

How can blank spots on the map be filled from the bottom up?

Examining the success factors in community-based participatory mapping: the case of Kenyan Map Kibera project

Mark Belkin, s2598981

Thesis presentation: 30th of June 2022

Public Governance across Borders

University of Twente, Enschede

Word count: 11,977

Ethical approval reference number: 220479

Contents

I.	Introduction.....	1
II.	Theory.....	3
1.	Community participation and social sustainability	3
2.	Participation theory: What, who and if.....	4
3.	Participation in a digital mapping context	6
4.	Participatory mapping in a Global South slum context.....	8
5.	Criteria for successful community mapping in three stages	10
III.	Methodology	15
1.	Case Study: Map Kibera in Nairobi.....	15
2.	Interviews with Map Kibera participants	18
3.	Analysis.....	20
IV.	Results	21
1.	Pre-mapping stage.....	21
2.	During the mapping process	22
3.	Post-mapping stage.....	23
V.	Discussion	24
1.	Overview of the results	24
2.	Map Kibera – fulfilling all success criteria?	25
3.	The emergence of new criteria	27
4.	Recommendations.....	28
5.	Limitations.....	29
VI.	Conclusion	29
	Publication bibliography.....	32

Abstract

This thesis contributes to research related to digital participatory mapping in the Global South. In contrast to conventional paper maps, most digital maps allow changes to the map easily through anyone with the required software and hardware. That enables bottom-up mapping, where local knowledge shapes the map in place of local authorities. Slums in the Global South are mostly left unmapped. Through a selective literature review, evaluation criteria for participatory slum mapping projects were established. This case study's subject, "Map Kibera", situated in a large slum of Kenyan Nairobi and considered highly successful, has been evaluated accordingly. Through semi-structured interviews with the project's participants and subsequent content analysis, mechanisms facilitating but also impeding community participation were identified. Among factors contributing to participation are a successful early involvement of participants and appropriate conflict resolution mechanisms. As a factor discouraging participation, a weak representation of participants' knowledge was established, as they were not involved in the map-generation process. Further, through the interviews, two new criteria relevant particularly for the Global South have been identified worthy of further study – participation safety risk and financial compensation. Policy recommendations include simplifying language and GPS software to attain higher participant diversity.

Acknowledgement

I wish to express my sincere gratitude to the Gerhard C. Starck foundation. The financial support of the foundation enabled me the freedom to keep my focus on my study and, ultimately, this thesis without having to cope with financial concerns.

List of abbreviations

GIS: Geo-Information System

ICT: Information and Communication Technology

OSM: OpenStreetMap

PGIS: Participatory Geo-Information System

UN: United Nations

UNDP: United Nations Development Program

UN-HABITAT: United Nations Human Settlement Programme

I. Introduction

Rapid urbanization is a global trend, with 60 % of the population projected to live in cities by 2030. The so-called "Global South" likely will carry 90 % of urban growth. The term was popularized through the UN initiative "forging a Global South". One understanding of the term is the grouping of low and middle-income countries according to the World Bank. In contrast to the popular term "development country, it does not imply a supposedly beneficial development towards industrialized countries (UNDP 2004). Particularly the African continent expects high levels of urbanization with projected urban population growth by a factor over three by 2015, with Dar-Es-Salaam and Nairobi being the fastest growing cities on the continent (UN-Habitat 2018). If accompanied by proper planning and management, urbanization can be an opportunity for poverty reduction through fair and sustainable employment and overall better quality of life through access to high-quality public infrastructure and service provision (United Nations 2021). However, realities in Sub-Sahara-Africa (SSA) are often adverse: *"characterized by unplanned and unregulated growth, exacerbated by the legacy of colonialism, structural adjustment, and neo liberalism that spawned weak urban planning institutions"*. In such an environment, urbanization only increases inequalities and, in many areas of the region, leads to the uprising of slums (Güneralp et al. 2017, p. 2). With over 50 % of the urban population housing in slums, SSA represents the global region with the highest share of slum settlements (UN-Habitat 2018). While housing large amounts of people and characterizing entire city landscapes, slums are often almost invisible – if viewed through the lens of most urban maps.

Maps are powerful tools. Local authorities either do not prioritize mapping slums and their facilities or actively leave them off the map to reject any responsibility and deny their existence. As a result, millions of slum residents across the continent and their efforts toward community improvement are not represented on any map. Local community members get together to generate their own bottom-up maps to create alternatives to official maps. Through "participatory mapping", the achievements of active citizens living in poorly mapped slums become visible to all, allowing all slum residents to make use of the existing structures. Moreover, local authorities can more efficiently identify areas with a severe lack of vital structures. Maps have the vital function of portraying what is there and what is not.

The practical aim of this research is to discover how such community-driven mapping approaches can be set up and improved to deliver such vital bottom-up maps. Those maps are only effective if they have been created by local community members who know their community's infrastructure and institutions, their urgent needs, and hidden potential. Citizen participation is mutually beneficial for local authorities and local citizens, given the

acknowledgement of the community members' efforts. While the authorities get a more nuanced perspective on what urban policy action is truly in demand, citizens get to know the city planning and policy process. Further, compromises among the two parties can be discussed, and hostilities reduced, further opening up the urban planning process for locals (Irvin and Stansbury 2004).

Digital mapping technology allows community-driven maps to be used by many slum residents – provided they have access to the required devices. Digital participatory mapping in a Global South context is mainly labelled under "participatory Geo-Information System" (PGIS) project, a term which will elaborate on in the third chapter of the subsequent theory section. With the emergence of open-access software like OpenStreetMap (OSM), projects facilitating such bottom-up maps, primarily through NGOs, have rapidly spread across many slums. However, it is questionable whether the NGOs allow the stakeholders – the residents of the slum communities – to make vital decisions concerning the slum maps. Therefore, the projects should optimally provide the slum residents with decision-making power in creating the map so that the stakeholders can decide over mapping priorities and set the agenda accordingly. The goal of this research is to examine the participative project aspect for the stakeholders through criteria-driven research. Scientifically, this research closes a vital gap in which most evaluation research of public participation is done in a Global North context. Because of its attributed success in the literature, the project situated in a slum of Nairobi, "Map Kibera", will be evaluated on its success in engaging the local slum residents.

Through semi-structured interviews, insights into the strengths and weaknesses of the Map Kibera project will be achieved through the lens of participation criteria, leading to possible improvement of current or future mapping projects within a similar context. Furthermore, as an intermediary research goal, the exclusionary effects of digital technology will be examined. Finally, the research aims to discover new criteria with particular relevance for the Global South, enriching the participation evaluation literature currently focused on Global North participatory mapping. That leads to the discussion of the central research question:

How to achieve successful participation in community mapping? Examining the success factors in community-based participatory mapping: the case of the Kenyan Map Kibera project.

As well as the sub-research-question:

How significant is the digital divide in the participatory mapping process? Examining the exclusive effects of digital technology.

II. Theory

1. Community participation and social sustainability

Participation can be characterized by empowering those not formally in power to make decisions on matters concerning themselves (Verba 1967). Exact definitions of the term "participation" are rare in the literature. Instead, primarily different levels of participation are discussed (see Rowe and Freyer (2004); Falco (2019)), which this research showcases in the second chapter of this section. Participation is a vital characteristic of a functioning democracy, according to Verba (1967). Political participation reaches beyond elections and can be expressed through engagement in a political party or the action through a trade union, among others. Both party and union membership are declining in member countries of the OECD (Organization for Economic Cooperation and Development) (Parvin 2018). Particularly those at the lower end of the socioeconomic spectrum engage less in political participation (as demonstrated through a well-established correlation, for example, in Lijphart (1997)). That connection is highly problematic since those whose issues are already disregarded in society also do not engage in activities that possibly improve their low socioeconomic status. There is a clear disenfranchisement between the political class and the citizens, particularly the poor. This trend also concerns informal politics and NGOs. Due to the increased complexity and technicality of decision-making, they have gradually moved away from a participative "grassroots and broad-base membership" to more professionally organized lobby organizations (Parvin 2018, p. 36). Decision-making in NGOs has become less focused on democratic participation, prioritizing the opinion of the expert as to the regular citizen. The decline in participation is problematic, as argued in the following paragraphs.

Participation can be considered a good in itself, as – particularly in more individualistic societies – it is considered a key value to control one's fate. Participation has instrumental benefits for decision-making in a formal political context but also in all other contexts where there is a difference in power among a group of people. One of them being agenda setting. Those in power can find themselves disconnected from those whom the decisions matter for – the stakeholders – unaware of their needs. Increased participation, particularly through marginalized and discriminated groups, could allow decision-makers to target their needs and issues better. Further, participative decision-making could result in an outcome that is more preferential for those in power. That is the case as a policy can turn out to be more efficient, given the increased scrutiny through the participation of many stakeholders as well as contribute to an increased legitimacy of the decision-makers' policies (Parvin 2018).

The UN has recognized the possible benefits of increased participation and has enshrined participation as one of three pillars of sustainable development. The pillars, being social,

environmental, and economic development, have been first discussed in the Brundtland Commission report from 1987, later forming the base for today's 17 UN sustainable development goals. Their overall aim is to achieve progress through human-centred development, leaving an intact environment for future generations and doing so in line with the creed "*leaving no one behind*" (United Nations n.d.). To fulfil this creed, social sustainability is essential, according to the World Bank: "[With] *growing awareness of the challenges of fragility, persistent inequality, and racial discrimination, social sustainability has been recognized as central to growth and poverty reduction*" (World Bank Group 2020). For the World Bank, participatory approaches like Community Driven Development (CDD), following the idea of help for self-help, are the centrepiece of sustainable development. They enable "*the most vulnerable, [to] reach their potential and develop their livelihoods*" (ibid.). Participation ideally leads to inclusive, bottom-up sustainable development, taking the interest of politically less represented citizens into account. The following section will discuss participation from a more theoretical perspective.

2. Participation theory: What, who and if

As shown in the previous paragraph, there is a growing awareness that participation is closely linked and crucial for sustainable development. Following the vagueness of the term, many researchers have questioned proclaimed participation in policies and projects in various themes, observing a dissonance between participation rhetoric and reality on the ground (see, for example, Poolman and van de Giesen (2006); Stern (2006) or Jones (2011)). To get closer to the essence of participation, a discussion will follow, dealing with the questions of what exactly can be considered participation, who should be involved in participation and whether participation can have adverse effects on participants.

What is participation?

The most well-known participation model is the ladder of citizen participation from Arnstein (1969). Her view of "real" participation is quite radical, and she is highly critical of participatory approaches that, in her opinion, are only pretentiously participative. At the bottom of the ladder, Arnstein has placed "*Manipulation*" and "*Therapy*", which she describes as "*Nonparticipation*" (Arnstein 1969, p. 217). The sole purpose of participation here is to achieve increased public legitimacy while entirely ignoring the interest of the participants. The following steps Arnstein summarizes as "*Tokenism*", where participants are informed and have the chance to issue their critique, but there is no mechanism that ensures a steady stream of participant feedback (ibid.). Lastly, she mentions the only "real" type of participation from her perspective, which is

"*Citizen control*" (ibid.). Here, participants act as co-deciders, having a veto and being able to make meaningful decisions, manifested through citizen committees.

Who participates?

The following question that arises concerns those involved in the participatory process. One approach is to enable participation that is possibly broad. The goal here is to represent the affected community as precisely as possible, since people from different backgrounds face different issues, which they can bring forward in the participation process. An example is a project on crime in multiple neighbourhoods of South Africa, where the only condition for participation is that all participants of one workshop must "*come from the same neighbourhood*" (Liebermann and Coulson 2004, p. 128). In this example, participant diversity is actively promoted, stating that "*a mix of ages and genders is encouraged*" (ibid.).

An alternative approach could be to invite "*engaged and knowledgeable community members*" who have skills and knowledge beneficial for addressing the issue at hand (Klain and Chan 2012, p. 105). Concretely the requirements could be as follows, exemplified in a community marine project: "*a) women over 18; b) women who knew the intertidal area well, and c) women who regularly practice intertidal gleaning*" (Paul et al. 2016, p. 83). Regardless of a broad participation or a "knowledgeable expert" approach, participation always entails an exclusive aspect. Due to practical limitations, not all community members can participate, and not everyone has an interest in participating. Those who do participate will never fully represent the entire affected community.

Potential drawbacks of community participation

Literature on negative consequences through community participation is scarce. Menezes (2003) reflects on a participatory project involving 14-year-olds, aiming to increase their interest in becoming active citizens and being open to different cultures. The project results were partly adverse: those who engaged in the project more often than others tended to value citizen responsibilities less than those who participated less often. Moreover, with one of the children groups involved, personal attitudes towards immigrants worsened after their project participation, achieving unfavourable results. She mainly attributes this observation to "*shallow*" participation, which is "*not particularly meaningful or balanced with opportunities for personal integration*" (Menezes 2003, p. 440). According to Menezes, there were too few opportunities to reflect on the participation, not enough emphasis on personal development and barely any interaction with people from different perspectives within the project. Menezes'

observations do not indicate a decrease in or even the cancelling of participation projects but instead promote the case for well-thought-through projects, taking the needs and interests of the participants into account.

3. Participation in a digital mapping context

Maps are inherently political and value-laden. They can manifest disputed borders or create new ones, thus legitimising political power. Mapping is most commonly done by "*a small group of experts, often on behalf of power holders and decision-makers*", using maps to shape reality (Cochrane et al. 2014, p. 9). Maps become particularly powerful not when they cause astonishment and uproar over the choice of demarcations or points of interest. Instead, they are powerful when they have been naturalized and are used as an objective piece of information, simply a tool to depict what is on the ground. This supposed objectivity is deceiving, as they suggest objectivity while being the product of values and human interactions, or as Harley puts it: "*Maps are a way of conceiving, articulating, and structuring the human world which is biased towards promoted by and exerts influence upon particular sets of social relations*" (Harley 2008, p. 129).

Characteristics of participatory mapping

A practice that challenges the implicitly manifested power relations is participatory mapping. Most commonly, participatory mapping is done by the local community housing in the area of concern, using local knowledge and resources to create a map alternative to the ones of the power holders. Next to the localized geographic aspect, those bottom-up maps are characterized by their participatory nature, not just in terms of the map as a product but also in the entire mapping process – although, as previously elaborated in the second chapter, the concrete participation in practice can vary drastically. The third characteristic of participatory mapping is transparency (Parker 2006). The decision-making process on what to depict on a map and how to do it is not traceable for regular maps. For participatory maps, it is crucial to disclose who participated in the mapping project, how data for the map was gathered and what criteria were used to create the final map.

Digital participatory mapping

In the case of classical cartography, for potential users of participatory maps to make practical use of them, the map needs to be printed and later reprinted after updates. That requires extensive financial resources. Additionally, those potentially interested in using the map need to be reached out in a time-consuming process. All three issues can be mitigated using web-based digital mapping technologies based on Geo-Information Systems (GIS). At its core, GIS software deals with the collection, organization, storage and analysis of spatial data (United Nations 2004). Ordinary GIS software is used linearly to convey spatial information gathered and organized by experts, similarly to classic cartography but in an online format.

This changes with the rise of "Web 2.0", the emergence of interactive social software, characterized by the blurring of boundaries between the providers and consumers of digital information. In a GIS context, Web 2.0 enabled the emergence of "*neogeography*", referring to "*people using and creating their own maps, on their own terms, by combining elements of an existing toolset*" (Turner 2006, p. 3). The umbrella-term neogeography mainly encloses three forms of participation-centred GIS – Public Participation GIS (PPGIS), Participatory GIS (PGIS) as well as Volunteered Geographic Information (VGI). Their distinction highly varies across the literature but with core commonalities. Both Ndzabandzaba (2020) and Brown and Kyttä (2014) agree that PPGIS practices mainly occur in the Global North, initiated by government agencies with the primary objective of improving mapping data. PGIS practices, on the other hand, are primarily situated in the Global South, initiated by NGOs and aimed toward social engagement and empowerment, with the created mapping as a secondary objective. VGI practices are common both in a Global South and North context. Its main characteristic is the decentralized nature of the mapping, mostly initialized by individuals. The participation is not bound to a single project but instead consists of an ongoing process where all individuals can contribute to the map at all times.

Practical limitations of participation-centred GIS

Particularly in PGIS, emphasis is placed on a community's involvement and empowerment. The practical usability of the gathered data and reaching out to possibly many potential users of created maps is a secondary goal. A meta-study of participatory maps revealed that most open maps are not being used or adapted by community members, with 61 % of analysed maps being identical to their default setting (Baillard et al. 2012). One reason for the low engagement might be the difficulty of navigating the map, with 36 % of surveyed crowd map users finding the map platform slightly confusing. Users and participants could be held back from using the map and contributing to it by issues related to the so-called "digital divide", the gap between those with skills or material needed to use digital technology like the PGIS maps

in this case and those who do not. Another reason for low user numbers could be related to a lack of financial resources to spread information about the map, as one of the biggest challenges in the study with participatory mapping platforms has been "*getting the word out quickly after the launch of the site*" (Bailard et al. 2012, p. 17).

4. Participatory mapping in a Global South slum context

It is not only critical how a region, its borders and physical entities are mapped but also if it appears on a map in the first place. Because of the top-down nature of conventional maps, powerholders can decide what to include in a map and what to leave out. In the case of slums and informal settlements, local governments tend to leave them unmapped: "*What is not on the map, does not exist, therefore what does not exist needs no attention and funds/solutions*" (Panek and Sobotova 2015, p. 4). Instead of using the term "informal settlement" as a euphemism for slum, the term "slum" itself will be used in this research. Informal settlements only imply their nature outside official city planning (Jason 2018). Inhabitants of those settlements do not necessarily suffer from poor living conditions and insecure environments. On the contrary, they may have consciously decided to move to a closed living community not recognized by the local authorities. Slum inhabitants, however, by definition, live in a disadvantaged environment. UN-Habitat has crystalized five criteria, which, if one or more are fulfilled, categorize a household as a "slum household": Lack of access to affordable, safe water, lack of access to safe sanitation, insufficient living space, insufficient housing durability and security of tenure preventing forced evictions (UN-Habitat 2007). Slums are predominately a phenomenon in the Global South, with most slum inhabitants in Eastern and South-Eastern Asia, followed by SSA and Central and Southern Asia in absolute terms. When related to the population size, urban regions of SSA showcase the highest share of slum inhabitants (Statista 2022). The issue of slums and their inhabitants' poor condition housing is widespread and demands relief options.

Mapping a slum does not directly improve the living conditions of slum households but has the potential to steer resources towards the most in need regions of a slum, thus improving living conditions. Next to the empowerment and skills mapping participants' experiences, the finished map could be of practical use to local authorities. Hasan (2006) researched the broader instrumental effects of participatory mapping and how mapping activities can lead to infrastructure improvements in slums. In his case study in India, the local government realized the potential of participatory mapping and decided to support the mapping activities initiated by a local NGO. The mapping serves as a sort of "SWOT analysis" (Strengths, Weaknesses, Opportunities, Threats), bridging the stark information asymmetry between the local government

and the slum. Because of a lack of interest or resources, authorities are often unaware of the concrete needs of slum inhabitants. Through mapping, critical education, sanitation, health, or security infrastructure can be targeted towards regions with the most urgent demand. Beyond, mapping has the potential to provide dignity to slum households, evoking a sense of recognition and validation as the efforts they have invested in their housing and their community become visibly recognized. Assembling an integral map, including all community members' demands and interests, is only possible through successful community participation. The next chapter will thus be dedicated to a set of theoretical criteria for evaluating PGIS projects.

Evaluation research of PGIS projects in a slum is scarce, as the mapping trend is relatively young. In this paragraph, three studies evaluating PGIS in different global regions will be presented, and their results summarized. Falco et al. (2019) research slums in the Venezuelan city of Caracas and take a more instrumental approach, evaluating not the mapping activity itself but how PGIS could influence city planning in the course of their so-called "action research". As coined by Kurt Lewin, this type of research actively involves the researcher in a participatory process and aims at problem-solving and can be viewed as "applied research". Through the action in the research, valuable knowledge is produced for a particularly vulnerable group (Walter 2009). On the critical side of the project, the researchers noticed a difficulty in collaborating with local authorities due to their opaque organizational structure as well as a disempowering effect of the used technology due to its complexity. Among positive results were the inclusion of information gained through the newly created maps in the two-year plan of local authorities. Further, the new maps enjoyed high popularity among the local residents, but interestingly only in a drawn-out, offline format.

Choplin and Lozivit (2019) analyse the experience of their PGIS action research in a slum of Benin's capital Cotonou. The most substantial impact of the map, according to their experience, has been evoking a sense of pride and community among the participants of the project. They were now being represented on a map the same as other neighbourhoods of the capital. One of the challenges they faced was a very low digital literacy among the participants, who were predominately young males. Apart from gender, the participants were diverse in their age, education, and employment status. Finally, they experienced difficulties in achieving autonomous continuation of the project without the involvement of the researchers.

Lundine et al. (2012) accompanied a PGIS project dealing with the Mathare slum in Kenya's capital Nairobi. In contrast to the project in Benin, an autonomous continuation of the project could be achieved through a local coordinator, continuing the project which researchers have previously kickstarted. Most participants had stable income sources, and those who stopped participating did so for monetary reasons. Beyond, the researchers have deemed

communication a vital project component. More precisely, they noted the importance of a simple language, constant communication and complete transparency in decision-making.

5. Criteria for successful community mapping in three stages

As elaborated in the second chapter, participation is a "*complex and value-laden*" concept. There is no overarching scientific consent on its definition and consequentially also not on methods evaluating it (Rowe and Frewer 2004, p. 516). For a plethora of reasons reflected on by Rowe and Frewer, evaluation of participatory projects should nonetheless take place: Firstly, there is a scientific interest in researching human behaviour in participatory projects, trying to understand power dynamics and the interplay among those participating. For ethical reasons, evaluation should ensure that participants are treated fairly and not deceived in the participation process. Lastly, evaluation is crucial for financial and practical reasons to design participation processes more effectively and reduce the costs of participatory projects.

This research aims to analyse the "success" of participation, which can be effectively translated into reaching a possibly high ladder from the participation frameworks from chapter one, empowering those who previously could not co-decide on matters concerning their own community (Verba 1967). Participation will be interpreted broadly, including criteria directly relating to participation (e.g. representativeness of the affected community). Criteria that indirectly affect participation will also be taken into account, such as convenience factors and conflict resolution, as participant discomfort could quickly result in project abandonment and thus decrease participation.

To narrow the research scope, the focus of this thesis will be the participation process instead of the outcome. Without a successful process, a successful participation outcome would be unlikely. Additionally, it is essential to note that multiple unknown variables may shape a successful outcome. Hence the process evaluation can turn out to be more precise (Rowe and Frewer 2004). For the evaluation, similarly to Cochrane et al. (2014), the mapping process will be spitted into three phases focussed on participation: the requirements for successful participation pre-mapping process, participation during the mapping process itself and post-mapping participation. Criteria (**which are highlighted in bold**) will be drawn mainly drawn from the extensive public participation literature review of Brown and Chin (2013), which they predominately based on the early works of Rowe and Frewer (2000). The focus will lie on their process criteria, while single criteria from other literature will be added.

Requirements for successful participation in the pre-mapping stage

During the early stages of preparation, the most critical matters concern the questions of who participates and how participants are being involved. The participants should be **representative** of the community there are mapping and "*comprise a broadly representative sample of the population of the affected public*" (Brown and Chin 2013, p. 565). Achieving an identical reflection of the affected population among the participants is often impossible due to practical reasons – young children or poorly mobile elderly people cannot do the mapping work in the field. Particular care should be given to gender, age, educational status and knowledge of the affected area to prevent the intensification of existing inequalities. In the worst case, only an unrepresentative elite would participate, leading to mapping outcomes beneficiary for a small group, exacerbating the distrust among the community.

Further significant is **early involvement** and seeking participants' input, particularly when decisions concerning community values need to be taken (Brown and Chin 2013). Practical circumstances limit early involvement. In mainly technical questions, involving the setup of GPS software, for example, involvement is not beneficiary for the participants and could overcomplicate the process. It should be communicated upfront what decisions have already been made and where there is room for participation. Decisions involving the well-being and safety of the participants and mainly decisions involving opinions and judgement, like the decision of what to map and to what community members to talk, must be made involving the participants. To prevent "*Nonparticipation*" or "*Tokenism*", as expressed by Arnstein (1969, p. 217), the project organizers should have a continuous mechanism for participant co-decision making, where they can make meaningful decisions instead of only issuing feedback to unilaterally decided matters through the organizers.

The decisions concerning the mapping have to be agreed upon **transparently**, so everyone can reconstruct how a decision has been made (Rowe and Frewer 2000). A lack of transparency can create distrust and cause conflicts, should sensitive information only be disclosed accidentally. That could lead to the abandonment of the project and general distrust from within the affected community. In a poor environment such as a slum, disclosure of potential financial compensation and attached conditions is necessary to prevent participants from being induced into unwanted actions through monetary incentives. Beyond, the project's sponsors should be made public so that the community members can at least assume their motivations for sponsoring the project. Next to financial aspects, organizers must be transparent about the aims and values of the project so that the participants can decide whether those resonate with their ones or not before agreeing to participate. Lastly, participants must be made aware of potential risks involved in their participation, even if insignificant, so that they are aware of all benefits and potential disadvantages before deciding to participate.

Moreover, the **task definition** needs to be clearly articulated, so participants know what processes they are involved in and when they need to make decisions (Brown and Chin 2013). Unclear role distribution and overlapping responsibilities can easily trigger misunderstandings, leading to dissatisfaction and conflicts among the participants. Optimally, the tasks and processes are communicated simply and straightforwardly to ensure participants with little to no GIS and mapping experience can easily follow the agreed-on instructions. Part of the task definition is the discussion of the participation's scope, i.e., where the task and the responsibilities of the participants end to prevent stress and overly long days of project work.

Lastly, as a practical matter, **comfort and convenience**, including timing the meetings right and making the participants feel comfortable, are not to be underestimated (Brown and Chin 2013). Participation in PGIS projects is primarily unsalaried or solely includes an insignificant expense allowance. Therefore, a positive and friendly atmosphere must be established to ensure that the participants feel appreciated and possibly recommend the project to others from the community. As part of that, the project organizers must ensure a respectful communication with participants. Regarding convenience, project meetings and mapping activities should be timed so that the most interested participants can attend all meetings and activities.

Requirements for successful participation during the mapping process

Technology is crucial in mapping execution and can have potentially exclusive effects. Therefore, the multifaceted framework of Van Dijk (2002) on technological access and usage will be employed to evaluate how well a project has managed issues related to the so-called "Digital Divide". In its report on the divide, UN-Habitat defines the phenomenon as the "*gap between those who have access to and use ICTs including internet connectivity, internet-enabled devices and digital literacy skills and those who do not*" (UN-Habitat 2021, p. 15). According to the report, the African continent faces the most significant gap in connectivity, with 23 % of the continental population having no access to a mobile broadband network. Furthermore, demographically, two groups tend to be affected the most by the digital divide: women (globally, 55% male population internet usage vs 48 % female) and the elderly (ca. 27 % of the urban older population lacks internet access).

The digital divide phenomenon is often viewed simplistically, and the issue is framed as a lack of computers or networks and user skills. Van Dijk (2002) views the issue more broadly and suggests a four-stage framework where he distinguishes four types of access barriers to digital technology. He commences with **mental access**, that being the mental barrier caused by anxiety or lack of interest in digital technology. The subsequent stage is the publicly most

widespread issue, **material access** and the lack of ICT hardware (ibid.). A report by the telecommunication organisation GSMA (2021) shows that despite 94 % of the global population being covered by mobile broadband, 3.4 billion people are still not using their available mobile connection. **Skills access** is widely understood as a lack of digital skills, knowing how to operate basic software and hardware (ibid.). In the case of digital mapping, where participants are mostly faced with GPS software that is novel to them, user-friendliness becomes a deciding factor for whether the participants' skills suffice for appropriate usage of the digital technology or not. Lastly, there has to be a significant application opportunity for using the ICT tool, allowing the participants to use the technology to its full extent (**usage access**) (ibid.).

On the non-technical side, the entire mapping process should have a **deliberative quality**, meaning the participants are given enough room to issue critiques and suggest improvements (Brown and Chin 2013). Practically, the deliberative quality could be manifested in regular meetings or digital platforms, enabling the participants to reflect on their mapping experience and communally discuss procedural, technological or interpersonal improvements.

Requirements for successful participation in the post-mapping process

In the post-mapping process, appropriate usage of the gathered data is vital. In this context, Sieber (2006) discusses the **representation of knowledge**. For a mapping context, the decision-making concerning the final visualized map is crucial. If the participation stops after mapping data gathering and does not include the final making of the map itself, the overall influence of the participants on the map must be questioned. Relying on the goodwill of the project organizers, designing the map according to the will and the information gathered by the participants can lead to misrepresentation. Especially in the map-making process, there will be highly technical steps, practically limiting input from the participants. Most foremost, participation is significant where judgements are being made, as previously stated.

A further criterium involving data is **ownership** (ibid.). Although one cannot "possess" data physically, one can have the right to data and decide what information gets published and who can access and change it. For example, data ownership issues could occur if a participant notices flaws or privacy concerns in the representation of data points he or she has gathered but is not granted access to make changes or deletions.

Finally, the **level of conflict** needs to be evaluated (Brown and Chin 2013). Tensions could arise when previously contested matters become "factualized" via maps, those conflicts need to be appropriately mitigated. To achieve overall participant satisfaction, all conflicting views should be discussed openly to agree on a compromise or a satisfactory solution for most

participants. All concerns should be taken seriously and not be easily dismissed by the organizers.

Each step of the mapping process requires a set of different evaluation criteria. In the following sections, the evaluation criteria that have been laid out in this chapter, together with the theoretical background on participation and participatory mapping, will be employed to conduct an analysis. A compact overview of all criteria can be viewed below in Table 1. Using the criteria, a case study involving a PGIS project will be evaluated on whether participation is successfully promoted according to the criteria.

Table 1: Criteria for successful community participation in digital mapping

Process evaluation Criteria	Source
Pre-mapping success criteria	
Representativeness	Brown and Chin (2013), Rowe and Frewer (2000)
Transparency	Brown and Chin (2013), Rowe and Frewer (2000)
Early involvement	Brown and Chin (2013), Rowe and Frewer (2000)
Task definition	Brown and Chin (2013), Rowe and Frewer (2000)
Comfort and convenience	Brown and Chin (2013), Halvorsen (2001)

Success criteria during the mapping

Mental access	van Dijk (2002)
Material access	van Dijk (2002)
Skills access	van Dijk (2002)
Usage access	van Dijk (2002)
Deliberative quality	Brown and Chin (2013), Halvorsen (2001)

Post-mapping success criteria

Representation of knowledge	Sieber (2006)
Ownership	Sieber (2006)
Level of Conflict	Brown and Chin (2013)

III. Methodology

A single case study approach has been employed to answer the research questions, involving semi-structured interviews to gather relevant data. In this chapter, the emphasis will lie on the reflection of the research method and tool. Further in this chapter, the approach to analysing the gathered data will be laid out. Deductive thematic content analysis has been used to structure and contextualize the data.

1. Case Study: Map Kibera in Nairobi

A single case study approach has been chosen to critically reflect on the underlying mechanics of participatory mapping: How do participants get to decide on what gets mapped? What happens if they have diverging views from the project supervisors? Beyond, the mediating role of technology in participation will be evaluated, and digital divide issues will be discussed with the interviewees. For case study research, "how" and "why" questions are most appropriate:

they tend to explain the underlying dynamics of a process and deeply explore the nature of the chosen case and are better for tracing a process over time (Yin 2009). Accordingly, the researcher should dismiss a case study approach if the research question and underlying theory suggest a different approach, such as statistical modelling. This approach, for example, would be more appropriate if the research question of interest focuses on two or more quantifiable variables and their influence on one another. According to Yin (2009), central in a case study is the concretization of the issue of interest. That is where the previously discussed criteria become relevant, as they work as structuring tools, guiding the judgement of the case study.

Single case study approach

The research questions will be approached with a single case study. While evidence from two cases might be considered more robust than a single case approach, the latter allows exploring the rationale of an unusual or extreme case more in-depth (George and Bennett 2005). The choice for a single case study approach falls back on the significance of the chosen case, making it particularly interesting to study. The researched project is well studied and often mentioned as one of the particularly "*significant cases of participatory mapping projects in informal settlements*", which is especially intriguing to study since "*the application of geo-information tools in informal settlements has not been as widespread as in more developed contexts*" (Falco et al. 2019, p. 3). In the literature, the project is regarded as particularly successful compared to similar ones in the same area (Falco et al. 2019; Panek and Sobotova 2015).

Case Study subject: Map Kibera

Concretely, the subject of this research will be the PGIS project "Map Kibera", named after the slum the project intends to put on a map, "Kibera", situated in the capital of Kenya, Nairobi. The name Kibera, translating roughly to "jungle", reflects the central issues of the slum from an urban city planning perspective: Kibera was a "*blank spot on the map*" (Hagen 2017, p. 11), with poorly planned and build road infrastructure, lack of clean water supply, poor health services, inadequate schooling facilities and barley any governmental security provision. Kibera is characterized by "*mass poverty, contagious diseases, conflicts, and other social, ecological and economic hazards*" (Mutisya and Yarime 2011, p. 200). Surprisingly, only 8.5 % of male Kibera inhabitants had no occupation, according to a 2011 study, which is the most recent one on Kibera socio-demographics. Nonetheless, job insecurity persists, with 45 % of respondents only working day-to-day jobs in the informal sector (Desgropes and Taupin

2011). Furthermore, 5 % of respondents of a 2014 study on Kibera youth reported having completed secondary school education or are currently studying, 7 % had completed vocational training or were currently in the process, and 3 % had a university degree or were currently enrolled in a degree program (Onyango and Tostensen 2014). From the local government side, the slum has either been visualized as a park or a small formal settlement (Panek and Sobotova 2015).

This poorly mapped area has an extremely high population density, with Kibera inhabitant estimates reaching up to one and a half million for an area of around 2.5km² (The White House 2010; Mutisya and Yarime 2011). Other researchers see this popular estimate as flawed and place the estimate to a significantly lower 200,000 inhabitants, based on areal satellite scans (Desgropes and Taupin 2011). The strong contrast in population numbers reflects the general lack of reliable data on Kibera and a lack of knowledge of the needs and achievements of Kibera slum residents. The Kibera slum does not represent a unique issue in Nairobi, as roughly half of the city's inhabitants live in densely populated slums, which take up only below 1% of Nairobi's city area (Mutisya and Yarime 2011).

Map Kibera's goal is to bridge the information asymmetry between local government and development organizations and provide slum residents with the tools to capture what is there and what is not in Kibera and manifest that information through a digital map. The project started in 2009 with the US consultancy firm Ground Truth Initiative, teaching a group of 13 slum residents to use a GPS device and identify what they found to be the most relevant points of interest in their familiar surroundings. Since then, the project has constantly been expanding. Themed maps were created emphasising education, water management and health institutions as well as showcasing security risks in certain areas. Beyond, the news network "Kibera News Network" and the radio "Voice of Kibera" have been brought to life. After a trial phase of mainly encouraging unpaid volunteers to map, the American project organizers switched to paying the mappers, realizing the little room for volunteerism, as the slum residents have little time on their hands, constantly needing to secure a daily income (Hagen 2017).

Map Kibera can be considered a typical example of a PGIS project, as elaborated in chapter three of the theory section. The project, initiated by an NGO, takes on a centralized mapping approach oriented around a row of regular projects. The final Map created is visualized through the free software OSM (see Figure 1). One of the project's success factors can be led back to the broad approach to community involvement within the project: Next to engaging local mappers, large forum meetings were held before and after mapping activities engaging local residents, village elders, governmental authorities, NGOs, and local media to discuss interests and priorities of the separate stakeholders and improve the mapping processes. As a result, map Kibera has been transformed into a permanent trust, consisting of the initial volunteers,

engaging new community mappers to update and thematically expand the digital Map of Kibera and continue the journalistic work – indicating the success of achieving project sustainability without oversight from the US-based NGO. Further, mapping activities have expanded to neighbouring slums. Unfortunately, information about the current funding mechanisms of Map Kibera's work cannot be found on the organization's website (Map Kibera Trust n.d.).

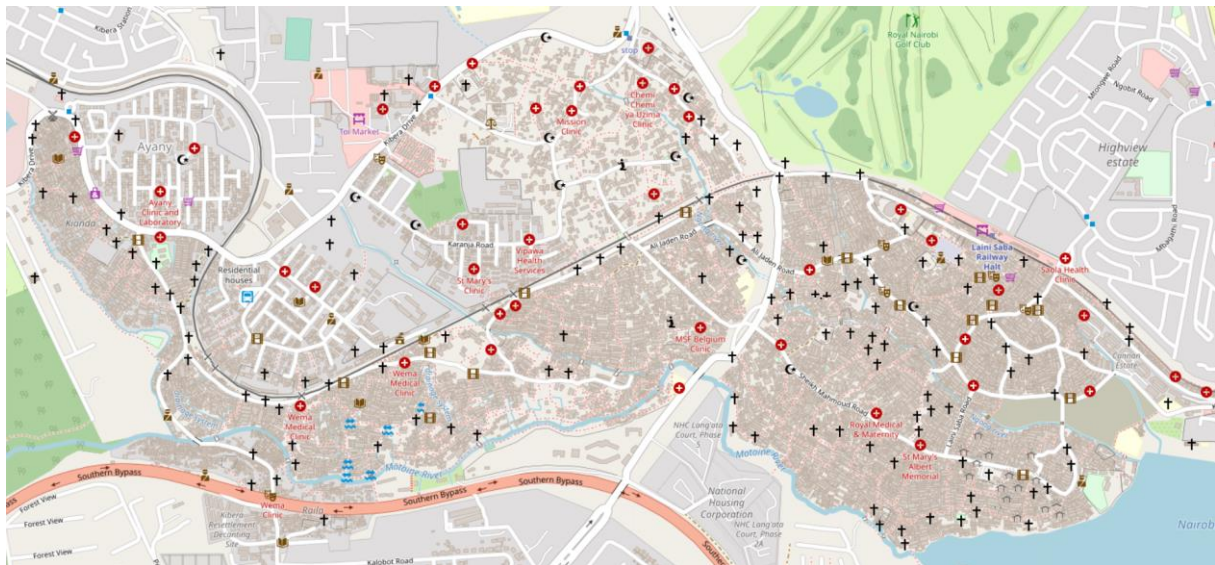


Figure 1: Screenshot of the OSM map of Kibera including facilities like hospitals, schools, or churches

2. Interviews with Map Kibera participants

A qualitative tool has been chosen, as the research goal is to gain new insights on a timely and specific issue that has not yet been extensively studied. Mainly, semi-structured interviews will be conducted. In the scope of such an interview, the researcher employs a mixture of closed and open-ended questions, followed by follow-up questions. The researcher can liberally deter from pre-prepared questions as long as the primary research question is addressed (Adams 2015). Most of the success criteria of interest are somewhat subjective, hence the ability to pose follow-up questions for clarification is beneficial. In the case of this research, interviews are more appropriate to gain reflected insights on participants' experiences and opinions rather than a more rigid questionnaire. While open interviews could deliver more significant responses since the interview can be "customized", the data evaluation takes considerably longer with that type of interview (Jupp 2006). A further matter to consider is ethical considerations, particularly receiving informed consent from the interviewees and assuring confidentiality (Given 2008).

Since the research interest lies in the current stand of Map Kibera's activities, ten participants of the previous mapping training, which took place between March and September 2021, have been reached out. Led by Map Kibera trust members (who will be followingly labelled as "organizers"), the participants were trained on mapping activities related to the central themes

of education, sanitation, and water management. In addition, they were taught how to use GPS mobile software. As a novelty, they were trained to conduct surveys among slum residents using the software "ODK". The surveys mainly dealt with the residents' experiences dealing with the COVID pandemic and accompanying restrictions.

To gain insights into Map Kibera participants' experiences, the success criteria for participation from the fifth chapter of the theory section have been operationalized into open questions. A sample of the most important interview questions can be viewed in Table 2. Before the interviews, consent forms and a document providing an overview of the research and the interview aims have been distributed to the eight participants and one organizer, with whom interviews could be secured. The sample breakdown of interviewees, including the organizer, can be found in Table 3. In total, nine interviews via the digital conference software Zoom have been conducted, lasting approximately 40 minutes each. The interviews were recorded, which has been highlighted in the consent forms and emphasized prior to the start of the recording.

Table 2: Interview question sample

Mapping stage	Question
Pre-mapping stage	<p>Did you feel like you had sufficient knowledge on Map Kibera after the first few trainings?</p> <p>Did you suggest your own ideas on the course of the training or mapping? What did you suggest? How was your suggestion reacted on?</p> <p>How would you describe the atmosphere during the training and in the mapping process?</p>
During the mapping	<p>How did the feedback mechanism during the training look like?</p> <p>How happy were you with the skills taught during the training? Did they turn out to be useful during the mapping?</p> <p>How did your initial feelings towards the used GPS technology change after the mapping?</p>
Post-mapping process	<p>Could you describe the process how the decision was made on what to include in the final map and what information to leave out? Were you content with that process? Why (not)?</p>

How comfortable did you feel to issue critique towards the training sessions or the mapping process?

Table 3: Interviewee sample breakdown (8 participants + 1 organizer¹)

Age	Gender		Highest education			Working status			ICT Skills ¹
	F	M	Secondary school	Vocational training	University degree	Volunteering	Student	Working in their trained field	
Average: 26	4	4	1	4	3	2	1	5	7
¹ Organizer: Male, working full-time for the Map Kibera trust, education and ICT skills unknown									

3. Analysis

After the nine interviews were conducted, the software "Amberscript" was used to transcribe the interviews and manually improve the transcription afterwards. The subsequent research steps were the analysis and evaluation of the interviews. Thematic content analysis for analysing the interviews has been chosen. The analysis aims to structure large sets of qualitative data like interviewees' perceptions, knowledge or experiences and link them to themes previously identified in the literature – in this case, the criteria of successful participation (Table 1). This analysis method allows the researcher to work with the qualitative data flexibly through the linkage with broad themes. However, the downside of this method is the assumption about the similarity of the interviewees' responses, involving generalizations and subjective decisions made by the researcher (Burnard 1991).

Concretely, the software "Atlas.ti" has been employed to perform the analysis. As the phenomenon of participation is well studied, the decision has been made to work mainly with a deductive analysis approach, as Elo and Kyngäs (2008) suggested. Using the participation literature mainly applied in a Global North PPGIS context, this research intends to expand its utilization and employ it in a PPGIS project in the Global South. After repeatedly reading through the interview transcripts while making notes, a series of codes have been established, providing relevant interviewee statements with "headings". Coded were statements that appear particularly often through multiple interviews or strongly contrasted the research

¹ self-assessed on a 1 to 10 scale (rounded average)

expectations and expectations derived from the literature. Subsequently, the codes have been matched to the themes from the literature. Since mostly open questions were asked, some responses led in thematic directions not previously foreseen. Those responses have also been coded, and new categories for new themes have been created inductively. After presenting the analysis based on the preselected participation success criteria in the following results section, the newly established themes will be presented in the discussion section.

IV. Results

This section will present the results of the criteria-driven interviews with Map Kibera participants. As done in the fifth chapter of the theory section, the evaluation criteria will be split up into three different stages while discussing particularly significant results more elaborately in the following discussion section.

1. Pre-mapping stage

The interviewee sample breakdown in Table 3 already foreshadows the low degree of **representativeness** of the training participants for the entire slum population. There is gender parity in the sample of interviewees. Their average age of 26 is higher than the current Kenyan average of 19.7 (World Population Review 2022). Only one interviewee has not had additional education after finishing secondary school level. Four have enrolled in some sort of vocational training, two have completed a bachelor's degree, and one is currently studying. Most have recently started working in formal employment relations, having secured a job in their training field. Two are currently volunteering within the slum community. Most have rated their ICT skills relatively high, with an average of seven on a scale from one to ten. Five interviewees currently reside in the Kibera slum, two in the Mathare slum and one in a neighbourhood outside the slum. Half of the interviewees had previous experience in working with Map Kibera.

All interviewees expressed satisfaction with their **early involvement** in the project. One interviewee highlighted that the organizers asked "*a lot of questions before we (the participants) started any activities*", dealing with the future course of the project (Interviewee ID 4²). The organizer pointed out that the survey, used by the participants to gather quantitative data on community members, was created in a participatory process. All interviewees could confirm that, and one pointed out that "*our (the group's) suggestions really [went] into surveying*

² for reasons of confidentiality, all interviewees have been labelled with IDs, which only I can match to the nine interviewees

and maybe [made] additions that played a crucial role in gathering the data that we needed", showcasing the high impact of participants on the survey (Interviewee ID 2).

Results on **transparency** were mixed. All interviewees were aware beforehand that they were financially compensated and knew the sum of money they would receive. 55 % of the interviewees were satisfied with the amount received. Only one interviewed participant was aware of the project's sponsor and financing model. The aims of the project were not clear to all. Particularly while surveying slum residents as part of the mapping process, 44% of interviewees issued uncertainty about the benefits of the project after being asked questions from the community like "*when I do this (fill out the survey), what is the outcome?*" (Interviewee ID 7). All interviewees reported being aware of potential project risks related to the project, mainly getting in uncomfortable situations with locals who could react negatively or even aggressively when being confronted with the survey.

75 % of interviewees reported satisfaction with the **task definition**. One interviewee mentioned a clear discussion of "*all our accountabilities while at the field, the dos and don'ts and what information we [should] collect*" (Interviewee ID 8). Two mentioned troubles with the "*demarcation of the areas needed to be mapped*", as some areas were mapped and surveyed twice, leading to an unnecessary workload (Interviewee ID 3). They both noted misunderstandings relating to the participants' responsibilities, as those were communicated in an unclear, too complex manner.

All participants reported a pleasant environment during the meeting, including enough breaks, a respectful tone from the organizers and a conveniently reachable meeting place, positively affecting **comfort and convenience**. All input from the participants has been taken on with appreciation, noted three participants. Two participants also suggested a change in the training time, and the proposition got acknowledged. A factor affecting personal comfort for some has been the GPS tracking of the participants themselves through the organizers. One participant reported feeling slightly uncomfortable through the tracking, and another one felt pressured, feeling like the organizers would "*assume maybe you are sitting (procrastinating) or having an unnecessary conversation*" (Interviewee ID 4).

2. During the mapping process

Half of the interviewees felt excited to use the little-known GPS technology, and none stated fear or discomfort with the new technology. Two reported the GPS trial run performed before the actual mapping process in the field as particularly helpful for getting comfortable with the technology and improving **mental access**. Entirely unproblematic has been the **material**

access. All participants were provided with smartphones carrying the GPS and survey software while having access to laptops. Further, their costly mobile data usage needed for mapping has been reimbursed, but only after voicing the expense as an issue to the organizers. **Skills access** has mostly been unproblematic, either. All but one interviewee reported confidence in using the GPS software after the training. The software mostly was seen as user-friendly, with one interviewee elaborating that it "*had already been set in such a way that maybe if I'm going somewhere (...) [it] will automatically give me the correct place that I am*" (Interviewee ID 1). Half of the interviewees reported minor technical difficulties at the start, which were quickly solved during the following days of mapping. Only **usage access** could be problematic since – as later elaborated – most participants were not taught how to compile the actual maps and thus could not fully benefit from the technology at hand.

All participants stated high satisfaction with the feedback system during the mapping process, indicating high levels of **deliberative quality**. Daily meetings took place before the participants were dispatched into the field, where the participants would "*discuss what the previous day was like the challenges and maybe the opportunities and what can be done better so that the project comes up successful*" (Interviewee ID 2). Feedback and suggestions were also communicated through the text-messaging group of the project, allowing real-time feedback while in the field. Overall, all participants felt they carried a significant function in the project and could meaningfully contribute to important decisions.

3. Post-mapping stage

All interviewees reported, that the map-making process and thus the final visualization of the map has been exclusively done by the organizers, showcasing flaws in the **representation of knowledge**. The generation of the map and analysis of the data was not meant to be part of the project and reached beyond the announced project timeframe. All but one participant expressed interest in joining the map generation process. For everyone interested, the organizers allowed to spectate the map-making process but – most likely for time constraint reasons, since that process took place beyond the agreed-on timeframe – no one used this opportunity.

Ownership of the collected data mainly was provided, as the utilized open-access map software OSM allows for liberal adjustments by anyone after the generation of the map. The participants were also taught how adjustments could be made on a technical level. However, interest in making changes was low. None of the interviewees reported having made any adjustments to the generated map.

The **level of conflict** was low. 75 % of interviewees stated the absence of any escalating disagreements among the participants or between the organizers and the participants. Two participants highlighted the importance of the daily morning meeting in conflict mitigation, as those offered rooms to discuss misunderstandings and find solutions for daily issues. Two participants experienced some level of conflict. They recalled the meeting times as well as the content of the survey as sources of conflict. Both reported satisfaction with the handling of the conflict topics. One of them underlined the horizontal conflict resolution: "*The officials did not rule. But it is the participants, the members, who agreed. We were given time to discuss and agreed*" (Interviewee ID 3).

After briefly summarizing the results of the interviews in the following section, a reflection on the overall success of the researched map Kibera training will follow, introducing new criteria that emerged through the interviews. Finally, recommendations will be issued, and the limitations of this study will be disclosed.

V. Discussion

1. Overview of the results

Overall, most criteria can be considered fulfilled after a thorough analysis of the interview material. In the pre-mapping stage, early involvement, as well as comfort and convenience were overall reported as satisfactory. A limitation to the comfort of some participants could be considered the constant position-tracking through the organizers. Task definition has overall worked well, with only two participants noticing minor misunderstandings. The organizers were not fully transparent with the participants. While the potential risks of the project participation and the financial compensation were openly discussed, most interviewees were unaware of the project's sponsor, and half had difficulties clearly describing the project's aims. Representativeness of the overall slum population was low. Most interviewees were well educated and had previous experience with mapping and overall experience with ICT technology. During the mapping, digital divide issues were not a significant concern. The participants were provided with the necessary hardware and skills to fulfil their tasks. The feedback system worked well through regular meetings. Problematic after the mapping was the weak inclusion of participants in the map generation. While they had the chance to learn the map-making process and later individually update the map, both were not designed as an integral part of the project process. Lastly, the conflict rarely occurred and was experienced in some form only by two participants who were fully satisfied with its resolution.

2. Map Kibera – fulfilling all success criteria?

The function of this chapter is contextualising and reflecting the research interview results. Apparent in the pre-mapping stage is the low representativeness. While ca. 90 % of the project participants had either done vocational training or a university degree, only 10 % of Kibera inhabitants have education beyond secondary school. The well-educated participants in a slum with poorly educated residents resonate with the "*engaged and knowledgeable community members*" approach mentioned by Klain and Chan (2012, p. 105). It is also worth mentioning that most interviewees have stable formal employment. The lifestyle and thus the issues, participants face in their daily living, significantly differ from those of the broad community. They have more career opportunities and benefit from a better social network. Including mostly privileged community members in the project could result in Map Kibera being viewed as "elite affair", alienating those without a stable income or higher education. Choplin and Lozivit's (2019) project achieved gathering participants from a high age range as well as a diverse employment. During their project in Benin, they actively sought participant diversity, which was not the case with Map Kibera. Further, the training in Benin only lasted eight days, in contrast to Map Kibera training lasting multiple months. The longer training suggests a higher complexity of the taught information, potentially requiring a higher education for full comprehension.

Positive from a representativeness perspective, was the fact that all participants have lived or are still living in the slum and thus are familiar with the community and difficulties. They might not have to face them to a full extent anymore as they can, for example, afford medical services or schooling for their children. Further, the gender parity among participants, in contrast to the project of Choplin and Lozivit (2019), where participants were mainly male, is significant. The unemployment among women in Kibera is 45 %, much higher than the 8.5 % unemployment rate among males, leaving women far more marginalized than men. The gender parity among Map Kibera participants shows that the organizers realized the problematic position of female slum residents and tried to empower them.

Few interviewees experienced issues related to the digital divide and digital access. The training prepared the participants well for the mapping and surveying activities, and the trial run helped to get familiar with the GPS technology. No interviewee reported limitations with participating in the mapping process due to the inability to afford required decisions or software. This contrasts with the experiences of Choplin and Lozivit (2019) in their Benin-based project, which faced issues with the utilized software due to the low digital literacy among participants. Most likely, the high level of education among Map Kibera participants could explain that difference. When viewed through Van Dijk's access framework, usage access appears problematic. The user of technology, in the optimal case, is supposed to be able to "*improve*

one's position in society" (van Dijk 2002, p. 3) using the full range of benefits technology offers. At the end of the project, the participants could not fully benefit from the map they created through the information they gathered based on their local expertise. Limiting access and not giving priority to participant involvement in the map generating step significantly decreases the participants' ability to co-design the final product of the project, the map.

Next to the lack of involvement in the map-generation process, the problem is that the map does not seem very significant for all participants. Only three interviewees said that they had made use of the map after they participated in Map Kibera. The map's low significance could explain some difficulties in clearly articulating the benefits and opportunities the map might open up to the surveyed community members. Even if the benefits of a map were communicated during the training – should they not resonate with the participants, decreased personal involvement in the project could be the effect. The participation could end up not being sufficiently "*meaningful*", as Menezes (2003, p. 440) puts it, resulting in a decreased interest in future community participation or even adverse reactions, as was the case in Menezes' case study, where participants developed a negative sentiment towards future participation.

The responses towards future participation from the participants counter this hypothesis. All expressed interest in working with Map Kibera in the future and would recommend the project to their peers, despite the supposed lack of meaningfulness of the map. This instance could be connected to the thought-through project coordination and successful active engagement of the participants. Questions about early involvement and task definition revealed the organisers' flexibility and interest in co-designing the training and mapping activities with the participants. A pleasant mode of communication, a comfortable working atmosphere and constructive conflict resolution might also have contributed to the participants' overall satisfaction and their perceived high degree of decision-making power. This observation resonates with a similar project carried out in the Kenyan Mathare slum, studied by Lundine et al. (2012), where the researchers deemed the simple, constant and transparent communication as centrepieces of mapping success. Moreover, both the mapping projects in Kibera and Mathare employed local coordinators and managed to autonomously continue the project, in contrast to Choplin and Lozivit (2019), where the project was discontinued after the researchers left. Granted that the local coordinator finds sufficient sponsorship and adequately discloses the sponsor to participants, this model could help achieve regular mapping activities, continuously updating the map.

3. The emergence of new criteria

The literature on public participation evaluation in a PPGIS setting in the Global North is relatively elaborate. On the other hand, literature for concrete criteria for evaluating PGIS projects situated in the Global Souths is scarce and exists mainly in the form of a recommendation segment at the end of action research literature (Paul et al. 2016; Falco et al. 2019). Thus, evaluation criteria have been used, which might not fully fit the context of a slum in Nairobi. In the course of the interviews conducted with the Map Kibera participants, new themes emerged which could be further explored due to the semi-structured nature of the interviews. Two themes particularly relevant for successful participation in PGIS projects in similar settings as Map Kibera have been identified and will be briefly discussed in this chapter.

Safety risk

Closely related to the notion of comfort is the factor of safety. Participants need to feel secure, knowing that the participation activity will not cause them any harm. The risk of participating should not outweigh the personal benefits achieved through participation. In an environment with concentrated poverty levels, such as a slum, crime rates are significantly higher than in areas outside of slums, as shown in a 2014 study on slums of Nairobi. The authors found that *"98.8% of slums residents have either witnessed or been victims of crime"* (Musoi et al. 2014, p. 16). Guaranteeing participant safety in such an environment is a significant challenge.

Financial compensation

A criterium particularly relevant in a poor neighbourhood like a slum is the financial compensation of the participants. A study on motives for community participation in China lists the *"lack of information, effective communication or convenient tools"* as examples of constraints to participation (Li et al. 2020, p. 3). Financial constraints are equally relevant, as most public participation projects are on a volunteer basis, hence assuming the participants should have the possibility to "work" without any form of compensation. That is not an option for many slum residents, particularly those without an occupation or only informal day-to-day jobs. Paying the participants, as was done in the project researched by Lundine et al. (2012), opens the possibility of participating in PGIS projects for those who cannot fall back on any savings. On the negative side, the payment could suggest an employment opportunity through the participatory project. Three interviewees wished for more regular PGIS projects through Map Kibera. A regular payment over extended periods could create the false impression of a stable income, which is not the project's aim. Clear communication that the project does not

substitute employment and a modest compensation, such as in the case of Map Kibera, could be considered.

4. Recommendations

Through employing the evaluation criteria on participation from the literature on Map Kibera and exploring novel criteria through the interviews, recommendations for NGOs or local authorities interested in setting up PGIS projects can be derived. PGIS projects need to include diverse community members to achieve a map representing the community's diversity. As seen with Map Kibera, public participation projects are at risk of attracting participants who are socially and financially privileged. Possibly simple language to avoid misunderstandings, user-friendly technology and some form of compensation should be employed to attract community members from low socioeconomic backgrounds. Daily meetings, asking actively for input in earlier stages of the project and aiming at participant involvement in every stage – if there is sufficient interest – decrease conflict and enable meaningful decision-making through participants. Moreover, efforts to include participants in the map-generating process should be increased. Map generation should be made an integral part of the project, teaching all participants the necessary software tools to perform basic steps towards creating the map, which experts could then review.

The issue of the low significance of the map should be subject to further research. The little map usage through the sampled project participants indicates a generally low demand for the map. However, a detailed study among slum residents concerning map usage would be needed to confirm this suspicion, which would be generally advisable after the conclusion of every project's mapping phase. A best practice from the Kibera project on map relevance is the inclusion of all relevant stakeholders prior to the start of the project, as elaborated in the second chapter of the methodology section, so that a collective agreement can be made on what information to include in the map and what digital or physical form the map should take.

The significant safety concern in high-risk areas such as a slum is challenging to mitigate. One way to decrease safety concerns is to only send locals of the mapped area into the field, which was the case with Map Kibera. 75 % of interviewees voiced security concerns. The 25 % of participants who felt safe said they felt that way because they knew the area they mapped well and had a network of community members looking out for them. A further safety strategy, which was previously discussed as a potential source of discomfort, could in turn increase the safety perception: the position tracking of participants. 75 % of interviewees viewed tracking as a positive factor, making sure that the organizers could quickly inform local police if participants should derail from the agreed-on route.

Particularly the new criteria, safety and compensation, could also be relevant for participatory mapping projects in a European context. Neighbourhoods where outsiders are unwelcome and could be endangered if they were to walk with a GPS and survey locals also exist in Europe. Mapping such areas could greatly benefit from the experience of locals who are trusted by the community and know how to avoid dangerous situations. Beyond, financial compensation for mapping in particularly disadvantaged areas could be considered. That would allow those who depend on their daily income to participate, contribute to their own community and gain valuable skills. Brief interviews with potential participants could rule out those who are purely motivated by the compensation and showcase no interest in the mapping activities.

5. Limitations

The results of this study need to be viewed within the context of the following limitations. First, reaching out to one cohort of participants has posed a challenge, as many do not have a constant internet connection due to the high costs of mobile internet. This issue was also problematic during the interview, as it consumed large amounts of mobile data, causing some participants to run out of data mid-interview. The language barrier has only been a minor issue with some interviewees. Instead, connection issues forced the repetition of many questions, possibly distorting some responses. Finally, it should be noted that the interviewed Map Kibera participant sample only represents a snapshot of Map Kibera's activities and can only offer a representation of the 2021 cohort and their experiences. It would be of scientific interest to purposefully select a participant cohort with less privileged demographics, such as an older, less educated group. Results will vary across different pieces of training of Map Kibera. Optimally, interviews with many participants from multiple cohorts should be conducted, which unfortunately reaches beyond the organizational capacity of this research.

VI. Conclusion

Public participation is a fuzzy concept, nonetheless benefiting from evaluation for scientific, ethical and instrumental reasons (Rowe and Frewer 2004). In the course of this thesis, distinct success criteria related to a broad understanding of participation in digital mapping projects were identified. The criteria split into three mapping stages have been particularly beneficial. Each step of the mapping requires a different set of criteria, contributing to the successful run of PGIS projects – providing community members who were previously not empowered with decision-making power. The criteria have been tested on a project considered significant, as it is often mentioned in the literature on digital participatory mapping: the mapping project Map

Kibera in a slum of Nairobi. Through the case study, room for improvement was detected in the overall representativeness of the slum community, transparency towards the participants and openness of the final map-making step. Nonetheless, valuable insights were identified through the evaluation of the project, namely mechanisms for the strong integration of participants in the early decision-making process, the free provision of simplified and user-friendly technology and a democratized conflict resolution. Further, two often overlooked criteria have been discovered: mitigation of safety risks for participants and financial compensation. Altogether this study has demonstrated what criteria need to be considered for the successful implementation of PGIS projects and, based on a criteria-based evaluation of Map Kibera, how those projects can be improved.

For future research, a more outcome-focused study of PGIS projects could be of interest. For example, the usage of the map through local authorities could be considered, researching how participatory maps could contribute to a more demand-oriented provision of certain services like sanitation, education, or health, as done in the Indian research by Hasan (2006), presented in chapter four of the theory section. Further of interest could be determining what factors influence the usage of a map by the targeted community. As done by Panek and Sobotova (2015), different mapping approaches could be compared in detail. Worth studying would also be the possibility of creating an offline map next to a digital map, as done in the action research of Falco et al. (2019), to produce a community map with the highest possible relevance for the community.

Publication bibliography

Adams, William (2015): Conducting Semi-Structured Interviews. In Maggie Walter (Ed.): Handbook of Practical Program Evaluation. Available online at https://www.researchgate.net/publication/301738442_Conducting_Semi-Structured_Interviews.

Arnstein, Sherry R. (1969): A Ladder Of Citizen Participation. In *Journal of the American Institute of Planners* 35 (4), pp. 216–224. DOI: 10.1080/01944366908977225.

Bailard, Catie; Baker, Rob; Hindman, Matt; Livingstone, Steven; Meier, Patrcik (2012): Mapping the Maps. - A Meta-Level Analysis of Ushahidi & Crowdmap. Available online at https://irevolution.files.wordpress.com/2013/01/internewswpcrowd globe_web-1.pdf, checked on 5/29/2022.

Brown, Greg; Chin, Sean Yeong Wei (2013): Assessing the Effectiveness of Public Participation in Neighbourhood Planning. In *Planning Practice and Research* 28 (5), pp. 563–588. DOI: 10.1080/02697459.2013.820037.

Brown, Greg; Kyttä, Marketta (2014): Key issues and research priorities for public participation GIS (PPGIS): A synthesis based on empirical research. In *Applied Geography* 46, pp. 122–136. DOI: 10.1016/j.apgeog.2013.11.004.

Burnard, Philip (1991): A method of analysing interview transcripts in qualitative research. In *Nurse Education Today* 11 (6), pp. 461–466. DOI: 10.1016/0260-6917(91)90009-Y.

Choplin, Armelle; Lozivit, Martin (2019): Mapping a slum: learning from participatory mapping and digital innovation in Cotonou (Benin). In *CyberGeo*. DOI: 10.4000/cybergeog.32949.

Cochrane, Logan; Jon Corbett; Peter Keller (2014): Impact of Community-based and Participatory Mapping: Unpublished. Available online at https://www.researchgate.net/publication/301691511_Impact_of_Community-based_and_Participatory_Mapping.

Desgroppes, Amélie; Taupin, Sophie (2011): Kibera: The Biggest Slum in Africa? In *Les Cahiers d'Afrique de l'Est / The East African Review* (44), pp. 23–33. DOI: 10.4000/eastafrica.521.

Falco, Enzo; Zambrano-Verratti, Jesús; Kleinhans, Reinout (2019): Web-based participatory mapping in informal settlements: The slums of Caracas, Venezuela. In *Habitat International* 94, p. 102038. DOI: 10.1016/j.habitatint.2019.102038.

George, Alexander L.; Bennett, Andrew (2005): Case Studies and Theory Development in the Social Sciences: MIT Press.

Given, Lisa (Ed.) (2008): The SAGE Encyclopedia of Qualitative Research Methods. 2455 Teller Road, Thousand Oaks California 91320 United States: Sage Publications, Inc.

GSMA (2021): The State of Mobile Internet Connectivity 2021. Available online at <https://www.gsma.com/r/wp-content/uploads/2021/09/The-State-of-Mobile-Internet-Connectivity-Report-2021.pdf>, checked on 2/6/2022.

Güneralp, Burak; Lwasa, Shuaib; Masundire, Hillary; Parnell, Susan; Seto, Karen C. (2017): Urbanization in Africa: challenges and opportunities for conservation. In *Environ. Res. Lett.* 13 (1), p. 15002. DOI: 10.1088/1748-9326/aa94fe.

Hagen, Erica (2017): Open mapping from the ground up: learning from Map Kibera: Instiute of Development Studies. Available online at <https://opendocs.ids.ac.uk/opendocs/handle/20.500.12413/13244>.

- Halvorsen, K. E. (2001): Assessing public participation techniques for comfort, convenience, satisfaction, and deliberation. In *Environmental Management* 28 (2), pp. 179–186. DOI: 10.1007/s002670010216.
- Harley, brian (2008): *Geographic Thought. A Praxis Perspective*: Routledge.
- Hasan, Arif (2006): Orangi Pilot Project: the expansion of work beyond Orangi and the mapping of informal settlements and infrastructure. In *Environment and Urbanization* 18 (2), pp. 451–480. DOI: 10.1177/0956247806069626.
- Irvin, Renee A.; Stansbury, John (2004): Citizen Participation in Decision Making: Is It Worth the Effort? In *Public Administration Review* 64 (1), pp. 55–65. DOI: 10.1111/j.1540-6210.2004.00346.x.
- Jason, Will (2018): Slums, Informal Settlements, and the Role of Land Policy. Available online at <https://www.lincolninst.edu/publications/articles/sustainable-development>, updated on 5/29/2022, checked on 5/29/2022.
- Jones, Michael (2011): European Landscape and Participation – Rhetoric or Reality? In : *The European Landscape Convention*: Springer, Dordrecht, pp. 27–44. Available online at https://link.springer.com/chapter/10.1007/978-90-481-9932-7_2.
- Jupp, Victor (2006): Interview. In Victor Jupp (Ed.): *The SAGE Dictionary of Social Research Methods*. 1 Oliver's Yard, 55 City Road, London England EC1Y 1SP United Kingdom: SAGE Publications, Ltd.
- Klain, Sarah C.; Chan, Kai M.A. (2012): Navigating coastal values: Participatory mapping of ecosystem services for spatial planning. In *Ecological Economics* 82, pp. 104–113. DOI: 10.1016/j.ecolecon.2012.07.008.
- Li, Wenshu; Feng, Tao; Timmermans, Harry J.P.; Li, Zhigang; Zhang, Ming; Li, Bowen (2020): Analysis of citizens' motivation and participation intention in urban planning. In *Cities* 106, p. 102921. DOI: 10.1016/j.cities.2020.102921.
- Liebermann, Susan; Coulson, Justine (2004): Participatory mapping for crime prevention in South Africa - local solutions to local problems. In *Environment and Urbanization* 16 (2), pp. 125–134. DOI: 10.1177/095624780401600204.
- Lijphart, Arend (1997): Unequal Participation: Democracy's Unresolved Dilemma Presidential Address, American Political Science Association, 1996. In *The American Political Science Review* 91 (1), pp. 1–14. DOI: 10.2307/2952255.
- Lundine, Jamie; Kovačič, Primož; Poggiali, Lisa (2012): Youth and Digital Mapping in Urban Informal Settlements: Lessons Learned from Participatory Mapping Processes in Mathare in Nairobi, Kenya (22). Available online at https://www.researchgate.net/publication/259751234_Youth_and_Digital_Mapping_in_Urban_Informal_Settlements_Lessons_Learned_from_Participatory_Mapping_Processes_in_Mathare_in_Nairobi_Kenya.
- Map Kibera Trust (n.d.): Map Kibera | Partners. Available online at <https://mapkibera.org/about/partners/>, updated on 6/4/2020, checked on 6/7/2022.
- Menezes, Isabel (2003): Participation Experiences and Civic Concepts, Attitudes and Engagement: Implications for Citizenship Education Projects. In *European Educational Research Journal* 2 (3), pp. 430–445. DOI: 10.2304/eeerj.2003.2.3.8.
- Musoi, Kyalo; Muthama, Thomson; Kibor, Johnstone; Kitiku, Jaws (2014): A study of crime in urban slums in Kenya. The case of Kibra, Bondeni, Manyatta and Mishomoroni slums. Nairobi, Kenya: Security Research and Information Centre (SRIC). Available online at

http://www.srickenya.org/publications/slum_Crime_Survey_Report_Thur_2.pdf, checked on 10/6/2022.

Mutisya, Emmanuel; Yarime, Masaru (2011): Understanding the grassroots dynamics of slums in Nairobi: the dilemma of Kibera informal settlements. Available online at http://center4affordablehousing.org/wp-content/uploads/2020/10/kenya-slums-understanding_the_grassroots_dynamics_of.pdf.

Ndzabandzaba, Coli (2020): Participatory Geographic Information System (PGIS): A Discourse Toward a Solution to Traditional GIS Challenges. In Stanley D. Brunn, Roland Kehrein (Eds.): *Handbook of the Changing World Language Map*. 1st ed. 2020. Cham: Springer International Publishing; Imprint: Springer, pp. 1–11.

Onyango, Philista; Tostensen, Arne (2014): *The Situation of Youth and Children in Kibera*. Available online at <https://www.cmi.no/publications/file/5527-the-situation-of-youth-and-children-in-kibera.pdf>, checked on 9/6/2022.

Panek, Jiri; Sobotova, Lenka (2015): Community Mapping in Urban Informal Settlements: Examples from Nairobi, Kenya. In *The Electronic Journal of Information Systems in Developing Countries* 68 (1), pp. 1–13. DOI: 10.1002/j.1681-4835.2015.tb00487.x.

Parker, Brenda (2006): Constructing Community Through Maps? Power and Praxis in Community Mapping*. In *The Professional Geographer* 58 (4), pp. 470–484. DOI: 10.1111/j.1467-9272.2006.00583.x.

Parvin, Phil (2018): Democracy Without Participation: A New Politics for a Disengaged Era. In *Res Publica* 24 (1), pp. 31–52. DOI: 10.1007/s11158-017-9382-1.

Paul, Sophie A.L.; Wilson, A. Meriwether W.; Cachimo, Rachide; Riddell, Michael A. (2016): Piloting participatory smartphone mapping of intertidal fishing grounds and resources in northern Mozambique: Opportunities and future directions. In *Ocean & Coastal Management* 134, pp. 79–92. DOI: 10.1016/j.ocecoaman.2016.09.018.

Poolman, Martine; van de Giesen, Nick (2006): Participation: Rhetoric and Reality. The Importance of Understanding Stakeholders Based on a Case Study in Upper East Ghana. In *International Journal of Water Resources Development* 22 (4), pp. 561–573. DOI: 10.1080/07900620600813191.

Rowe, Gene; Frewer, Lynn J. (2000): Public Participation Methods: A Framework for Evaluation. In *Science, Technology, & Human Values* 25 (1), pp. 3–29. Available online at <http://www.jstor.org/stable/690198>.

Rowe, Gene; Frewer, Lynn J. (2004): Evaluating Public-Participation Exercises: A Research Agenda. In *Science, Technology & Human Values* 29 (4), pp. 512–556. DOI: 10.1177/0162243903259197.

Sieber, Renee (2006): Public Participation Geographic Information Systems: A Literature Review and Framework. In *Annals of the American Association of Geographers* 96 (3), pp. 491–507. DOI: 10.1111/j.1467-8306.2006.00702.x.

Statista (2022): Share of urban population living in slums by region 2018 | Statista. Available online at <https://www.statista.com/statistics/684694/percentage-of-world-urban-population-in-slums-by-region/>, updated on 5/30/2022, checked on 5/30/2022.

Stern, Rebecca (2006): The Child's Right to Participation – Reality or Rhetoric? Juridiska institutionen. Available online at <https://www.diva-portal.org/smash/record.jsf?pid=diva2%3A168647&dswid=-6645>.

The White House (2010): Audio Slideshow: Dr. Biden Sees the Neighborhoods of Kenya. Available online at <https://obamawhitehouse.archives.gov/blog/2010/06/08/audio-slideshow-dr-biden-sees-kibera-kenya>, updated on 8/19/2015, checked on 6/6/2022.

Turner, Andrew (2006): Introduction to Neogeography. Farnham: O'Reilly. Available online at [https://books.google.de/books?hl=de&lr=&id=oHgDv4feV-8C&oi=fnd&pg=PA24&dq=Turner,+A.J.+\(2006\)+Introduction+to+Neogeography&ots=w-u5_yUTb0&sig=Cv5xRoAnLjCTc7AryzcFiWvJ4UA#v=onepage&q&f=false](https://books.google.de/books?hl=de&lr=&id=oHgDv4feV-8C&oi=fnd&pg=PA24&dq=Turner,+A.J.+(2006)+Introduction+to+Neogeography&ots=w-u5_yUTb0&sig=Cv5xRoAnLjCTc7AryzcFiWvJ4UA#v=onepage&q&f=false).

UNDP (2004): Forging a Global South. United Nations Day for South South Cooperation.

UN-Habitat (2007): State of the World's Cities 2006/7. Available online at https://mirror.unhabitat.org/documents/media_centre/sowcr2006/SOWCR%205.pdf, checked on 3/13/2022.

UN-Habitat (2018): ADEQUATE HOUSING AND SLUM UPGRADING. Available online at https://unhabitat.org/sites/default/files/2020/06/indicator_11.1.1_training_module_adequate_housing_and_slum_upgrading.pdf, checked on 11/6/2022.

UN-Habitat (2021): Addressing the digital divide. Available online at https://unhabitat.org/sites/default/files/2021/11/addressing_the_digital_divide.pdf, checked on 3/31/2022.

United Nations (n.d.): Sustainable Development | Economic and Social Council. Available online at <https://www.un.org/ecosoc/en/sustainable-development>, updated on 5/20/2022, checked on 5/20/2022.

United Nations (2004): Geographic Information Systems and Geoinformation Techniques. Available online at <https://www.un.org/esa/sustdev/natlinfo/indicators/idsd/methodologies/gis.htm>, updated on 4/20/2004, checked on 5/28/2022.

United Nations (2021): Urbanization: expanding opportunities, but deeper divides | UN DESA | United Nations Department of Economic and Social Affairs. Available online at <https://www.un.org/development/desa/en/news/social/urbanization-expanding-opportunities-but-deeper-divides.html>, updated on 2/21/2020, checked on 6/11/2022.

van Dijk, Johannes A.G.M. (2002): A framework for digital divide research. In *Electronic journal of communication* 12 (1). Available online at <https://research.utwente.nl/en/publications/a-framework-for-digital-divide-research>.

Verba, Sidney (1967): Democratic Participation. In *The ANNALS of the American Academy of Political and Social Science* 373 (1), pp. 53–78. DOI: 10.1177/000271626737300103.

Walter, Maggie (2009): Participatory Action Research. In *Social Research Methods*. Available online at https://www.academia.edu/3563840/Participatory_Action_Research?from=cover_page.

World Bank Group (2020): Five Things You Need to Know About Social Sustainability and Inclusion. In *World Bank Group*, 1/9/2020. Available online at <https://www.worldbank.org/en/news/feature/2020/09/02/five-things-about-social-sustainability-and-inclusion>, checked on 5/22/2022.

World Population Review (2022): Kenya Population 2022 (Demographics, Maps, Graphs). Available online at <https://worldpopulationreview.com/countries/kenya-population>, updated on 6/9/2022, checked on 6/9/2022.

Yin, Robert K. (2009): Case Study Research. Design and Methods: SAGE.