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Participatory Mapping in a Developing Country Context: Lessons from South Africa

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Abstract: Digital participatory mapping improves accessibility to spatial information and the way in which knowledge is co-constructed and landscapes co-managed with impoverished communities. However, many unintended consequences for social and epistemic justice may be exacerbated in developing country contexts. Two South African case studies incorporating Direct-to-Digital participatory mapping in marginalized communities to inform land-use decision-making, and the ethical challenges of adopting this method are discussed. Understanding the past and present context of the site and the power dynamics at play is critical to develop trust and manage expectations among research participants. When employing unfamiliar technology, disparate literacy levels and language barriers create challenges for ensuring participants understand the risks of their involvement and recognize their rights. The logistics of using this approach in remote areas with poor infrastructure and deciding how best to leave the participants with the maps they have co-produced in an accessible format present further challenges. Overcoming these can however offer opportunity for redressing past injustices and empowering marginalized communities with a voice in decisions that affect their livelihoods.

Keywords: D2D mapping; PGIS/PPGIS methods; epistemic justice; social justice; local knowledge; landscape management; ethics

1. Introduction

Increasingly, researchers and policy makers are recognizing the importance of taking a multiple evidence approach to co-produce knowledge that can enhance our understanding of the governance of natural resources for human well-being [1–3]. Scientific, local, indigenous and practitioner knowledge represent different, complimentary understanding of the real world [1,2,4]. Integrating across these knowledge streams offers opportunities for shifting towards research and management processes that are more transparent, just, legitimate, and sustainable [1–3]. One tool that has been extensively used to integrate local and indigenous knowledge with scientific and practitioner knowledge in the context of spatial planning, health sciences and public policy, is participatory mapping [5–8].

Participatory mapping, in its many guises, offers many opportunities to co-construct knowledge with communities. By engaging holders of local and indigenous knowledge in a participatory mapping process, the researcher is able to translate certain kinds of scientific knowledge in a discursive manner [9]. Maps allow translation of scientific information onto a canvas that may project local and indigenous knowledge [10]. In the process, community members and researchers are able to observe ecosystem change over time or, at varying scales, the location of key services such as clinics or schools, relative to the population size and distribution, and understand the implications of these changes for human well-being, using this to lobby for improved provision of services [9]. The mapping process and the created maps can also aid in the transfer of local ecological knowledge from one generation to another [11]. As ecosystem services change, ecological degradation and the resilience of traditional and

local institutions are closely related [12–14], the process of inter-generational knowledge sharing plays a crucial role in sustaining traditional knowledge systems and promoting ecosystem resilience [15–17]. In terms of environmental management, the participation of multiple stakeholders, each offering different knowledge types, helps to inform multiple evidence approaches [1], that improve the legitimacy and accuracy of decision-making [18,19]. The mapping process can also facilitate negotiation among community members regarding resource area priorities and value, a process that can build community cohesion [11,20].

Whilst participatory mapping has been widely praised for its role in just and sustainable natural resource management, investigators have nevertheless cautioned against its irresponsible application, recognising that maps are inseparable from the political and cultural contexts in which they are created and used [5,21,22]. Although participatory mapping processes can empower the voiceless, they can also perpetuate existing inequalities by favouring the voices, perceptions, realities, and spatial languages of those that are already privileged [22–24]. Additionally, by sharing spatial information, communities or individuals can put themselves at risk by revealing spatially sensitive information (at times unintentionally), or may risk exploitation of their intellectual property for research and management [22].

1.1. From Participatory Mapping to Digital Participatory Mapping

Participatory mapping encompasses a broad diversity of techniques and approaches [25]. Participatory Geographic Information Systems (PGIS) refer to participatory planning processes in rural areas of developing countries, using a combination of participatory learning and action methods and GIS [26], where community empowerment and the building of social capital is often the aim [27]. In contrast, public participation GIS (PPGIS), and its close relative volunteer geographic information (VGI), generally pertains to participatory mapping conducted in developed country contexts and often takes the form of online mapping surveys [26] and places more emphasis on obtaining spatial data accuracy [27].

Technological advances, particularly around the accessibility of spatial information and aerial and other remotely sensed imagery [22], has allowed the evolution of participatory mapping to shift to more digital platforms, e.g., [28–31]. These shifts to digital platforms have been accompanied by new participatory mapping methodology. The ‘Direct-to-Digital’ (D2D) mapping technique uses Google Earth to directly map information from community workshops or interviews onto a digital platform, negating the need to digitise and transcribe data collected in the field [7]. This method (and slight variations of it) has been used effectively, and extensively to represent indigenous knowledge and rights in traditional land-use studies in Canada [7], the United States [6], Russia [32], and Australia [33].

There are many reasons for shifting to more digital platforms for understanding local and indigenous people’s relationship with natural resources, and their management of it. Aside from reducing the amount of technical work needed to post-process data [7], digital platforms may offer increased access to spatial data and diversify the forms of spatial knowledge used in environmental management [19]. Although all digital participatory mapping processes are community-integrated, D2D stands out as it allows for variability and diversity in representation of spaces when the mapping is done directly onto the map, thus capturing subtle particularities of a space and presenting a real ‘depth of place’ [7,34]. In some cases, the output maps from digital participatory mapping methods can be richer in content, more accurate, and easier to update than those produced on hard-copy maps [32].

Whilst these techniques offer new opportunities for better and more just natural resource management, digital platforms also present a new set of logistical, technical, as well as ethical and legal considerations [6,7,35,36]. For one, it requires training of facilitators in the use of new tools, as well as familiarising community members with a different representation of the world [31]. In participatory processes, the critical role of the facilitator [37,38] can determine who takes part in a participatory process and its outcomes, as well as influence power dynamics [22,37]. With digital participatory mapping, the capacity to engage with digital media (or not) is a particular capacity that can yield power,

and facilitators need to be able to remove barriers to this, in addition to the usual considerations of managing power related to venue, group, and participation [22,39–41]. They also need to acknowledge and account for potential uncertainty, credibility and bias that may result from the realism embedded in virtual globes [42].

Digital platforms offer the potential of much broader dissemination of spatial information [31], and, importantly for cases where maps are used for legal and planning purposes, can also improve the spatial accuracy of information collected [7]. Whilst this may offer elements of empowerment, it also carries an increased risk for communities and individuals, [32,36,43]. Whilst intellectual property rights should always be considered in participatory mapping projects, the legal aspects around who owns what parts of the map in digital mapping approaches is undoubtedly more complex [7]. Since many digital platforms belong to larger corporate companies, much concern has also been raised around privacy [44], and serving the needs of large corporate companies [45]. Many digital participatory mapping protocols, such as D2D, only work on digital platforms that can be used and cached offline [7].

Whilst digital methods in participatory mapping (and other co-production platforms) have been more commonly used and studied in developed countries [46,47], they offer exciting opportunities for more representative and just natural resource mapping (among other applications) in developing countries, where they have been increasingly applied [31,47,48]. However, many of the ethical risks associated with participating with digital platforms are exacerbated in these countries, or may be unique to their contexts. Hereto, there has been little discussion of said exacerbated or specific ethical implications of moving participative mapping onto digital platforms in developing country contexts. The history, social environment and the political-economic reality in which these countries are embedded have serious implications for the ethics of engagement, and the rights of community members involved [5,22,49]. For example, in many rural areas in developing countries, communities may be much more naïve (compared to indigenous communities in developed countries, for example) to the ethical concerns around privacy on digital platforms, and the legal implications of sharing knowledge here. Furthermore, the cultural differences in the understanding and consequently the representation of the space, demand a critical perspective on how the mapping process will be conducted [36]. For digital participatory mapping to achieve its potential as a tool for enhancing inclusivity and engagement in places where it is most needed, it is critical to understand the ethical dimensions of participatory mapping processes, particularly as it pertains to social and epistemic justice [50,51].

1.2. Justice and Participatory Mapping

Justice is multi-faceted [52], but two dimensions are particularly relevant in the context of this paper: social justice and epistemic justice. Social justice has its roots in philosophy and it is widely used in social sciences [53], legal debates [54] and in everyday discussions. In broad terms, social justice refers to both a process and a goal [55], in which the benefits and burdens of society are divided between its citizens, not at random, but according to a set of principles defined by society. The rights of individuals and groups are respected by all decision-making apparatus; and individuals are treated with dignity and respect by all [56]. Thus, social justice has distributive, procedural and interactional justice elements at its core and institutions play a role in enabling or hampering this. Rawls argued that “justice is the first virtue of social institutions” ([57], p. 3), illustrating the role of institutions in the pursuit of social justice.

At the core of participatory mapping is knowledge co-production and the drive for a more inclusive and collaborative process to address the injustice embedded in more extractive and unrepresentative data collection methods [8,29]. This kind of injustice is specifically related to *epistemic* injustice, the injustices embedded in knowledge production and dissemination. Epistemic injustice occurs when a person or group of people are wronged in their capacity as knowledge bearers or when there is a gap in the interpretative framework of a person or a person’s ability to understand someone else [50]. In these cases, people who are experiencing epistemic injustice are labelled as unable to bear knowledge

and are not given any credibility in knowledge exchanges, being assigned a passive role in this process and therefore having their voices suppressed [58]. People may also experience epistemic injustice when their questions and issues are discredited through practices and institutions that prevent them from pursuing their enquiries [59]. For example, an illiterate person trying to find information about his/her plot of land, is unable to do so because it requires that they complete a written form in English.

The involvement of communities in natural resource management addresses both epistemic and social injustice. By bringing communities to the table in the discussions about natural resource management in their areas, their voices and claims gain legitimacy through the process, triggering credibility on the part of the hearers of those claims. PGIS (in both its analogue and digital forms) emerged to address the lack of resources and tools available to certain groups, which speaks directly to epistemic injustice [50]. In this case, the gap in interpretative resources is the lack of access to the technology necessary and ‘language’ refers to the technological jargon that typically accompanies the use of these tools. Scientists and society therefore acknowledge community members as credible knowledge-bearers. This also speaks to the distribution of knowledge and knowledge holders, which refers to social justice.

Epistemic and social justice lie at the centre of any participatory mapping approach. These approaches, however, carry assumptions that affect their implementation and ultimately challenge their goal of inclusivity and knowledge democratization. Thus, what are the ethical challenges that researchers face in a developing country context and what are the assumptions embedded in such technological approaches that challenge their implementation in this context? In this paper, we use a social and epistemic justice lens to analyse the technical, logistical and ethical challenges of conducting participatory mapping in a developing country context, analysing these dimensions by using a critical reading of two case studies. A case study approach supports the exploration of complex themes with a recognised role in community-based research [60]. Both cases focus on D2D methodology in a PGIS context, as this represents the most common digital participatory mapping approach in developing countries. In both cases, Google Earth was chosen as the mapping platform for four reasons: it presents the option of adding additional layers (e.g., rivers, protected areas and old farms); the visual information is easier to grasp than other digital mapping platforms (i.e., Open Street Map); it offers the possibility of adding photos to the map; and it can be used without requiring access to the internet through cached imagery. Following our case analysis, we discuss how ethical considerations, especially regarding power dynamics, could inform future D2D participatory mapping in developing country contexts.

2. Case Studies

This article discusses the technological, logistical and ethical challenges of using D2D mapping in two case studies in the Eastern Cape province of South Africa. Each case study presents a historical introduction to the area in which the mapping took place; the context of the mapping project itself and the methods employed; and the main challenges faced by the authors. The ethical concerns of these studies were approved by the Department of Environmental Science in line with the Rhodes University Ethical Research Guidelines.

2.1. Case Study Selection

Our selected case studies illustrate both the risks and rewards of using the D2D method in a developing country context and the ethical implications of using this approach. Given that D2D is most often used to understand and decide upon land use [7], South Africa is a particularly apt country in which to investigate the ethics of using this approach. Both colonisation and Apartheid led to racial and land ownership inequalities [61], and as such, the contestation of land has been an integral part of South Africa’s recent history, and is closely linked to social identity [62]. The past English and Afrikaans governments aimed to ensure the valuable land in the country would stay in the hands of the white minority [52]. The 1913 Natives’ Land Act limited the territory where Africans could

live, stripping cash tenants and crop sharing labourers from their land, converting their ownership to labour tenancy. Africans, who corresponded to 80% of the population, were restricted to only 7% of the total territory of South Africa (later extended to 13.6%), through the formation of the homelands. The demarcation of homelands, such as the Ciskei and Transkei in the Eastern Cape, were part of a strategy to divide and control [61]. The White Paper on Land Reform from 1997 centres redress as one of its goals, therefore recognising the injustices of the past and the need to address them in order to move forward [63].

The injustices regarding land ownership in South Africa are intimately linked to how land is represented. Mapping thus becomes a political exercise as it has, in the past, only reflected one way of understanding the land [64]. The case studies below are both located in the former independent homelands of the Eastern Cape Province, an area within which the dominant race is the amaXhosa people. This is one of the poorest provinces in the country and an area characterised by female-headed households, a high unemployment rate and illiteracy, high HIV prevalence, and dependency on state issued social grants. At the time of the last census, the province had the lowest proportion of people (20%) who had completed grade 12 schooling, with figures from the district municipalities within which these sites fall being closer to 15% [65]. School attendance rates have however grown since democracy and around 80% of the population between the ages of five and 24, attend schools in these regions. This has important implications for the degree to which D2D participatory mapping is accessible for what are two distinct generations. One which has borne the brunt of Apartheid-induced inequality and been blocked from receiving an education and the other, the focus of the current governments' transformation policies which seek to provide opportunities to previously disadvantaged members of South African society.

2.1.1. Case Study 1: The Likhayaletu Community and the Great Fish Nature Reserve

The Great Fish Nature Reserve is situated in the former Ciskei homeland between the towns of Grahamstown and Alice. Three reserves were amalgamated to form the nature reserve: Andries Vosloo Kudu Reserve, Double Drift Nature Reserve, and Sam Knott Nature Reserve (Figure 1). The nature reserve has been in operation since 1994 and covers 45,000 hectares [66].

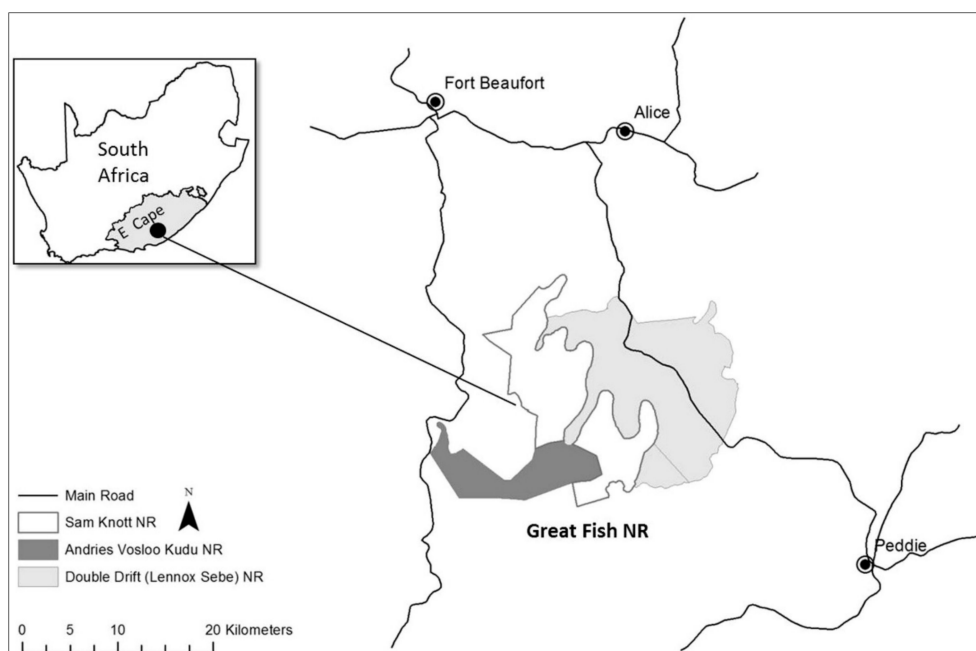


Figure 1. Location of case study one: the Great Fish Nature Reserve and the Likhayaletu community [67].

Members of the Likhayaletu community lived in the Double Drift part of the nature reserve and were evicted from 1979 to 1992 from this area and relocated to 11 nearby villages. The new villages had different environmental conditions to what the community was used to. In the new villages, water availability was an issue and the different soil composition meant that their farming knowledge was inefficient at their new homes. Following democracy in 1994, which brought with it opportunities for land restitution, the Likhayaletu community submitted their land claim in 1998 for part of the Double Drift section of the Great Fish Nature Reserve. In 2012 they signed the settlement agreement, which gives the community legal ownership of the land. However, since the land is now a protected area, the community is legally obliged to co-manage the land with the conservation agency in charge, the Eastern Cape Parks and Tourism Agency.

With the aim to explore the dynamics in a land claim case, 31 life history interviews were conducted in 2015 with members of the Likhayaletu community. Community members which contributed to lodging the original land claim in 1998, and with a good recollection of this, were selected with the help of the secretary of the Communal Property Association, the recognised community leadership body. During the interviews, it became clear that participants' attachment to Double Drift, decades after eviction, was still strong. Knowing that the place was of special importance to them, we decided to map these special places in 2016 by going back to the same households we interviewed in 2015 and asking them to be involved in the process. In March 2016, permission to conduct the research was granted by the Communal Property Association. D2D mapping was conducted from April to June 2016 and a map with the heritage sites was given back to each household in 2017. By the time the mapping was conducted, both the researcher and the interpreter had been working with the Likhayaletu community for one year and over this period, gained the trust of the community. From the beginning of their relationship in 2015, the researcher was careful to be transparent about what the aim of her research was and what the community would gain from it.

The heritage mapping of the Likhayaletu community was done with Google Earth Pro. D2D mapping was conducted in each of the 11 villages and all the households that participated in the life history interviews were invited to participate in the mapping session. A projector was used on a wall in one of the houses in each village so all those present could see Google Earth Pro. To help members of the Likhayaletu community orientate themselves we started the session showing on the map the nearest towns of Alice and Fort Beaufort (see Figure 1). We would then ask the community members to direct us to their village, leading us to where we were at the time of the mapping. Once they could see their village, we would then ask them to direct us to Double Drift. We would follow their instructions as to how to arrive at those places. This would help them understand how the map works. Once in the reserve, we would ask each family to show us where they had previously lived and if there were any places that were special to them such as the graves of loved ones or places they used to go to when they were younger. Some of the members of the Likhayaletu community have not been back to the reserve since their evictions. To jog their memory, pictures of the reserve were taken prior to the D2D session and embedded on the map to aid the visualisation of key points in the reserve, which was extremely helpful.

In contrast to the life history interviews, where the younger generation did not seem interested in participating, the D2D mapping drew their attention. The mapping session was open to all the members of the households interviewed in 2015 and the younger generation happily participated in the process. Their presence was crucial in explaining to the older generation how the map worked. The older the participant, the more difficult they found grasping the concept of Google Earth. Both groups, however, did not have concerns about sharing their knowledge. Although the researcher did explain the purpose of the project and obtained consent from participants, it was notable that no additional questions were asked about who would have access to the map and what the map would be used for. This is a clear example of how easily one can exploit a community for their knowledge, even unintentionally. The lack of questions speaks to the history of South Africa when outsiders were never questioned

during Apartheid rule, so community members, especially the older generations, might be reluctant to interrogate the research and the researcher even today.

Looking at the history of the territory, the injustices are clearly evident. The social inequalities inherent in the Apartheid governments' policies are reflected in social injustices in terms of land access. Speaking to epistemic injustice, the voices of the evicted communities about their wrongful evictions were not heard. Moreover, epistemic injustice is embodied in the fact that despite the history of these communities predating the arrival of the white settlers, the current heritage mapping of the Great Fish Nature Reserve reflects only the history of the white farmers. Engaging the communities in this project has helped deal with this by guiding them through the process of mapping their own heritage and leaving them with the product thereof for the benefit of their future generations.

2.1.2. Case Study 2: The Mzimvubu Water Project and the Tsitsa Project

The area between Maclear and Tsolo in the north-eastern part of the Eastern Cape Province (Figure 2) has been earmarked for a large-scale hydro-electric power scheme. The Mzimvubu Water Project (MWP) will involve the building of two dams, namely the Ntabelanga Dam and the Laleni Dam, on the Tsitsa River, a major tributary of the Mzimvubu River which drains one of the largest catchments in the country.

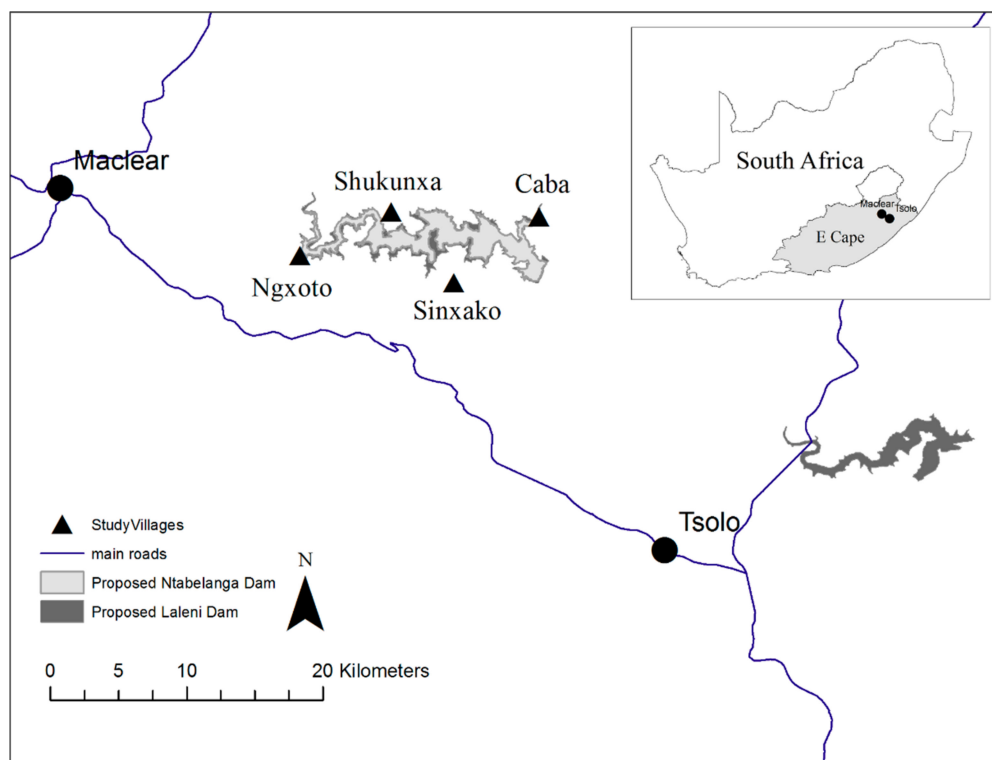


Figure 2. Location of case study two: the Mzimvubu Water Project and the Tsitsa Project.

The study area encompasses both private and communal land, the latter being part of the former Transkei homeland. This area is socio-politically complex and is inhabited by members of different amaXhosa tribal groups that share a history of conflict with one another [68,69]. The abject poverty that typifies this area has meant a history of substantial reliance on the natural environment for livelihood activities. With time and the transition to a democratic government, this has changed to some extent: where crop cultivation, animal husbandry and the harvesting of natural resources were historically dominant livelihood strategies, there is now a greater reliance on a cash-based economy mediated largely through access to social grants provided by the government [68]. Nonetheless, the landscape

still provides critical ecosystem services to those inhabiting it, particularly in the form of cultural services which, despite modernisation, still form a major component of the amaXhosa lifestyle.

The Tsitsa project is a restoration project that came about as a strategy to improve the likelihood of successfully implementing the proposed MWP [69]. Due to the highly degraded landscape and erosive soils [70], sedimentation of the Tsitsa River would likely render the proposed dams prematurely inoperable if not dealt with. Thus, sustainable and co-produced restoration interventions were required [69]. As local communities still rely heavily on the natural environment for both their livelihoods and general well-being, identifying hotspots of overlapping ecosystem service provision was deemed important to inform restoration interventions which could lead to the exclusion of people and livelihood activities from certain areas. Additionally, it was important to understand how the dams, once built, were going to affect people's livelihoods and well-being.

As part of this larger restoration project, a study was initiated to build understanding around the locals' interaction with their environment, how this has changed over time, and how this might impact the future of the area, and the proposed large-scale projects. An important component of this process involved identifying key resource areas of value to the locals and gaining an understanding of the degree to which communities were reliant on the natural environment for their livelihoods at the time. The D2D method was identified as a useful tool for this process and served to engage local communities in discussion about their use of the landscape.

A series of workshops were held in each of four selected villages. These workshops included the leaders and elders of the community, livestock owners, crop cultivators, traditional healers and other natural resource collectors, as well as young-adults. Involving the locals in decision-making processes is one way of rectifying past social injustices [71] but the methods one employs can serve to further alienate already alienated communities. This applied to the use of the D2D technique which presented certain challenges. Given the history of totalitarian leadership and top-down imposition of discriminatory laws, it was important to consider the racial makeup of the workshop facilitators in impacting participants' ability to engage and use their voice. The less forthright participants may feel obliged to share information they aren't necessarily comfortable sharing, while those in positions of authority or power may choose to withhold information because of past experiences and for fear of being taken advantage of by authorities. For example, the communities residing in the vicinity of Tsolo recall clearly, from as early as the 1910s, the impact of government restrictions placed on their use of locally available natural resources for their livelihoods [72]. For some, the late 1950s hold particularly traumatic memories as around 400 households were forcibly displaced for the purposes of afforestation [72]. Some of the community members that took part in this research were themselves victims of forced removals, as the Apartheid government zoned land for human settlement, livestock grazing, and crop cultivation and imposed restrictions under the policy of so called "Betterment" [73].

The success of both the restoration project and the proposed dam developments was therefore, to a large extent, hinged on the success of these initial engagements with the community and the degree to which trust could be established through clear communication and transparency between all parties involved and exercising patience and sensitivity when working with people from different cultural backgrounds.

A further challenge was that this marginalised and underprivileged population has had, until recent times, little exposure to modern digital technology. As a result, the use of D2D required great sensitivity to avoid excluding people, exacerbating existing epistemic injustices on account of their unfamiliarity with the technology.

The gulf between the generations in terms of literacy also required careful navigation but the use of digital participatory mapping did also offer an opportunity for bridging this divide, allowing the youth who are typically more comfortable with technology, to assist the elderly with the sharing of their knowledge. In doing so, D2D provided an opportunity to share and preserve traditional local knowledge. After carefully introducing and explaining Google Earth, local participants responded very

positively to the technology and being presented with the opportunity to visualise their landscape in a way they had previously never experienced. Communities will eventually receive these co-produced maps, which could be used to lobby for or against future developments that may be proposed for their region. The maps will also be used in discussions around the implications of the two large-scale developments on their livelihoods and well-being, thus representing a potential instrument of community voice. However, careful consideration is once again required when deciding who this information is ultimately left with and in what format, to ensure that it is accessible to all community members, regardless of their literacy levels, but also to avoid a situation where local elites use it to further their own agendas at the expense of the marginalised in the community. Table 1 presents a summary of the two case studies, highlighting the aim of each D2D mapping exercise, the main challenges experienced and the lessons learnt from these.

Table 1. Case study summaries.

Case Study	Aim of the Mapping	Main Challenges	Main Lessons Learnt
Likhayaletu	Heritage mapping of a successful land claim community.	Older generation unfamiliar with the technology. Lack of participant questions indicate a lack of understanding of the ethical implications.	Taking time to familiarise participants with the technology makes the process easier. Ethical considerations need to be thought through and discussed with participants. Digital participatory mapping allows knowledge sharing across generations.
Tsitsa Project	Understanding locals' interaction with their environment to inform restoration interventions.	Socio-politically complex region with history of discrimination and conflict requiring sensitivity when forming the research team and using this technology among marginalised groups.	Participatory mapping can be a tool to bridge inter- and intra-cultural divides if the correct environment is created for knowledge sharing and trust building. Importance of understanding local power dynamics and managing expectations between parties involved.

3. Discussion

The two case studies provided valuable insights on the ethics of D2D mapping in the South African political landscape. Direct to digital mapping poses risks wherever it is used, however in developing countries these risks are either exacerbated due to the historical context and social inequalities, or result in unexpected risks. The power dynamics in the mapping process as well as the ethical considerations are the two themes that stand out from both cases. These are discussed below.

Within this branch of participatory approaches, the method employed influences who takes part, the power relationships between those involved, and the ultimate outcomes of the endeavour [5]. The influence of power dynamics can, for example, manifest in local elites or outsiders utilising information that is shared for their personal gain such as through locating locally important resources that they may wish to exploit [11]. This risk is of course not confined to digital participatory mapping and can present itself in any form of participatory research, however, because of South Africa's history of exploitative leadership, participants are particularly vulnerable and unlikely to be aware of the risks.

The choice of facilitator can have profound impacts for the exercising of social and epistemic justice in digital mapping exercises. In the participatory mapping literature it is generally recognized that the facilitator can exacerbate power dynamics through the exclusion of marginalised, less literate members of a community by, purposefully or unintentionally, involving local experts or those better educated rather than the less forthright members of a community who may actually have different, complementary perspectives to offer [22,41,74]. In the cases described in this article, the framing of the projects meant that traditional and local knowledge were valued as critical knowledge streams, requiring the involvement of largely illiterate participants with knowledge of the history

of their respective homes. This presented the ethical challenge of exposing the older generation to technology they were very unfamiliar with, and stirring up upsetting memories from the past. However, the mapping process did improve social and epistemic justice outcomes in that residents had the opportunity to voice their feelings about past injustices, and were able to influence natural resource management decisions regardless of their social standing or demography. Moreover, the development of a map solely based on the knowledge of these communities legitimises their knowledge of the spaces mapped, further addressing epistemic justice. Having said that, the racial profile of the facilitators in both cases (which were more similar to the historical oppressors than the historically oppressed, namely a coloured foreign woman and a white man) may have undermined epistemic justice in that participants may not have felt comfortable or able to voice criticism or questions regarding the mapping process.

Subtle details, such as the location of the venue used for the workshops, can also play a significant role in exacerbating or diminishing a perceived power imbalance. To conduct digital mapping activities requires access to a venue where a projected map is visible, and electricity to power computers and projectors is available [7,32]. Although such pragmatic considerations are crucial in choosing a venue, so are the considerations of power [39]. The location of the venue not only changes how people interact with the researcher, but also how people interact with one another, thus making its location part of the data analysis [39,40]. In both case studies challenges were encountered involving local elites hosting the workshop but then being inclined to dominate proceedings and participants feeling less freedom to participate, intensifying epistemic injustice. Tribal tensions in rural areas of developing countries can be complex and tense and manifest in intra-village politics and conflict. This can also mean one does not obtain a representative sample of participants unless the venue is located in a neutral space located outside of the villages in conflict. Thus, knowledge about the local context is key in achieving a more inclusive and therefore representative map.

These social and epistemic justice considerations have profound implications for the ethics of D2D mapping in developing country contexts. As in many developed country contexts [7], maps developed by communities can be of great value to them, as they represent a first attempt at a geographical representation of natural resources, and therefore a document that can be used to negotiate legal rights to land and resources [7,32]. However, it also represents a document that lists valuable resources, and access to such a document may leave a community vulnerable to exploitation [32]. Communities thus need to be clear on what the information they are supplying will be used for and the possible risks associated with these uses, which may be potentially graver in a developing country context. In the case of the Tsitsa Project for example, the information shared by local communities regarding the location of important resource areas, may lead to their temporary exclusion from these sites for the purposes of rehabilitation interventions. This could bear striking resemblance to the Betterment planning process some underwent if the purpose of the intervention and research informing it is not clearly explained. Thus, epistemic injustices relating to participants ability or willingness to raise concerns or protect their data (indeed, to insist on rights to their data) may translate to further social injustices.

To exercise their mapping power, local communities need to have access to the maps that they have produced, and should be able to share their knowledge for the benefit of improving their communal well-being. In a rural developing country context, where access to digital technology on a day-to-day basis may be limited on account of digital literacy and infrastructure, this may be a particularly hard ethical challenge for D2D projects to overcome. Without access to their digital knowledge, and the literacy to use these tools to engage in debates, negotiations and discussion (which relates to epistemic injustice), social justice for communities are at best not improved, and at worst undermined.

Prior to the knowledge creation process, the rights of participants must be thoroughly explained. The voluntary nature of participation and the participants' right to leave a mapping process should they wish, should be made explicitly clear in any mapping initiative. However, certain historical contexts require more attention be given to the explanation of one's rights. In a former dictatorial state locals may tend to maintain submission to those who even unintentionally may be deemed elite purely by

virtue of them being outsiders who arrived by vehicle and came bearing modern technology. It needs to be made clear to participants that they are not at all obligated to be involved in the discussion or to volunteer information.

Understanding the historical background in each context is critical for a sound and respectful mapping process. This can shed light on the power dynamics within and between villages, but also topics and themes that might be sensitive to these communities. This is the case with the Great Fish Nature Reserve evictees, the history of conflict among the communities involved in the Tsitsa Project and, in both cases, the delineation of tribal boundaries which had the risk of resurrecting old feuds. Moreover, although some events took place decades before the mapping initiative, the implications of such events might still be felt today, and therefore still pose a risk of triggering strong emotions.

In summation, what is going to be mapped, who is going to be involved, how the final product will be utilised, what the expected impact of the tools to be utilized will be, the expected accuracy of the final product, and the resources available, are all important considerations when choosing to adopt this method [5,75].

4. Conclusions and Practical Recommendations

Digital participatory mapping presents ethical risks and can undermine social and epistemic injustice, but also offers opportunities of social and epistemic redress by enhancing participation of the previously marginalised in decision making processes, enhancing social capital, and improving inter-generational knowledge transfer and connections. Drawing on our analysis and discussion, we make the following recommendations for conducting ethical, and socially and epistemically just digital D2D mapping in similar developing country contexts. Figure 3 below details the suggested decision-making process that one should follow in this context.

In developing country contexts, ensuring participation from illiterate remote communities in digital processes requires the availability of electricity and internet. Even in places where there is reliable electricity, researchers must consider providing money to pay for what is used, and should preferably still take portable generators and the necessary extensions and equipment. Researchers should also be prepared to conduct digital mapping 'offline', requiring the use of cached imagery. The accessibility of your venue is also a logistical consideration as road access in remote rural communities of developing countries often presents a significant challenge.

It is common research practice, in the social and environmental sciences, to explain ethical principles and informed consent to research participants. Informed consent deserves additional attention in D2D exercises, as ethics boards approving informed consent forms may not be sensitive to specific risks related to digital and participatory mapping [22]. Additionally, in part because of past social and epistemic injustices, participants may be less likely to question their rights, or understand what to question. Thus, facilitators need to take extreme care to explain all risks and processes, from participation to dissemination, in a way that participants can engage with. This includes (but is not limited to) using language that is most comfortable for the participants, thoroughly briefing interpreters about the ethics of mapping, the mapping process itself and the rights of the participants, and avoiding the use of jargon.

A second key principle relates to building trust. Based on (recent) past relationships between oppressors and the oppressed, the presence of outsiders alone might prompt communities to say 'yes' to everything, even when risks are understood. Taking time to build trust and dismantling misperceptions is key for a just and ethical mapping process. Part of building trust is managing expectations, which is also linked to transparency. In many developing countries, communities rely on outsiders for developmental opportunities, services and jobs. There is thus the risk that participants may believe that appeasing visiting researchers may be linked to a better life, a misconception that should be explicitly dispelled in favour of an honest knowledge generating partnership.

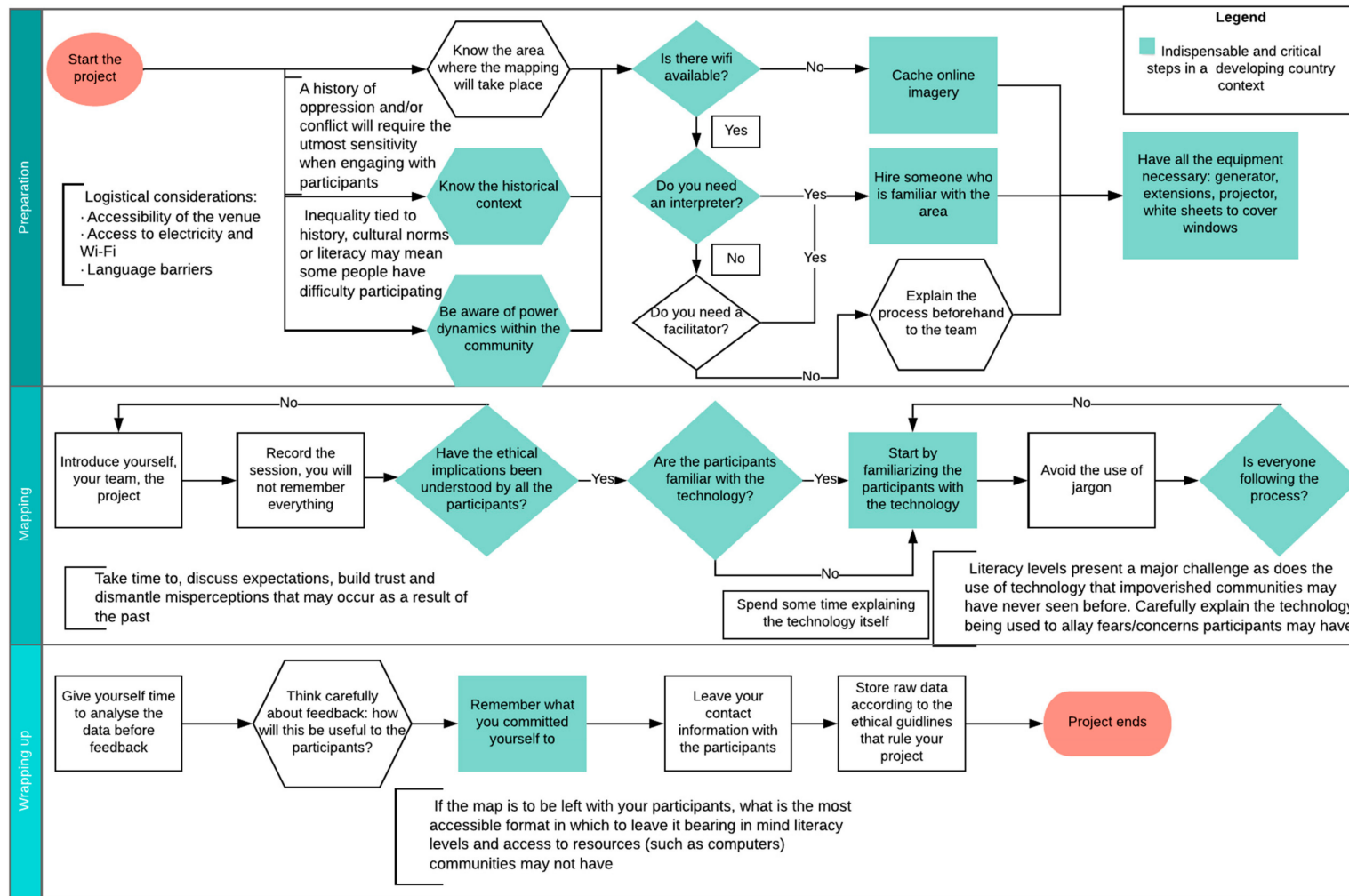


Figure 3. Flow diagram for suggested decision-making process when conducting digital participatory mapping in a developing country context.

Thirdly, we've discussed how power dynamics within communities, between different communities (if the mapping requires different communities to take part), and between the researcher and community members may undermine social justice. Thus, facilitators need to explicitly acknowledge inequalities in the group, be they tied to gender or literacy or past injustices/historic conflicts. The researcher also needs to be sensitive to cultural protocols for interaction, and the implications that these may have for running a process that is epistemically just. The selection of the mapping venue is also closely related to the power dynamics of a community. If the mapping is done in the house of the village chief, for example, other members might not feel comfortable to add to the discussion, as was observed in the case of the Tsitsa project.

A fourth, closely related recommendation links to obtaining adequate representation. Understanding how to conduct D2D workshops in a way that captures all voices and represents all relevant knowledge holders requires a thorough understanding of the local context, and building relationships within a community. A D2D process that is epistemically just will often require multiple workshops with multiple groups to achieve this.

Lastly, to ensure that the positive benefits of digital mapping exercises with local communities are realised over the long term, the final product should be left with the communities that helped produce them and in a format that is accessible to all including the less literate or the illiterate. If the maps are to be resources for the communities that develop them, facilitators and the communities themselves will be pushed to conceptualise maps that are understood and useful to all community members. This may mean translating the existing maps into hardcopy, laminated versions, but may also mean improving digital literacy, and access to digital infrastructure and technology.

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