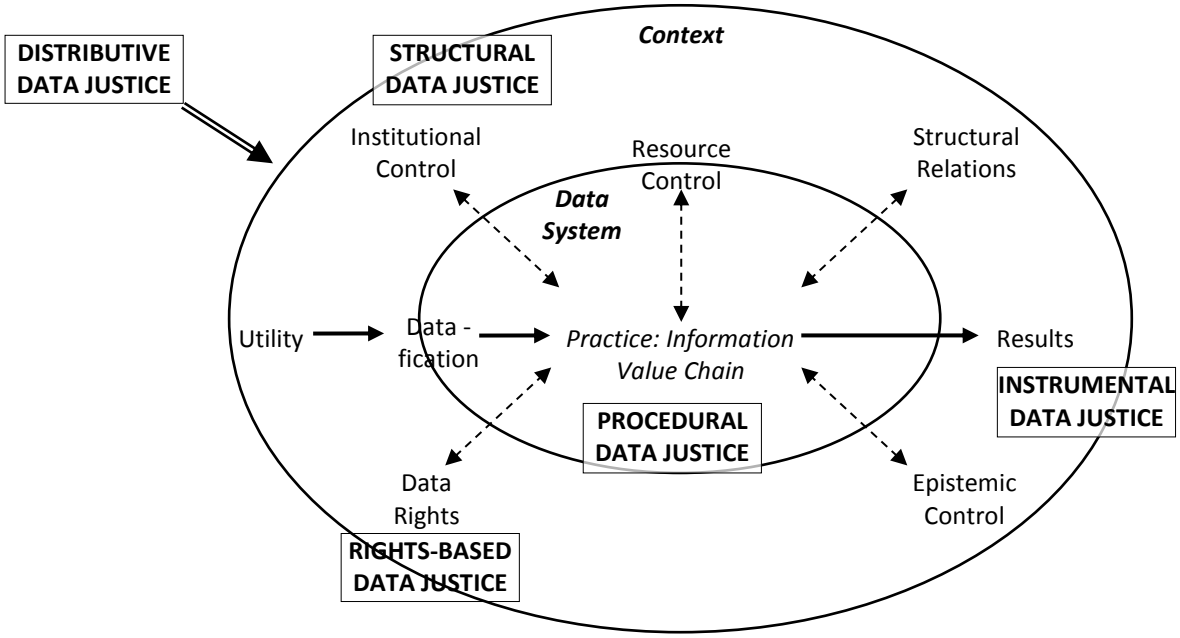


Figure 2: Heeks & Shekhar (2019) conceptual model of data justice

The five dimensions of data justice as defined by Heeks & Shekhar (2019: 995) are:

- "Procedural justice: fairness in the way in which data is handled.
- Instrumental justice: fairness in the results [*or outcomes*] of data being used.
- Rights-based justice: adherence to basic data rights such as representation, privacy, access and ownership.
- Structural justice: the degree to which the interests and power in wider society support fair outcomes in other forms of data justice.
- Distributive justice: an overarching dimension relating to the (in)equality of data-related outcomes that can be applied to each of the other dimensions of data justice."

The information value chain, which is shaped by and which shapes the five dimensions of data justice and the particular socio-economic and political context within which it is produced, comprises of three steps: upstream steps of data capture or collection; mid-stream steps of data processing and visualisation; and downstream steps of data use in decision making. This is shown in Figure 3.

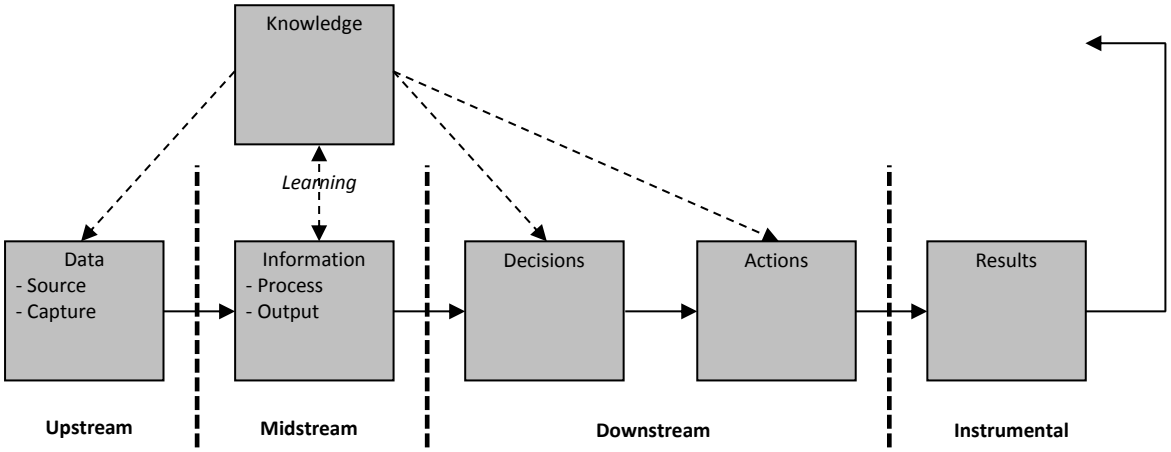


Figure 3: The information value chain (Heeks & Shekhar 2019)

This case study will use the information value chain and data justice model – developed by Heeks (2017) and applied by Heeks & Shekhar (2019) to four PEDIs in the developing world – as an analytical framework to reflect on datafication and data justice in an informal settlement in Durban, South Africa. It will expand on a number of elements included in the model, as a result of the analysis of datafication undertaken in Quarry Road West informal settlement. Context is considered critical to data justice analysis and hence the final part of the background section reflects on informality and informal settlements in the global South; particularly in South Africa.

B3. Informality and Datafication in Cities in the South

Informality is a way of life both globally and in Durban, with just over 25% of the global population and 27% of Durban residents living in informal settlements (eThekwini Municipality 2017; UN-Habitat 2018). Poverty, the rapid pace of urbanisation, a lack of affordable housing, the decompression of existing crowded urban settlements, migration, a decrease in urban household size, natural population increase and environmental risk are contributing to the growth in both the number and size of informal settlements (Braathen et al 2016; eThekwini Municipality 2017; UN-Habitat 2018). Formal planning processes, financial and social resources and state capacity are not able to keep pace with housing demand in Southern cities, leading to significant housing and service backlogs. As a result, the urban poor illegally invade land and develop informal settlements, which reflect their efforts at securing their 'right to the city' (Lefebvre 1968). Informal settlers typically have no security of tenure, only somewhat rarely being granted tenure by the state in progressive cities and countries that recognise informal housing as part of urban life (e.g. some locations in India, Brazil and South Africa); they lack access to basic infrastructure and services; they have poor standards of housing that usually do not comply with planning and building regulations; and they live on marginal or environmentally hazardous sites (Braathen et al 2016; Davis 2006; UN-Habitat 2018).

National and city governments in the global South adopt a wide range of responses to informal settlements including repressive approaches, where evictions and forced relocations are common; ambivalence, where informal settlers inhabit the city with little

support from the state; to progressive approaches, where informal settlements are considered to be part of the solution to housing the urban poor, with national and local governments planning and implementing upgrading programmes (Braathen et al 2016; Dupont 2013; Huchzermeyer 2011; Satterthwaite et al 2018; Sutherland et al 2016).

Understanding the discourses that national and city authorities and informal settlers adopt towards informal housing is therefore critical in reflecting on their place and future in the city. Knowledge and hence data about informal settlements plays a critical role in framing the discourses associated with informal settlements and shapes the way in which they are governed (Huchzermeyer 2011; Jordhus-Lier et al 2016). City authorities in the global South struggle to address the multiple challenges associated with informal settlements, which are distributed across the urban landscape, with their different characteristics, which emerge from their varied contexts. Human settlement or housing departments in local governments therefore tend to focus on informal settlements across the city, collecting data on the number, location and boundaries of informal settlements. However, they often have limited knowledge on their internal configuration: their history; age; political organisation and social capital; and the number and composition of individual households. This is reflected for example, in the significant variation in data on the number and percentage of informal households in Kisumu in Kenya (Karanja 2010) and in six cities in India, Peru, Brazil and South Africa (Dupont et al 2016). For example, in Durban the percentage of informal households varies from 12 percent to 31 percent depending on which state authority is doing the counting (Sutherland 2016). Given their scale, informality, dynamic nature and complexity, most informal settlements are therefore only 'known' or 'mapped' at the settlement scale by local governments in cities, which renders the 'human-ness', 'organisation' and 'resilience' of life in an informal settlement invisible to the state (Karanja 2010; Mazeka et al 2019; Sim et al 2019).

In South Africa, city authorities have lacked the political will, capacity and resources to collect detailed data on individual households in informal settlements. Some officials argue that given that informal settlements are so dynamic, it is not useful to map or collect data on settlements at the household scale, as they grow and change at such a rapid rate (Human Settlements Official pers comm 04/07/2017). South African municipalities record data on individual households in informal settlements through informal residents registering their informal house with their local government Human Settlements Unit, thereby obtaining a housing number, which protects their right to be there and which will be used to allocate them a formal state-subsidised house, should relocation take place (see Figure 4).

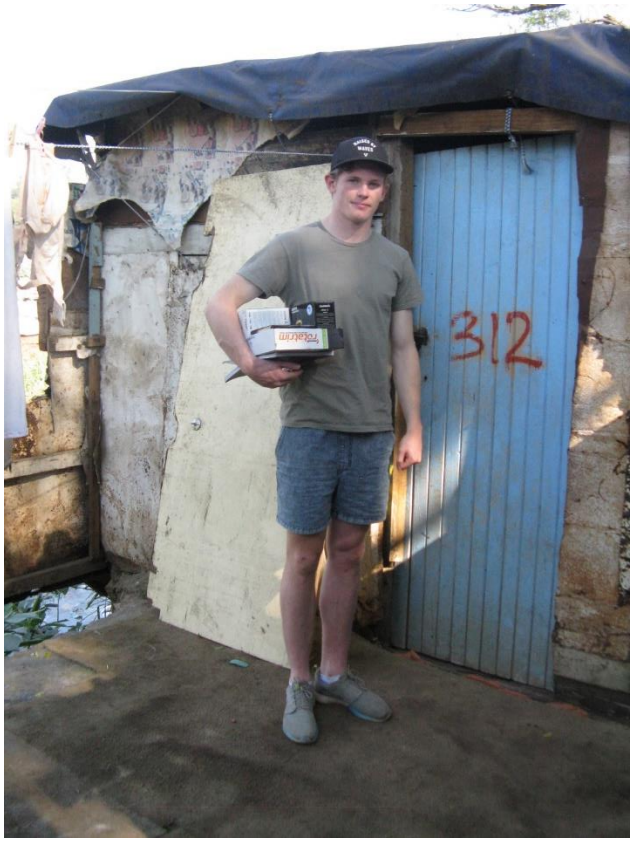


Figure 4: Housing number in Quarry Road West informal settlement registered with the Human Settlements Unit (Source: C. Sutherland 06/07/2017)

However, this data is not regularly updated which leads to outdated data being held by the city on the size and composition of informal settlements (Mazeka et al 2019). Durban, as part of the implementation of the city's Resilience Strategy, is currently conducting an enumeration exercise in its informal settlements in an attempt to obtain more accurate data on its 556 informal settlements and 226,000 informal households (eThekwini Municipality 2017).

eThekwini Municipality has always had a relatively progressive approach to informal housing, which is reflected in, for example, its incremental service provision programme, where the local state provides basic services, including communal water points, communal ablution blocks and electricity, to informal settlements which are not due to be relocated in the near future. Efforts around informal settlement upgrading have recently been intensified through the iQhaza Lethu Partnership Project, which is a partnership between Project Preparation Trust (PPT), Slum/Shack Dwellers International and the Human Settlements Unit of eThekwini Municipality. This applied partnership project is funded by the European Union (2018 to 2020). iQhaza Lethu aims to create a cohesive and collaborative effort towards upgrading of informal settlements, drawing on the knowledge and expertise of the municipality, NGOs, researchers and communities. Settlements selected as pilot studies will become sites of innovation and experimentation in informal settlement upgrading (eThekwini Municipality & PPT 2018).

Datafication of development can play a role in achieving social and environmental transformation. However, it can also produce greater inequality and social injustice due to

the power embedded in data processes: collection, production and use of data. Informal settlements represent the most unequal, precarious and vulnerable sites of human habitation or 'a place to put your head' (Quarry Road West Mapmaker pers comm 14/08/2019), in cities in the South. They are also largely excluded from urban datafication processes. For data justice for development to be achieved where it matters the most, greater research and empirical testing of the datafication of informal settlements is required.

C. Methods

Quarry Road West informal settlement is a precarious settlement, as it is located on the narrow floodplain of the Palmiet River adjacent to a major freeway and secondary roads (Figures 5 and 6). The settlement is characterised by its poor living conditions, high levels of poverty, its lack of basic services and poor housing, and its vulnerability to multiple environmental and social risks, including flooding, poor drainage, illegal electricity, fire, disease and crime (Mazeka et al 2019; Williams et al 2019).

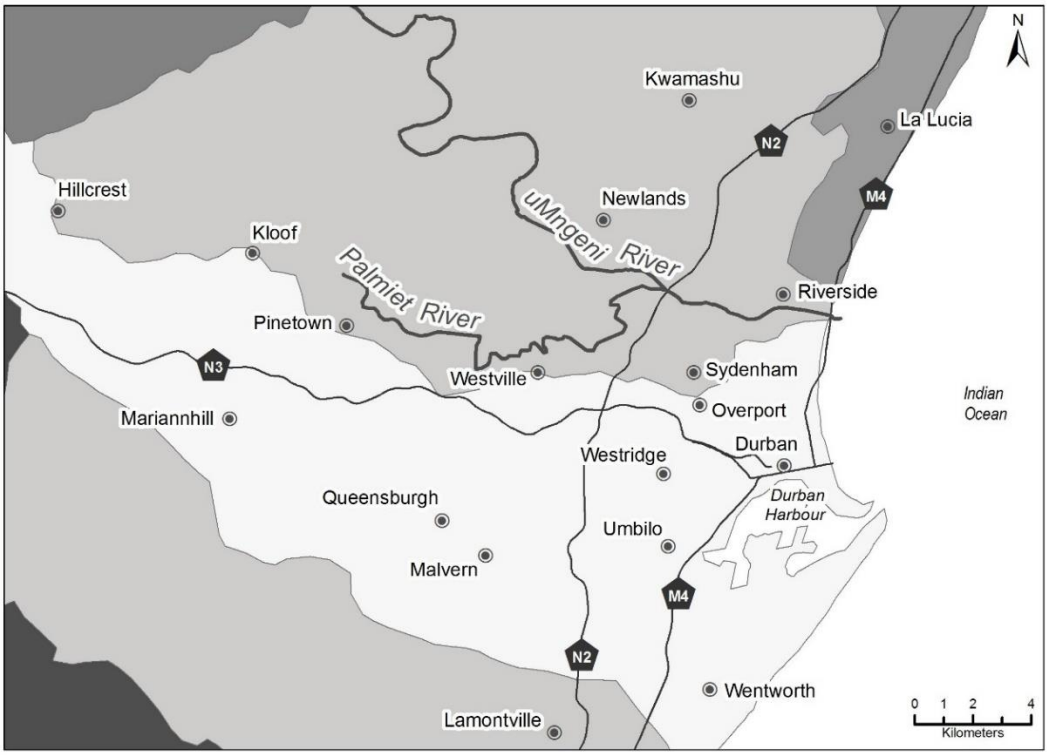


Figure 5: The location of the Palmiet River and Palmiet Catchment in the uMngeni Catchment (map produced by Eduaction in 2016)

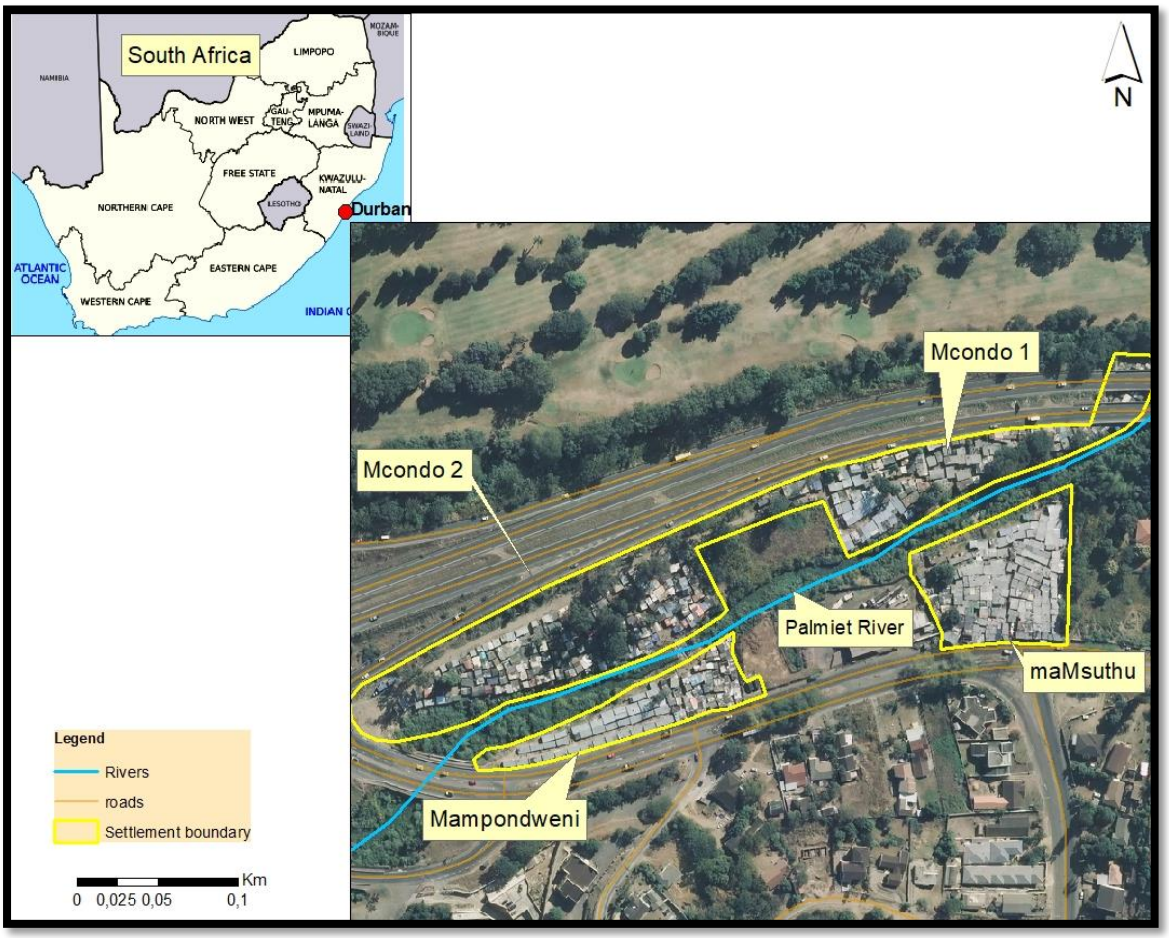


Figure 6: The location of the Quarry Road West informal settlement and its four sub-sections Mcondo 1, Mcondo 2, maMpondweni and maMsuthu, on the Palmiet River (Source: Mazeka et al 2019)

Quarry Road West informal settlement is categorised as a 'deferred relocation' by the Human Settlements Unit, due the lack of availability of state-subsidised low cost housing in the city. It is located on a high risk site, the narrow floodplain of the Palmiet River, which is prone to flooding after storm events (Williams et al 2019). It will therefore be challenging to upgrade the settlement in-situ. The settlement is well established, it has been in existence for over 32 years and it is not likely that it will be moved in its entirety in the near future, due to the large housing backlogs and slower delivery of formal low cost housing in the city, as well as the resistance of the community to move to state-subsidised housing on the periphery of the city. Under the iQhaza Lethu project, the municipality is considering innovative approaches to addressing the environmental risk of the site, to determine if in-situ upgrading is possible, given the broad socio-economic benefits the location of the site offers its residents (Mazeka et al 2019; Sim et al 2019).

The datafication project in Quarry Road West informal settlement forms part of the Palmiet Catchment Rehabilitation Project. When the PCRP was established in 2014, the UKZN researchers argued, in their initial meetings with the eThekwini Water and Sanitation Unit (EWS) from eThekwini Municipality, that it was critical to co-produce knowledge on the catchment with community-based organisations using participatory approaches, if resilient and sustainable water and climate governance was to be built (Vogel et al 2016). From the

outset of the project, the UKZN researchers set about building relations and constructing knowledge with the community of Quarry Road West informal settlement, to understand their relations with the Palmiet River. This knowledge production process is what is critically analysed in this case study, to explore the extent to which it has achieved data justice.

This case study was selected for analysis because data has been co-produced between the informal settlers and university researchers over a long period of time and hence there is a well-established data production process or information value chain. This reveals the changing nature of data produced as issues in the settlement change and as researchers and community members build their capacity in collecting data in an informal space. Quarry Road West informal settlement is exposed to high environmental risk, is politically and socially well organised and it displays high levels of social cohesion and identity, which makes it a good case study to explore data justice (Sim et al 2019). Perhaps what is most important, is that at the outset of the PCRP, state officials could not enter the settlement without high levels of security, due to the conflictual and confrontational relationship between the state and the informal settlers, as a result of a lack of trust on both sides. By 2016, a relationship between the state and citizens had been established and by 2018 informal settlers were conducting river clean-ups in municipal uniforms funded by municipal supported co-operatives (see Figure 7). The relations between citizens and the state had shifted as a result of procedural justice which opened up possibilities to build instrumental, structural, rights-based and distributive justice.

Figure 7: Cleaning up the Palmiet River: informal settlers as municipal workers during a week of river rehabilitation (Source: C. Sutherland 28/06/2018)

The data production process which is analysed in this case study produced the data, maps and knowledge outlined in Box 1.

Box 1: Data co-produced between university researchers and informal settlers in Quarry Road West informal settlement

- Baseline data: history and geography of the settlement
- Engagement in the PCRP and the production of the PCRP Action Plan (Martel & Sutherland 2019; Williams et al 2018; Williams et al 2019)
- Community-based and participatory GIS mapping (Mazeka et al 2019)
- Participation in development of Durban's Resilience Strategy (100RC) (eThekwini Municipality 2017)
- Risk mapping (community-based, GIS and drone mapping analysis) (Mazeka et al 2019).
- Development of a climate smart informal settlement handbook (Sutherland et al 2019a)
- Exploring the 'narratives of home' in an informal settlement (Sim et al 2019)
- Innovative sanitation technologies: Gates Foundation's 'Reinvent the Toilet Challenge'

Interviews on the concept of data justice were conducted with four officials from the Human Settlements Unit, Environmental Planning and Climate Protection Department (EPCPD), Coastal Stormwater and Catchment Management Department in eThekwini Municipality through action research in the PCRP. A focus group was held on 20 March 2019 with 14 members of the mapmakers team from Quarry Road West informal settlement to explore the question of whether the data they have produced has achieved social and environmental transformation in the settlement. This was facilitated by Open Data Durban. The data and reports that have been produced for the PCRP, listed in Box 1, were critically evaluated on an ongoing basis between January 2019 and July 2019. This was undertaken in meetings held in the community and at the university between the mapmakers, university researchers and municipal officials as they continued to engage in the work of upgrading the settlement and improving water and climate governance within it. The authors who have written this case study are the researchers involved in the datafication of Quarry Road West informal settlement. We therefore acknowledge our positionality in the project and the way in which this will have shaped the analysis presented here, as we are embedded researchers. The data justice model by Heeks & Shekhar (2019) is used as a framework to reflect on the information value chain that is emerging through the project and to critically analyse the datafication taking place in Quarry Road West informal settlement. This includes a reflection on how the datafication process has built state-citizen relations (structural and procedural justice), has helped to address challenges in the settlement (instrumental, procedural and structural justice) and how it has supported the upgrading and transformation of the settlement to date (instrumental, procedural and rights-based justice).

D. Findings

Mapmakers from Quarry Road West informal settlement have been co-producing data with a team of researchers from UKZN since 2014 (see Box 1). However, life in the settlement remains precarious, and has become even more challenging after a major flood which devastated the settlement on 22 April, 2019. This raises questions about the value of the datafication process in achieving development. Data has been collected, processed and produced through participatory knowledge production practices, in the upstream and midstream activities of the information value chain. Some data has moved downstream in the information chain, to the spaces of decision making and implementation, largely through the efforts of 'bridges' or data intermediaries. Two university researchers, two municipal officials and three mapmakers, who have developed their skills in data presentation through the datafication project, have acted as the main 'bridges' in the project. These data intermediaries have actively sought opportunities to present, both individually and collectively, the data on the settlement in multiple platforms in the city.

This activism, through the way in which the data has been constructed and presented to support progressive discourses on informality, has therefore played an important role in both moving the data along the information value chain, and in the form the embedding of the data in the value chain takes. This includes presenting data in PCRP meetings, in international conferences held in the city that had a strong municipal presence (IAIA 2017), in stakeholder workshops for the development of Durban's Resilient City (2016-2017), in videos produced for the Bill and Melinda Gates Foundations Re-Invent the Toilet Challenge (2018) for a global toilet fair in China in 2018, in the KwaZulu-Natal Province's Climate Change Summit (14/08/2019), in municipal forums and meetings held to address critical water, climate and housing issues in the city, and in events to showcase the data produced in the settlement, including the Narratives of Home photographic exhibition held in the settlement (21/03/2019). The data intermediaries have therefore acted as 'champions' for informal settlement upgrading in the city through the datafication process being undertaken in Quarry Road West informal settlement. The role of champions is well recognised as being critical to just transformation and sustainable development (Roberts 2016).

However, the extent to which the data has resulted in meaningful change in the settlement is questioned in a city grappling with informality. Some instrumental outcomes have emanated from the co-production of data. However, these outcomes relate more to changes in governance, shifts in discourses towards informal settlements and their 'right to the city', empowerment of the community and having their voices heard, and opportunities for engaging with the municipality in innovative projects, than tangible outcomes related to changes in the built environment of the settlement. In time, these may yield more substantive outcomes on the ground, such as the provision of improved services, most notably sanitation and stormwater drainage, the reduction of the risk of the river to the community, the upgrading of the settlement, or even the relocation of the settlement in its entirety. These substantive outcomes require significant shifts in political will and bold governance by the state. However, the 'soft' outcomes are important in creating institutional shifts, which can lead to social and environmental transformation. They therefore may be just as valuable over the longer term for development, as 'hard' outcomes reflected in changes in the built environment. The knowledge that has been built has made

the settlement more 'visible' and this visibility has brought other actors and projects to the settlement, which has led to change both in the settlement, and in the institutions engaging with it (see Figure 10). However, these efforts are also being constrained by the broader political struggles around informality that are dominant in the municipality at present, both between political parties and within them. In most instances, the changes in Quarry Road West informal settlement represent 'little victories in the face of big defeats', as the gains are small, and are often overwhelmed by the challenges and politics of living in an informal settlement in a city struggling to address and cope with increasing informality. However, they bring hope of change in the settlement, and it is this hope that motivates informal settlers to persevere in data collection processes (Open Data Workshop 21/03/2019).

This case study analyses the value of datafication in two ways. It first presents the *value of the data itself* in supporting social and environmental transformation in the settlement and reflects on the structural elements that constrain or enable the movement of data downstream in the information value chain. Second, it reveals the *value of the data production process* and the state-citizen-university relations it has built, in leading to change through data justice. The first section reflects on the data produced, which is multi-modal and in most cases is not the digital data of development informatics, but rather qualitative data that opens up opportunities for listening and learning (Kennedy et al 2019). The case study reveals that qualitative data produced at the local scale can play a valuable role, along with quantitative and digital data, in making informal settlements more visible through 'just' datafication. This finding is supported by Kennedy et al's (2019) case study on informational politics in Hyderabad and Chakraborty et al's (2015) and Willis' (2017) research on community-based mapping.

D1. Valuing Different Forms of Data in Different Contexts for City Datafication

Individuals and communities at the 'bottom of the data pyramid' (Arora 2016) are often excluded from big data, digital data and the datafication of the city. They do not always emit data, nor are they digitally captured or recorded as citizens in the same way as those that are connected to the global and national economy; to the benefits and services of formal city life; and to the dominant political and social networks of a particular society. Informal settlers find themselves on the periphery of city datafication, due to their particular histories and geographies, their informality, poverty and inequality, and the way in which others who have power, construct their 'place' and 'identity' in the city.

As the urban poor, they claim their 'right to the city' through illegal land invasions. They claim land, build their own housing and attempt to access basic services. They seek representation and hence they organise themselves politically. However, they often remain invisible, due to the repressive discourses of informality in the city, which construct informal settlements as places to be removed, relocated or as places that are 'not meant to be there' or are 'not known' (Councillor 1 pers comm 23/04/2019). So how do informal settlers begin the process of being represented in the data of the city?

An analysis of the data, maps and images co-produced by the mapmakers and UKZN researchers from 2014 to 2019 on Quarry Road West informal settlement, reveals the wide range of data that has been collected, processed and more recently transferred into

decision-making spaces through 'bridges' or data intermediaries (Heeks & Shekhar 2019). The data ranges from creative, qualitative data to technical and digital data, collected and represented using participatory GIS. The different forms of data have travelled within and from the informal settlement outwards, and hence have played a role in ensuring some level of data justice in the settlement, albeit in small ways. The types of data collected and the purpose of collecting the data was decided upon collaboratively, as the mapmakers and the university researchers explored both the relationship between the informal settlers and the Palmiet River, and critical issues that emerged in the settlement, as the research partnership evolved. The role of different forms of data (see Table 1) in achieving some level of data justice and examples of this data (see Figure 8) are presented below. Table 1 describes the type of data collected and produced and the impact it has had, and it reflects on the type and level of data justice achieved.

Table 1: The role of different types of data in achieving data justice

Type of data	**Impact of data**	**Data justice**
A: Community-based maps: maps sketched by the community showing main sections, features and risks	Develops a context of the settlement, helps data producers to understand the organisation of the settlement and its main characteristics and risks. Many informal settlements in South Africa are divided into sections that have historical, geographical and political meaning, and this is critical to understand in any development process, but is often missed in interventions planned from 'outside' the settlement. Supports qualitative open-ended listening and dialogue about the settlement and its social, economic, environmental and political dimensions.	This form of data is valuable to data producers as it provides a platform upon which an understanding of the context of the settlement and other data is built. It is used in upstream activities. It supports procedural justice as the community constructs and provides the first baseline map of the settlement, setting the boundaries of and framing the datafication process at the outset.
B: Participatory GIS maps and risk maps: maps co-produced between informal settlers and researchers; data collected on each household, which is included in an attribute table. Each household is spatially geo-referenced as are the risks in the settlement	GIS data and maps provide an accurate spatial record of households in the settlement at a particular point in time. The settlement is mapped at the household scale, which protects residents against evictions, as their 'right to the city', enshrined in the South African Constitution and housing legislation, is recorded and spatially geo-referenced on the map. The GIS map provides a temporal record, which is critical in determining which residents have rights to the settlement after natural and human-induced disasters disrupt the settlement.	Procedural, instrumental, structural and rights-based justice is built through communities owning and producing GIS maps of their settlement in partnership with university researchers. Community members decided which attributes were mapped for each household. Power relations are challenged as informal settlers, rather than only the municipality, hold data on the households in the settlement and their 'right to the city'. The GIS maps have been used in legally challenging evictions, thereby protecting 'mapped' residents since 2017.

Type of data	Impact of data	Data justice
C: Data on climate adaptation for climate smart informal settlement booklet. Data on impact of and response to natural disasters reflected in drone maps which are being used in the iQhaza Lethu project	Mixed qualitative and spatially-referenced data in the form of community-based maps, community sketches and photographs of climate smart informal houses, GIS risk maps of environmental and human-induced hazards in the settlement, as well as drone maps which are being used in the construction of a Disaster Risk Management Plan for the municipality.	Procedural justice as informal settlers define adaptation and resilience in the settlement on their terms. Data on adaptation practices, is evaluated in relation to knowledge on adaptation from the literature. Potential instrumental justice as informal settlers are using this data to inform and produce a Disaster Risk Management Plan for the settlement for use by EPCPD and the Disaster Risk Management Department.
D: Photographic images and narratives on the meaning of home in an informal settlement: collected using a range of qualitative methodologies including focus groups, photovoice[1] and interviews	Powerful data, which has shifted multiple actors' understanding and discourses about informal settlements. Data humanises informal settlements and their residents.	Procedural justice as the narratives and visions of home were constructed by informal settlers, using an established qualitative methodology. This ensures that the voice of informal settlers is the main voice in the data presented. Instrumental, rights-based and structural justice are being enhanced as the narratives of home project has played a role in shifting repressive state discourses on informal settlements through presentations made by both researchers and informal settlers in public forums.
E: Data collected on water and sanitation access, practices and use by informal settlers in partnership with university researchers for Engineering Field Testing of EAWAG Waterwall as part of the Gates Foundation's 'Reinvent the Toilet Challenge'	Data is informing an international project on the development of innovative sanitation technologies and hence has local and global impact.	Procedural and instrumental data justice, which ensures the voice of beneficiaries is heard in the development of global technologies for innovative sanitation systems and is included in the planning and service provision strategies of eThekwini Water and Sanitation Unit.

[1] Photovoice is a qualitative methodology developed by Wang and Burris (1997), where participants provide narratives of photographic images they have taken to reflect the topic under research (Sim et al 2019).

Figure 8: The different types of data produced (the letters A - E refer to the letters in Table 1 above) (Sources: A & D: Sim et al (2019); B: Mazeka et al (2019); C & E: C. Sutherland 17/04/2019)

The multi-modal data collected and processed in Quarry Road West informal settlement reflects procedural justice and rights-based justice in terms of how it has been produced, as the community has ownership over the data construction process and over the data itself. The mapmakers' frustration lies in how this data can move downstream and be used to transform their everyday lived worlds, as they argue that they produce the data through their own civic duty, but then the data "gets stuck and does not change our lives" (Open Data Workshop 21/03/2019). The mapmakers have had to rely largely on 'bridges' or data intermediaries to move the data downstream in the information value chain. The 'bridges' are all engaged in the PCRP and so are committed to the datafication process over the longer term. Except for one official, they have all been participants in the project for over five years. This has created institutional memory and strong partnerships, which have supported the advocacy role of the 'bridges', who have acted collectively to reduce risk and improve quality of life in the settlement. As a result, data developed from the outset of the project continues to be transferred into various decision-making spaces within the municipality, which open up when the politics of the city allows this to happen. Having explored the different types of data collected and produced, the second part of the results of this case study reflects on the value of the data production process, the relations it has built and the outcomes it has achieved.

D2. The Value of the Datafication Process

The value of the datafication process is analysed by reflecting on the outcomes of the process, as it has evolved over time. Two phases are identified: the first phase, where the datafication process had a limited influence on instrumental, structural and distributive justice, and the second phase, where the datafication process built on what was achieved in the first phase, and began to influence downstream activities, leading to potential instrumental, rights-based, structural and distributive justice.

This became possible when the data began to flow into an innovative upgrading programme, iQhaza Lethu, in the municipal department with the most power to transform life in Quarry Road West: the Human Settlements Unit. While data had been presented to officials in this Unit in the first phase, it had had little impact as there was resistance to the data, with housing officials explaining that they had 556 settlements to deal with in the city, and so data at this 'microscale' and level of detail was not helpful to them. They also argued that it was unreliable as informal settlements are dynamic and hence this data 'would change all the time'. They argued that the informal settlers were registered with their housing numbers on the municipal database, and this is what they worked from. They also stated that Quarry Road West was a deferred relocation and hence they would not invest in upgrading efforts in the settlement (Human Settlements Unit Official pers comm 04/07/2017).

The major flood in the settlement in April 2019, also resulted in movement of the data downstream in the information value chain, as the GIS mapping and evidence of 'life in the settlement' contained in the Narratives of Home Report (Sim et al 2019; see also Figure 10) became critical to protecting people's rights to the settlement. Both iQhaza Lethu and the major flood, therefore acted as levers of change. A certain level of procedural justice was achieved in both phases, as data was produced by the community, based on their identification of data needs and transformed into development results. This was in the form

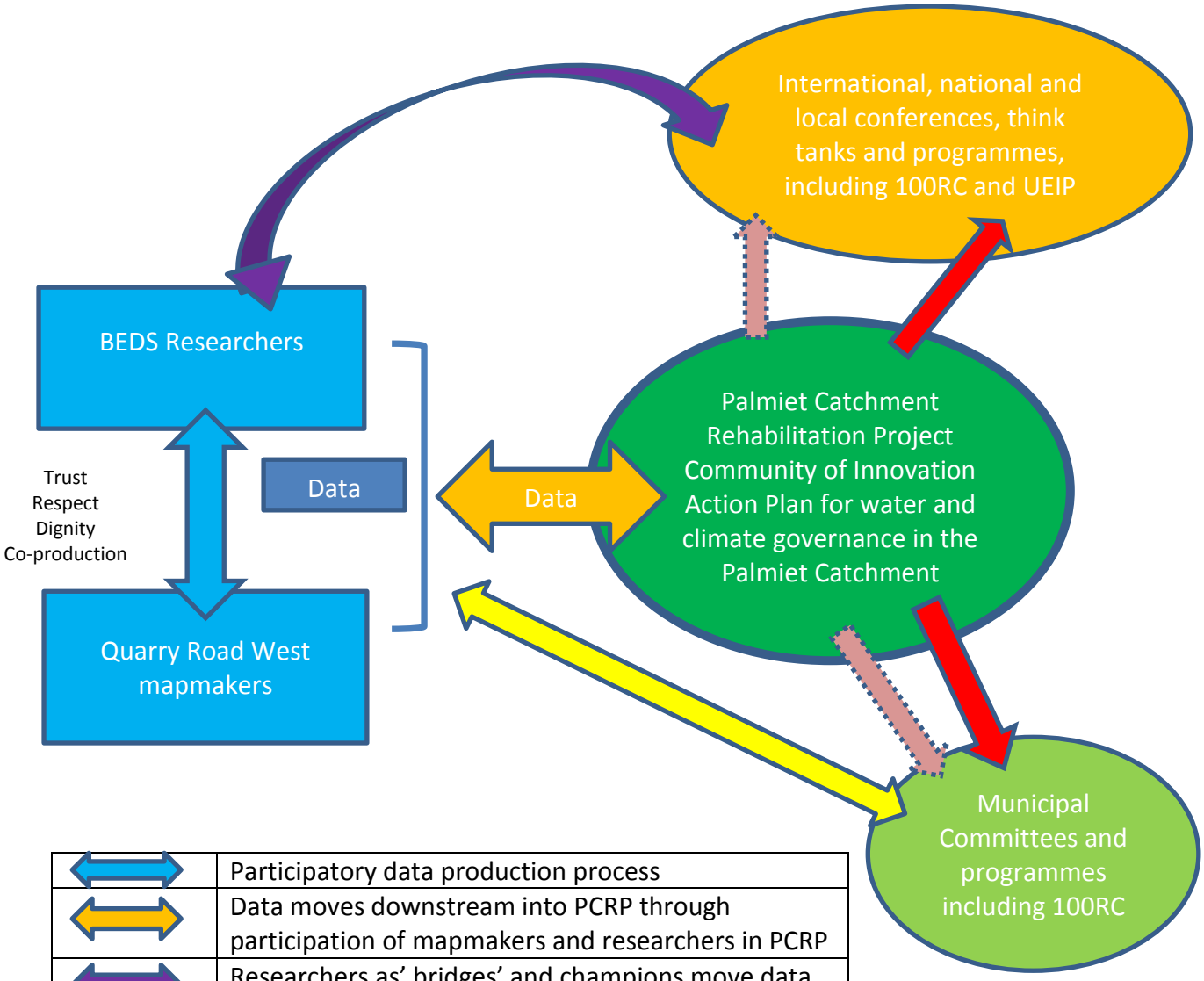
of both 'soft' outcomes, focused on building knowledge, a governance arena, and capacity and power to act in the first phase, and downstream activities embedded in municipal, research and international projects in the second phase, which are starting to contribute to instrumental, structural, rights-based and distributive justice.

Phase 1 of the datafication process

The first phase of the datafication process, which took place between 2014 and 2017, emerged through the building of a relationship between the mapmakers and the School of Built Environment and Development Studies (BEDS) researchers, with a focus on exploring the relationship between the community and the Palmiet River[2]. The datafication process was therefore initiated as part of connected state-citizen-university action research projects: one part of the UEIP and the other two, national and internationally funded research projects located in BEDS, UKZN. The data that was produced during this phase included the community-based and GIS maps of the settlement (data types A and B, see Table 1 and Figure 8).

The datafication process had a relatively small sphere of influence. The data was predominantly moved downstream into the PCRP, which focuses on building multi-stakeholder action for improved water and climate governance in the Palmiet Catchment. The data was used to shape the Action Plan developed as part of the PCRP. It also played a critical role in illuminating the challenges and risks facing the Quarry Road West informal community in the catchment and their desire to participate in decision making affecting their 'right to the city'. It therefore shifted both PCRP municipal and civic science actors' views of informality, as a platform was created for community voices to be heard. The data also began to travel into more significant epistemic and decision-making spaces, including committees and programmes in the municipality, largely through municipal champions. This led to 'soft' outcomes, such as raising awareness, questioning of dominant repressive discourses on informality, and humanising informal settlers (see Figure 9).

[2] This research formed part of the PCRP and UEIP, a National Research Foundation (NRF) and Norwegian Research Council SANCOOP research project (CLIMWAYS) and a Water Research Commission project, WRC 2354.



	Participatory data production process
	Data moves downstream into PCRP through participation of mapmakers and researchers in PCRP
	Researchers as' bridges' and champions move data downstream into academic and research forums
	Data moves downstream and informs Durban's Resilience Strategy as part of global 100 Resilient Cities (100RC) programme
	Municipal officials in Climate Protection Branch as 'bridges' and champions transfer progressive discourses on informal settlements, water and climate governance into global, national and local governance spaces
	Municipal influencers who have knowledge of the PCRP and the datafication process, and who have access to those with positions of political power, begin to influence discourses around informality

Figure 9: Phase 1 of the datafication process

The initial decision to construct data in, and on, Quarry Road West informal settlement, was taken jointly by members of the informal community, led initially by an African National Congress (ANC) Branch Committee and sub-ward committee member, and university researchers[3]. The datafication process therefore started from the bottom up, using the political structures present in the settlement. The university researchers' first meeting with the community was organised by EWS as part of the initiation of the PCRP, policed by undercover security, given the conflictual relationship between the state and citizens in the informal settlement prior to 2015. This conflictual relationship was due to poor service delivery, the threat of evictions and the community members' desire to participate in decisions about their future, in the face of an interventionist and managerial local state (Sutherland et al 2018).

The first meeting provided the researchers with an opportunity to explain the focus and purpose of the PCRP, namely improved water and climate governance across the catchment, by focusing on people's relationship with the Palmiet River. The focus on the river attracted the interest of community members, as they have a close relationship with the river, which provides both benefits and risks to the community. Questions about how people relate to the river in the informal settlement did not initially trigger politics. This meant that the early processes of engagement were not thwarted by power struggles between political actors, including councillors, who wanted to control the process. The relations between the community and the river have since emerged as being highly political, particularly after the flood in April 2019, which has been part of the learning in the PCRP. The researchers met regularly with the informal settlement committee after the first meeting, openly discussing the framing of a research agenda. Trust began to be established and discussions held about what the first data gathering exercise in the settlement should be.

Exactly why and how this initial trust was established is difficult to determine. The team of researchers from UKZN, who have worked in other medium-sized informal settlements across the city over the past ten years, attribute the building of relationships to three factors. The willingness and desire of informal settlers to participate in the politics and transformation of urban life and to be made 'visible' and 'known'; the openness of a participatory research process which has inclusivity and the co-production of knowledge as its focus; and the continual 'going-back' of researchers to the settlement, to listen and learn. Informal settlers state that relationships are built because of the on-going engagement between the community and the researchers; because of their desire to engage in and learn about knowledge production processes, an opportunity provided by the university; because they wish to be 'made known' and be recognised in the city; and because they want to make a difference to the development trajectory of their settlement and their individual lives.

Research projects offer a new space of learning and engagement, which is shaped by the politics of the settlement, but which is also not defined and controlled by it. This was

[3] In 2014 when the project was initiated, Quarry Road West informal settlement was an ANC-led settlement in an ANC ward, Ward 23. In 2016 after the local government elections, the ward was won by the Democratic Alliance (DA) and is now a DA ward (2016-2021), with the sub-committee in Quarry Road West informal settlement being DA led. The ANC still has a strong presence in the community and the representative councillor from the ANC, as well as the previous ANC councillor continue to engage with the community.

evident in 2016 when the ward within which the settlement is located, changed from being an ANC-led ward to a Democratic Alliance (DA)-led ward, as a result of local government elections. This introduced an interesting dynamic, as the mapmakers supported both political parties, as well as others. However, they agreed to work together, respecting their political identities, but not allowing them to define and control the datafication process. This outcome is extraordinary in the political landscape of South Africa, as it is not common for a group of people involved in a process as political as datafication, to be able to work across different political alliances. The social learning and relationships that had been built in the data production process, has created a space of inclusiveness in the community, that has enabled the team of mapmakers to work together, cutting across not only political lines, but gender and age lines too.

The data produced in Phase 1 remained largely an upstream and midstream activity (see Figure 9). Both community members and university researchers argued that the data had become stuck. It was not helping to change the living environment in the settlement, as it did not move easily into the spaces of decision making in eThekwini Municipality, particularly the Human Settlements Unit and EWS, where the data potentially could have greatest impact. The data was presented and reported in the PCRP, of which EPCPD is a lead actor, and in which other municipal departments participate. However, as an environmental planning and climate protection department, EPCPD is more of a facilitating and co-ordinating agency, rather than an implementing agency of the local state and could therefore "not operationalise and invest in the elements on the action plan, this was not what EPCPD does" (EPCPD Municipal Official pers comm 04/02/2019).

The datafication of the settlement provided insight and learning about the settlement, which was shared by EPCPD officials in other municipal forums, but it did not lead to significant outcomes in terms of service delivery or changes in the built environment. The data supported the progressive discourses of the local state, in terms of informal settlement upgrading, and so it flowed easily into, and was taken up in spaces where these discourses were evident. However, it was 'blocked' by the repressive discourses of some senior managers and departments in the municipality, in spaces where informal settlement upgrading was presented. However, an innovative city-wide programme located in EPCD, Durban's 100 Resilient Cities journey, provided an opportunity for instrumental, rights-based and structural justice. Data flowed downstream in 2016 and 2017, as the Quarry Road West informal settlers and university researchers used the knowledge gained in the PCRP to provide input into the construction of Durban's Resilience Strategy, which has a strong focus on collaborative informal settlement action in the city (eThekwini Municipality 2017; Sutherland et al 2019b).

Phase 2 of the datafication process

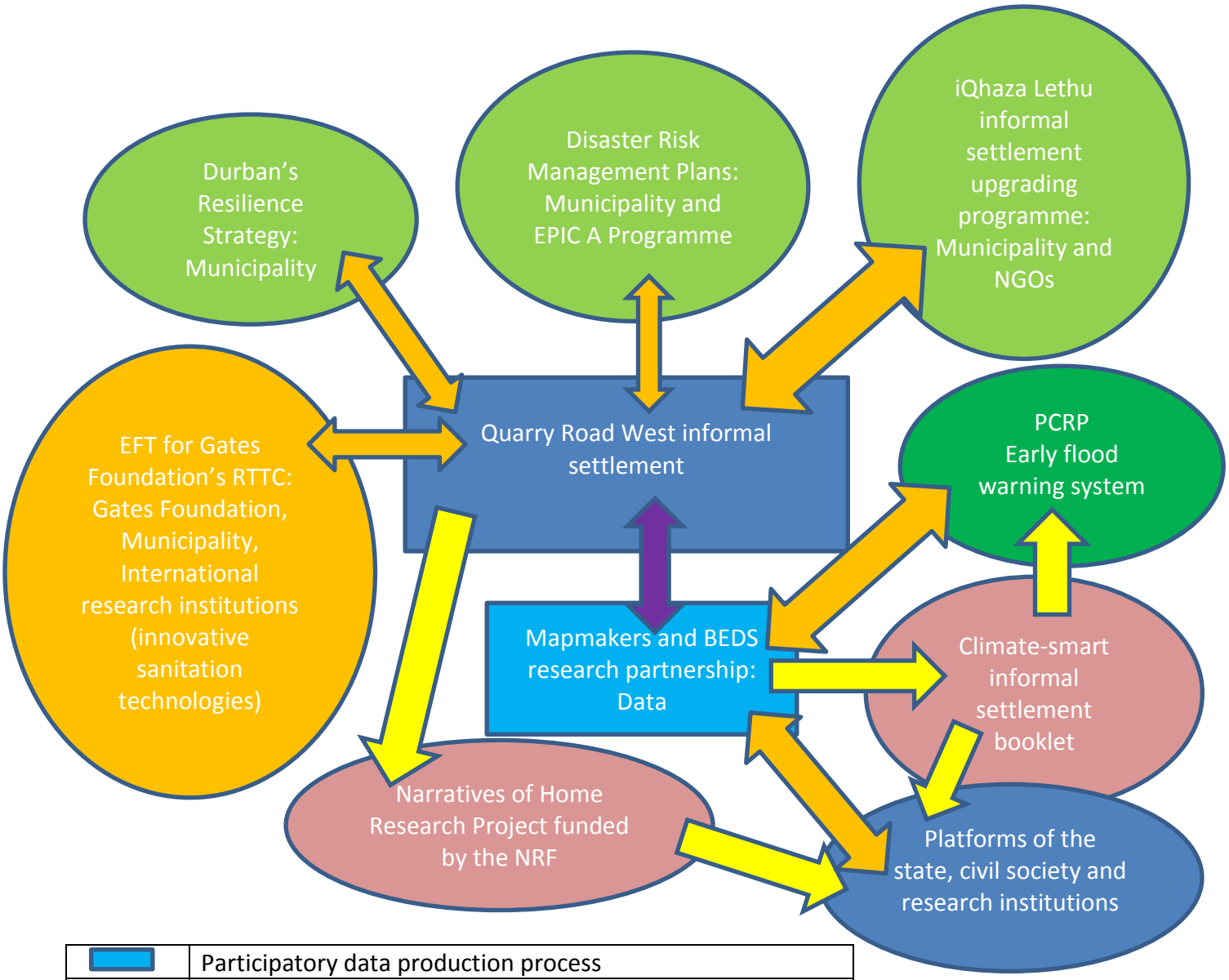
The second phase of the datafication process started in 2018, and is ongoing (data collected: types C, D and E, see Table 1 and Figure 8). As shown in Figure 10, a major breakthrough in the value of the datafication process was achieved when the Human Settlements Unit, in partnership with Project Preparation Trust and Slum/Shack Dwellers International launched the iQhaza Lethu upgrading project, which is funded by the European Union. This opened the door for the data collected in the PCRP and Quarry Road West informal settlement to

flow downstream and to start shaping state policy and discourse within the Human Settlements Unit, as the unit began to explore options and practices for informal settlement upgrading based on a partnership approach.

However, this was dependent on two important factors: one of the 'bridges' or champions of the datafication process was placed in iQhaza Lethu in the Human Settlements Unit as an official; and a second 'bridge' influencing the iQhaza Lethu programme, presented data from Quarry Road West informal settlement at initial planning meetings. The large amount of data that had been collected in the settlement, and hence the knowledge about it, as well as the influence of the data intermediaries, resulted in Quarry Road West being selected as an iQhaza Lethu pilot project, even though it is an unlikely candidate for in-situ upgrading, being categorised by the municipality as a deferred relocation. iQhaza Lethu is building up knowledge on informal settlement upgrading and will shape policy and practice in the future, so the datafication of Quarry Road West informal settlement, will shape the discourses and practices of informal settlement upgrading in the city, leading to improved instrumental, rights-based and distributive justice.

The data on the settlement is starting to flow into other spaces too, as the informal settlement has become the site of the implementation of a number of innovative projects in the municipality. This includes the Engineering Field Testing (EFT) being undertaken by EWS as part of the Bill and Melinda Gates Foundation's Re-Invent the Toilet Challenge (RTTC) and the drafting of a Disaster Risk Management Plan, as part of the 'EPIC A' project, which is a learning partnership between the municipality and the university. The choice of Quarry Road West informal settlement as a site for experimentation and social learning, through externally funded municipal projects, is attributed to the datafication of the settlement.

The role of 'bridges' or data intermediaries, who promote the value of engaging with the settlement, due to the knowledge and capacity that exists within it, as well as the governance platform that supports it, is important. This represents a form of instrumental justice as the datafication of the settlement has led to the implementation of these different projects within the settlement. These in turn have begun to address development deficits, through for example, constructing development options for the upgrading of the settlement, and building a playground, as a result of the participation of the community in the EFT. The settlement was also selected as a case study for a research project funded by the National Research Foundation: Narratives of Home and Neighbourhood: Possibilities for re-imagining Urban Planning.



	Participatory data production process
	Data moves downstream into a range of municipal and international projects. The projects in turn shape everyday life in Quarry Road West informal settlement resulting in some level of procedural, instrumental and rights-based justice
	Researchers and mapmakers have formed a research partnership that draws in other community members and supports research in Quarry Road West informal settlement. They act as' bridges' and facilitators between the settlement and other municipal projects and research programmes, which have landed in the settlement due to the datafication process
	Data is used to produce research reports, which move downstream and begin to shift informal settlement discourses in the city

Figure 10: Phase 2 of the datafication process

The in-depth data produced in this research project, which was made possible due to the strong relationships that exist between the mapmakers and the BEDS researchers as part of the datafication process, has had a significant impact in a number of forums in the city, as it has humanised informal settlers for those that hold more repressive positions related to informality.

A second event, the April 2019 flood, has created opportunities for the value of the datafication process to emerge. It has also revealed how challenging it is for data to result in instrumental, structural and distributive justice in a city grappling with rising informality, which holds both progressive and repressive discourses towards informal settlements. The flood had a dramatic impact on the settlement, as both land and informal houses were lost. As a result of lack of meaningful disaster response from the state after the flood, informal residents began to rebuild houses on all remaining open space in the settlement. This prompted a response from the Land Invasions Unit in the municipality, who identified these houses as 'new builds' and hence activated their process of removing all 'new builds' as part of the policy of the Human Settlements Unit. They placed red crosses on the doors of all the new builds, even though they had housing numbers on them, and warned residents that these houses would be taken down by the state. Residents, who were not newcomers after the flood, responded by stating that they had lived in the settlement for many years and had rebuilt on the open space, as they had lost their land in the flood. Housing officials told them they needed to provide evidence of this. The residents then activated the data, to claim their rights to the settlement. One resident, who is also a mapmaker, used the image of her household from the Narratives of Home research, to claim her right to the settlement (see Figure 11). She placed a copy of the image she took of her original house (before the flood washed her home away), as part of the photovoice methodology in the Narratives of Home research, on the door of her 'new build', to protect herself from the actions of the Land Invasion Unit. This image is contained and referenced in the Narratives of Home report (Sim et al 2019) and hence it has led to rights-based and instrumental justice for herself and her family. The GIS maps and database and the drone maps that have been flown of the settlement from June 2018 to July 2019 are also being used by community members who lived in the settlement prior to the flood, to protect their right to land in Quarry Road West, as the response to the floods and the 'new builds' unfolds.

Figure 11: Using data to claim the right to the settlement (Source: C. Sutherland 28/07/2019)

Residents of Quarry Road West informal settlement adopted two strategies in the aftermath of the floods: the one was to protest and the other was to present a memorandum of demands to the Deputy Mayor of the Municipality. This memorandum stated that the community wanted to work in partnership with the municipality, drawing on the data and knowledge they have of their settlement, partly as a result of the datafication process, to plan a future for their community, that addresses the impact of the flood and reduces the risk of the river on the settlement in the future.

Protest action resulted in the Deputy Mayor visiting the settlement. She asked the community not to protest and rather to present a memorandum to the city, by delivering it to her office. Protest always achieves an immediate reaction from politicians and senior officials, although it seldom leads to longer term action and change. The community, through a participatory political process, drafted a memorandum, drawing on the datafication process, and submitted this to the Deputy Mayor. To date (August 2019) there has been no response to the memorandum, but this is most likely due to the recent replacement of the Mayor and the Deputy Mayor and executive committee of the municipality, due to corruption charges, which has led to significant political changes at the senior level. This political crisis has therefore impacted on the efforts of the Quarry Road West informal community to engage with the city. Bigger political struggles therefore play a major role in how data is taken up in downstream activities.

E. Discussion and Conclusions

The datafication process in Quarry Road West informal settlement has made the settlement more 'visible' to the informal settlers who live within it. They state that they have learnt more about the place they live in and how it is shaped by its social, economic, environmental and political context. They have also improved their understanding of the mandates and capacity of local government and the limitations that it faces in meeting the needs of the urban poor (Open Data Workshop 21/03/2019). The settlement has also been made more 'visible' to the BEDS researchers, who are engaged in learning and knowledge production processes on how to govern for social and environmental transformation in informal settlements in cities in the global South; and to the state, which is tasked with managing the ongoing challenge of the growth of informal settlements in Durban, while trying to build urban resilience and sustainability. Over time, the datafication process has expanded the reach and influence of the settlement in city politics and decision making around informality, but this reach and influence is yet to have significant impacts on the everyday lives of those who live there and on the discourses and politics of informal settlement upgrading in the city. It has supported and strengthened a new governance arena that has emerged through the PCRP, which includes state, university and civil society actors, which may lead to instrumental and structural justice in the future, as a platform for dialogue and change has been built. The platform is perceived as being legitimate and having influence by a wide range of actors both within and outside of the state, because it is underpinned by multi-modal data and knowledge and this gives it power.

The case study has revealed that it is the coming together of actors, data, and opportunities or windows for change, at particular moments in time, in the life and politics of the city, which leads to some level of data justice for development. It is also evident that datafication has supported procedural and rights-based justice due to the epistemic control the mapmakers have had of the data produced within the settlement (see Figure 12). A critical question in the datafication process is whether the mapmakers are accepted by the broader community as trustworthy data producers and data intermediaries. While some community members have raised issues around how the mapmakers benefit from the datafication process, which in some instances has included small stipends, it has been evident throughout the project that they are trusted in this position in the community. This was most clear when they engaged in the highly political process of collecting data on households in the settlement for the participatory GIS mapping project. The mapmakers mapped the settlement in a very short period of time, they were assisted by community members who all wanted to be part of the process and they encountered no resistance to the process they were undertaking (Mazeka et al 2019). Thus far, they are respected and trusted as researchers in the community (Open Data Workshop 21/03/2019). However, the political struggles over land that have emerged as a result of the flood, with newcomers moving into the settlement, has begun to create tension over the meaning and use of the data.

It is also evident from the case study that trust cannot be taken for granted, that it can be broken very quickly, and that the politics in the settlement can change, shifting or breaking down relationships between the state, citizens and university researchers. This tension is beginning to emerge, as a result of the significant impact of the April floods on the

settlement and the land crisis this has evoked. Trust is essential in ensuring procedural justice, as it relates to ethics in data production, respect for different forms of knowledge, the ownership and control of knowledge, and the willingness and faith to allow others to act as 'bridges', data intermediaries and champions, to move data downstream in the information value chain.

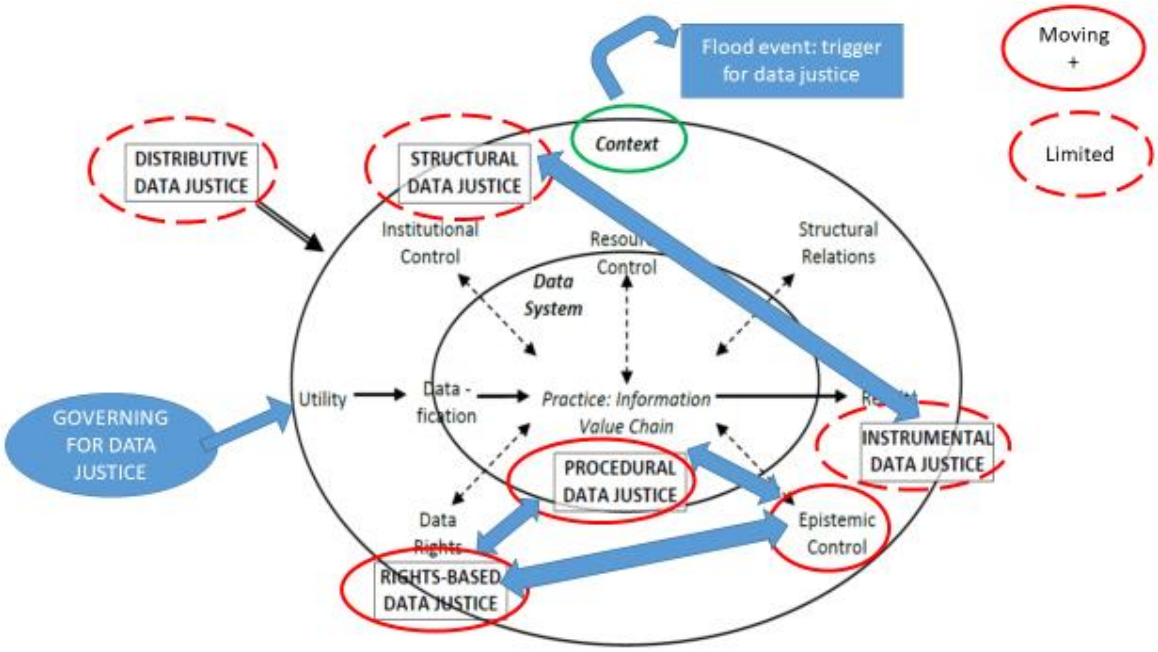


Figure 12: A data justice model for Quarry Road West informal settlement (adapted from Heeks & Shekhar 2019)

Forms of instrumental and structural justice are beginning to emerge, with these two forms of justice being connected. The research has shown that it is very difficult to obtain 'hard' outcomes in the settlement without there being significant changes in the structures of the city, which result in more progressive discourses, planning for and investment in, informal settlements. However, 'bridges' or data intermediaries have played a positive role here, and have ensured that the 'soft' outcomes of the datafication process, including the building of a governance arena, social learning and opportunities that are created to shift conceptions of informality in the city, have gained traction and made a difference.

Governing for data justice has emerged as being critical to advancing data justice for development as this case study has shown and hence Heeks & Shekhar's (2019) model has been expanded to include governance as a critical element. Perhaps the most critical aspect of governing for data justice, is the relations built between the state and citizens, with researchers (or NGOs) acting as 'bridges' to support the building of these relationships and the movement of data downstream between citizens and the state. The impact and role of triggers or opportunities for change created by 'critical moments or events' such as a flood or a major protest, is also recognised as a result of the research undertaken in Quarry Road West informal settlement.

The case study has "gone beyond 'justice as a set of theoretical principles' to 'justice-in-practice'" (Heeks & Renken, 2018: 96). The final section presents the main lessons of the project and the recommendations that emerge from these lessons.

E1. Recommendations

- Building state-citizen relations is critical in supporting data justice for development.
- Qualitative and GIS data that is collected and produced at the local scale, can, with the support of data intermediaries and champions, move downstream into the decision-making spaces of the state. This form of data, when collected, produced and presented using established and rigorous research processes, is powerful in shifting conceptions and discourses on informality.
- Building trust and ensuring respect for all actors in the knowledge production process, and the different forms of knowledge they produce, is critical to data justice for development.
- Datafication, when undertaken in inclusionary spaces that are defined by all actors in the process, can enable people to work across political, gender and age boundaries, moving development beyond the 'gains' of party politics or a particular group's interests.
- Datafication in an informal settlement makes the settlement visible to the informal settlers, to the state and to researchers and NGOs, providing new perspectives on how development can unfold and who needs to engage in the development process.
- Informal settlers are empowered in terms of their 'rights to the city' when they hold data on the number of households and their characteristics in the settlement.
- Datafication processes produce data, but often the 'governance and knowledge platforms' created through the process of inclusive datafication are more powerful than the data itself in achieving transformation. These platforms consist of: epistemics (what all parties have learned about each other) and social relations (the formation of a new social structure). It is these, rather than the data per se, that form the basis for impacts and interventions.
- The datafication project, rather than the data produced directly in the project, has led to some shifts of power in the relations between citizens and the state.
- Data produced through participatory processes are time consuming and rely on committed relationships to see the process through. This effort and commitment is undermined when data does not move downstream in the information value chain. Here data becomes 'stuck' and actors involved in the process question why they are collecting and producing data, if the conditions of their everyday lives do not change. Only when this data enters the spaces of powerful actors in the state, when the state sets the agenda to engage with the data as it serves their interests, does change begin to happen and the data becomes meaningful in terms of what it may achieve in shifts in policy and practice in informal settlements. The powerful actors in the state therefore hold the most power in producing tangible 'built environment' outcomes from datafication processes.
- Datafication when it is inclusive and builds procedural, rights-based, instrumental, structural and distributive justice supports 'the right to the city' which is "the right to the city is, therefore, far more than a right of individual access to the resources that the city embodies: it is a right to change ourselves by changing the city more after our heart's desire. It is, moreover, a collective rather than an individual right since changing the city inevitably depends upon the exercise of a collective power over the processes of urbanization. The freedom to make and remake ourselves and our cities is, I want to argue, one of the most precious yet most neglected of our human rights" (Harvey 2008: 1).

E2. Future Research Agenda

This case study has explored the extent to which a well-established research partnership, between researchers within a university and 'mapmakers' from an informal settlement in Durban, has produced data that has made informal settlements more 'visible' to a wide range of state and non-state actors in the city, and achieved some level of social and environmental transformation. The instrumental and structural justice outcomes of the data process are only just beginning to emerge. It is therefore important to undertake a similar reflection, or case study, in three years, to reflect on whether, and how, life has changed for the residents in Quarry Road West informal settlement as a result of the datafication process, drawing on concepts from a data justice framework, which also will have evolved. It is also important to determine whether big data or digital data becomes more prominent in the settlement over time, and what form the 'datafication of development' takes. Will informal settlements remain in the more marginalised space of community-produced data? This data is valuable, as this case study has shown, but it is often neglected and not recognised in decision making; it is time consuming to produce; and it relies on significant effort from the community, data champions and data intermediaries. Or will big data, digital data and the new forms of data streams being produced, which support those connected in to the formal systems of the city, begin to reach into, or become accessible to informal settlements, thereby connecting informal settlers to broader 'datafication for development' processes (Heeks & Shekhar 2019; Spratt & Baker 2015; Taylor & Broeders 2015).

Based on the results of this case study, it is evident that a future research agenda should include a focus on governance. How is data governed or 'steered' and who has the power to govern its 'outcomes'? This could include an analysis of the different forms of 'governmentality' of data for development. Future research needs to determine what form of governance and institutions provides the best support for data produced, to ensure it moves according to just principles, down the information value chain and impacts on decision making. What sets of rules, norms and social values, in terms of both formal and informal institutions, act as levers of change for data justice for development? Should data be governed through multi-actor partnerships? What is the role of the state in ensuring that procedural, instrumental, rights-based, structural and distributive justice is achieved? What kind of state can ensure this? As this case study has shown, data becomes stuck, when it remains outside of the critical decision-making and implementing agencies of the state.

Change in informal settlements, in terms of state interventions, is a slow process, given the regulations, bureaucratic and decision-making processes of the state. However, change, in terms of the shocks and stresses faced by informal settlements and their ability to adapt to them, are far more rapid, as informal settlements are dynamic environments that never 'stand still'. Data collection and production, when undertaken by informal settlers in partnership with universities, is a relatively quick process when human and financial resources are available. Further research needs to be undertaken on levers of change that can be activated to move data down the information value chain more quickly, and can ensure a more responsive, adaptive and flexible state, that can act on data produced at the local scale, and which is 'smart' enough to be able to 'read this data' and scale it up, and apply it to other informal settlements across this city, with a commitment to 'data justice for development', while not losing site of the importance of context. A big challenge, but one that is required and is essential, to ensure the rights of informal settlers to the city.

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