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Digging through Betterment: An archaeological investigation into nineteenth and twentieth century farming in rural south-eastern South Africa.

A dissertation submitted to the Faculty of Science, University of the Witwatersrand, in fulfilment of the requirements for the degree of Doctor of Philosophy

Tiffany Fae Henshall
Johannesburg 2021

Declaration

I declare that this Thesis* is my own, unaided work. It is being submitted for the Degree of Doctor of Philosophy of Science at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.



_____

(Signature of candidate)

_____12_____day of_____May____2021_____in___Joannesburg_____

Abstract

Betterment Planning in South Africa has been extensively researched and documented by social anthropologists and historians. The research has found that Betterment Planning had a devastating impact on the communities in rural Eastern Cape, and is a policy that was resisted throughout South Africa.

While this social science research is comprehensive, this thesis uses remote sensing to examine the macro spatial changes that occurred in settlement and farming as a result of Betterment Planning in Cata in the Eastern Cape, and the long-term impact that this Betterment Planning had on the landscape. These changes are placed in the context of longer-term continuity and change in settlement configurations in the Eastern Cape under colonial rule (nineteenth and twentieth century), apartheid and post-apartheid South Africa. This is accomplished by the mapping, classification and interpretation of historical settlements in Cata using aerial imagery as well as more recent satellite imagery. This investigation was combined with environmental data to understand how the area has changed over time.

The pre-Betterment phase is represented by the original settlement until 1963. The Betterment phase, from 1964 until the end of apartheid in 1994, comprises the time during and shortly after the implementation of Betterment Planning. These periods were individually investigated to identify the spatial configuration of each period in the development of the Cata community. The individual datasets are then discussed in relation to each other, to establish how the community evolved over time and how national and local regulations impacted the community, with a view to understanding why the Cata area has developed into the village it is today. This data is compared with current environmental data to investigate the longer-term impact of Betterment Planning on Cata.

For my husband Timothy Marais. There is no sentiment to sufficiently describe my gratitude for your existence.

Acknowledgements

This thesis is the result of consultation with many brilliant people, without whose guidance it would have been an impossible task.

To my supervisors Professor Alex Schoeman and Professor Mulala Simatele, thank you for your comments and guidance throughout the compilation of my thesis. A special thanks to Professor Schoeman for your continued support and assistance. I am so grateful for all the time and effort you have put in over the last seven years.

To Professor Chris de Wet, thank you for your assistance in the field and for your comments on my writing. Your knowledge of and passion for the village of Cata has been a valuable resource.

To the wonderful people of Cata, thank you for your hospitality and willingness to share your stories and history with researchers over the past few decades.

Much appreciation goes to the National Research Foundation (NRF) and Dr Schoeman for providing the funds that made this thesis viable.

Special thanks go to Judy Henshall, Lizzie Mikosi and the women of the Siyavuma Foundation, for giving me the opportunity to learn from the wonderful women who form the foundation on which this country is built. I am so grateful to have been a part of the wonderful work the Siyavuma Foundation has done.

To my awe-inspiring friend Nicole Burri, thank you for all of your advice and patience. Your knowledge of environmental processes has been an invaluable contribution.

To my incredible husband, Timothy Marais, I am unable to find a way that adequately describes how thankful I am for all of your help and support. If I had

not had you there to motivate me when I was struggling and offer your perspective when I needed to process, I would not have finished this project.

To the wonderful Adam Saber, my editor, cheerleader and confidant, thank you for your time and effort. I could not ask for a better friend.

To my sister Tayla Henshall, thank you for always being there for me. You are often my light in the dark, and you are the best emotional support animal I could have asked for.

A big thank you to my extraordinary mother Lianne Harding for raising me to be a person with high standards and an understanding of how important the role of women in our society is. Thank you to both of my parents for creating opportunities for me to succeed. I hope my father would be proud.

Lastly, to my beautiful niece Lily Mia Marx, may you become an empowerer of those around you and use your privilege to aid those who have not been equally blessed.

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Chapter One – Introduction

1.1 Introduction

Betterment Planning in South Africa was an apartheid policy designed to forcibly relocate and reorganise communities. It was motivated by the premise that their existing way of life and agricultural practices were damaging to the environment and needed intervention to avoid extreme erosion. This essentially led to the restructuring of land use with no consideration given to the needs of the community, their social structure or agricultural practices that had already adapted due to pre-existing stressors in the community (de Wet 1985).

Betterment Planning had a devastating impact on the communities in rural South Africa, including the Eastern Cape, and it was widely resisted. The impact of Betterment Planning, and resistance to it, has been extensively documented by social anthropologists and historians. The aspects researched include farming untouched by Betterment (e.g., Andrews 1992; Board 1962; McAllister 1991), the impact of Betterment (e.g., Board 1962; De Wet 1989, 1994, 1995a; Letsoalo & Rogerson 1982) and resistance to Betterment (e.g., McAllister 1989, 1991; Ngcaba 2002).

While this research was comprehensive, the long-term impact of Betterment on farming and grazing potential in the Eastern Cape, that I investigate in this thesis, has implications for long-term modelling of African farming systems, as well as contemporary land policy. Creating a holistic view of the impact of Betterment Planning is necessary in order to understand the consequences of this type of community removal/relocation in present times, as well as how these communities may be assisted.

This thesis aims to address the void apparent in the research on Betterment Planning in the Eastern Cape. While the impact of Betterment was studied

intensively in the twentieth century, very few scholars are focussing on the long-term changes and spatiality. In addition, the history of farming in this region has poor visibility in contemporary academic publications. This is part of the broader lacuna, in which the spatial and material configuration of pre-twentieth century farming in southern Africa in general is not well understood. This thesis attempts to contribute to the body of existing contemporary archaeology by providing further examples as to how archaeology can be a useful means to examine the recent past and how effective a multidisciplinary approach can be.

Anthropologists and historians have suggested that Betterment Planning had three major consequences: reconfiguration of settlement patterns (de Wet 1985, 1989, 1994); the depletion of soil nutrients (Heron 1990; McAllister 1989) and a loss of economic independence and related social implications in the capitalist economy i.e. a need to create monetary income to pay taxes and purchase goods etc. (Andrews 1992; McAllister 1989). This thesis focuses on two of these consequences of Betterment Planning: changes in settlement patterns (where farming occurs, how land is redesignated and what changes occur in the way the space is used) and soil erosion.

This study employed remote sensing techniques to investigate the impact that Betterment Planning had on the macro spatial residential and farming configuration of Cata, a rural faring community in the Eastern Cape, as well as the long-term impact of these changes on the physical landscape. I specifically focus on erosion and the loss of top soil, which has implications for soil fertility and carrying capacity for domesticated animals (such as cattle), both of which are factors in long-term sustainability of farming.

This research was carried out by combining various techniques in order to expand the body of research, such as utilising GIS to map and manipulate historical and contemporary imagery, providing a quantitative dataset, and investigating understudied components such as the homestead gardens. By following a more scientific approach than that used in research carried out on

this area in the past, the hope is that verifiability will be improved, as mapping and the study of the broader physical changes in the landscape and settlement structures can be viewed outside of political and other influences that may have been present at the time, unlike written and oral records.

This thesis locates Cata (see Figure 1.1) in the longer-term continuity and change in settlement configurations in the Eastern Cape under colonial (nineteenth and twentieth century) and apartheid rule. This has been accomplished by the extensive mapping, interpretation and classification of historical aerial imagery as well as more recent satellite imagery.

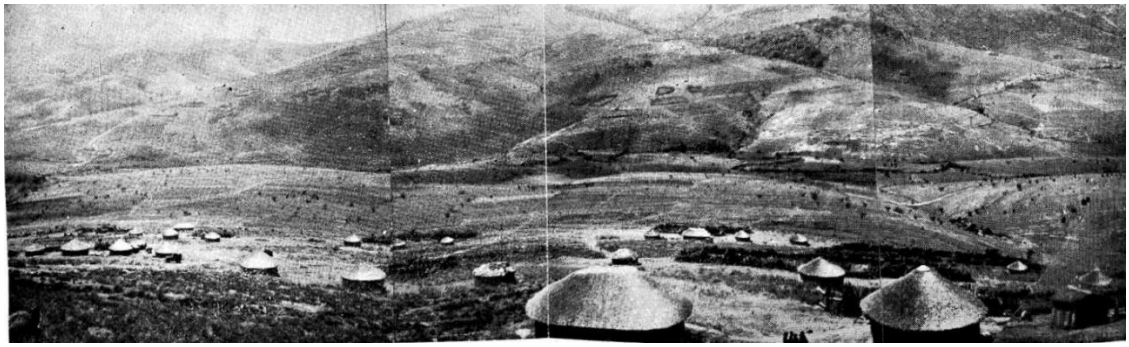

Figure 1.1: Panoramic photograph of Cata pre-Betterment, taken by R. Lindsay-Robb (Mills & Wilson 1952) (see Appendix A for a larger version of this image)

These datasets were combined with environmental data to create a broad dataset for the study area and how it has changed over time. These datasets had not previously existed and will hopefully aid in any further research on this area. In addition, the spatial data from Cata where Betterment was implemented, is compared with previous studies carried out on Shixini, in Willowvale, where Betterment was never fully implemented due to successful community resistance.

The generated dataset, combined with existing historical and anthropological research, focused on exploring change and continuity in rural Eastern Cape farming practices, and associated settlement patterns, in the nineteenth and twentieth centuries. These patterns highlight the impact of colonial and

apartheid policies, resistance to these policies, and the resilience of the Willowvale and Cata communities.

Archaeology is a suitable vehicle for the exploration of long-term continuity and change in this context, as the discipline focuses on the materiality and spatiality of people's lives (see Hayashida 2005; Hodder 2000, 2012a; Nanoglou 2009; Patnaik 1995; Pikirayi 1999; Reid 2016; Schmidt & Walz 2007; Shackel & Little 1992; Trigger 2006). Archaeology has also evolved in recent years, allowing the study of more recent sites and subjects. Contemporary archaeology combined with scientific methodology can provide a unique view on Betterment Planning in a broad sense, and more specifically as it relates to Cata – a view that had not previously been applied to this area (González-Ruibal 2014b; Vilches et al 2015).

Archaeology can also be a useful means to explore contemporary history, as it is a theory-laden field. The material evidence found does not stand alone; rather, it requires interpretation. The interpretation of this material evidence is generally guided by the theoretical framework adopted by researchers (Dornan 2002; Gardner 2009; Joyce & Lopiparo 2005; Meskell 1999; Pauketat 2000a, 2000b; Thomas 1996, 2004; Whitney *et al*. 2014; Wylie 1991).

The primary study site is Cata, Eastern Cape, South Africa (see Figure 1.2). This study area contained an agricultural village with food production derived from both fields and gardens. The community had deeply ingrained social structures, which played a vital role in their adaptability and general survival.

This study explores the changes that occurred in this area over three periods: the pre-Betterment phase, which was the period prior to the implementation of Betterment Planning at Cata (from original settlement in the late 1850s until 1963); the Betterment phase, which was the period during and shortly after the implementation of Betterment Planning (from 1964 until the end of apartheid in 1994); and the post-Betterment phase, from 1994 to the present day.

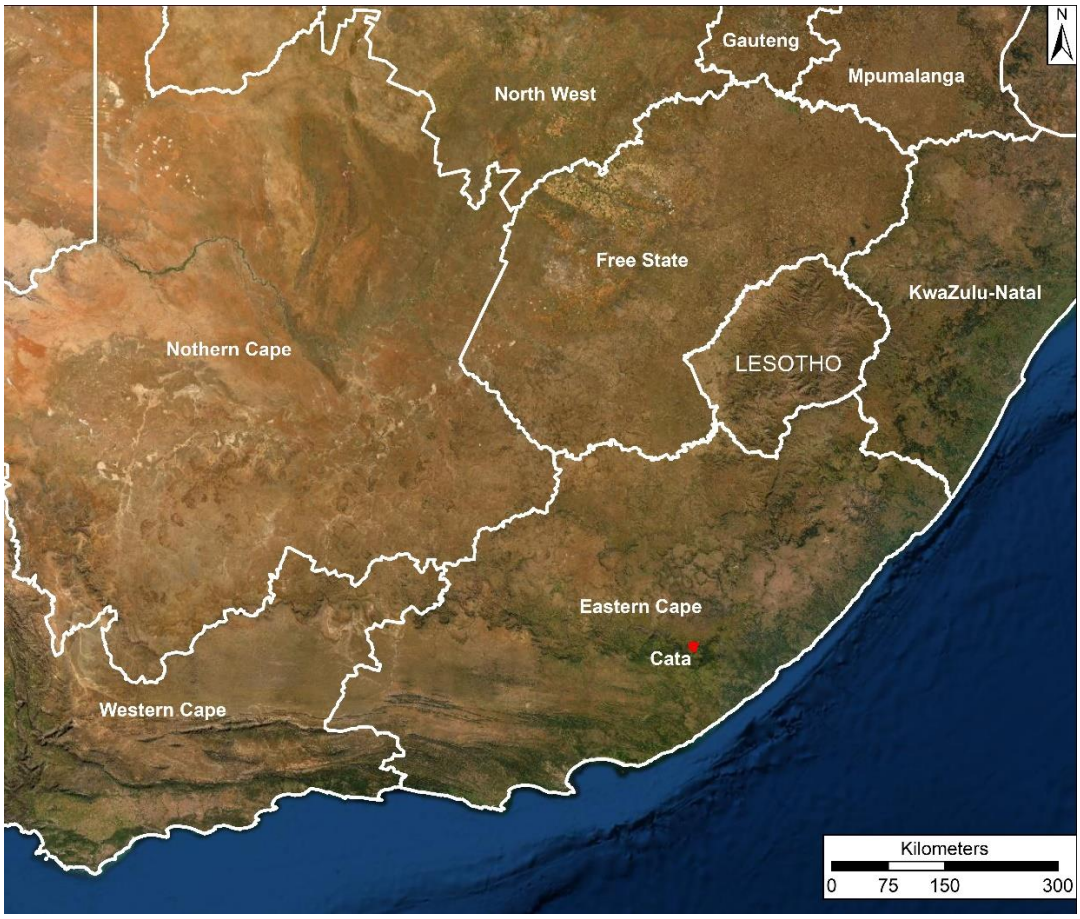

Figure 1.2: General map of South Africa indicating the location of Cata, Eastern Cape (ArcGIS 10.2)

The study examines key features of Cata village and compares them over the three defined periods. These features include: agricultural production from gardens and fields; access to necessities such as grazing land, water sources and wood; access to land for expansion; the social structures of the area's residents; and the interconnectedness of residents with the space and layout of their living and production spaces.

1.2 Chapter outline

The body of this thesis contains eight chapters including this introduction.

Chapter two reviews the body of available literature relevant to this thesis. It looks at studies that have been carried out on the archaeology of the recent past, and on farming in Africa in general and South Africa in particular. In

addition, it gives a brief overview of land reform and Betterment Planning in South Africa. The chapter is concluded with an overview of Cata, the focus of this thesis, and Willowvale, our comparative site.

Chapter three describes methods and techniques used to generate the datasets incorporated throughout the course of this thesis. A description is given of how the data was collected, and what methods were used to process the data.

Chapter four focuses on the pre-Betterment period of occupation in Cata. This chapter examines settlement patterns and land use to form a basis of comparison for the subsequent phases in the evolution of this settlement. This chapter contains two significant datasets: a description of the mapping results, and the range of yields calculated for the mapped gardens. An overview of environmental factors, such as average rainfall and climate data, is also given.

Chapter five examines the second phase of the village's occupation. This chapter comprises an overview of Betterment Planning, based on anthropological, historical and archival sources. The mapping, processing and evaluation of the new settlements is presented and the yield calculations on all of the mapped gardens are displayed and discussed.

Chapter six explores the third phase of settlement, and the long-term impact of Betterment on the landscape. This chapter largely provides comparisons between the datasets generated in chapters four and five. The mapping, yield and area calculations are compared. The other primary component of this chapter is the environmental data generated for the field area.

Chapter seven discusses the primary objectives of this thesis, interrogating the results presented in the previous chapters. The generated data is examined within the broader political context of South Africa, through the different phases of settlement, with focus on understanding the impact that land reform can have on a community.

Chapter eight provides a conclusion to this thesis. It starts with a summary and an overview of more recent interventions that have been implemented in the Cata area. It also lays out the constraints of this thesis, and considers suggestions for further research.

Chapter Two – Literature Review

2.1 Archaeology of the recent past - contemporary archaeology

In a speech in the House of Commons circa 1948, Winston Churchill as cited by Shapiro (2006:154) famously stated, “For my part, I consider that it will be found much better by all parties to leave the past to history, especially as I propose to write that history myself.” This, perhaps reductively, highlights why, in a period often understood purely through historical and anthropological records, the inclusion of a potentially less biased, more objective record can be vital. Archaeology could be the ideal vehicle for research into the last 200 years, partly as its focus on the material record and spatiality allows the stories of those without a written history to be examined (see Horning 2011; Nanoglou 2009; Shackle & Little 1992).

Archaeology of the last 200 years in Africa is drawing increasing attention from scholars on a global level. The nineteenth and twentieth centuries are a period of critical change in the history of the African continent with long-lasting consequences (González-Ruibal 2013a; Graves-Brown *et al*. 2013). This period should, however, not be viewed in isolation, but rather as part of a complex history. During this period, there were many factors and processes that impacted economic systems, social infrastructure, and political relations – often at the most basic levels. Advances in technology, increased travel, the abolishment of the transatlantic slave trade, greater numbers of settlers, and the acceleration of colonialism, were some of the drivers behind dramatic changes during this time (Graves-Brown *et al*. 2013).

This period is also marked by conflict, both in the form of civil wars and European nations fighting to expand their African territories. Later, independence and the enforcement of political policies such as apartheid,

again resulted in shifting identities, reshaping of landscapes, and changes to socio-political infrastructure (Pikirayi 1999; Swanepoel 2016).

A common goal among researchers in the field of African historical (contemporary) archaeology is to create an intentional move away from the common practice of privileging the evidence and sources rooted in the European perspective. This has been a long-standing issue in the examination of the African past (e.g. Reid 2016; Reid & Lane 2004; Schmidt & Walz 2007). Researchers such as Reid (2016) and Schmidt & Walz (2007) have tried to consciously uncouple their approach from a predominately European perspective. The prioritising, where possible, of oral and other material sourced directly from the communities being studied has helped to achieve this goal. This thesis takes a similar approach, by placing importance on the information gathered by anthropologists through interviews and consultation with the affected community.

While there is an abundance of source material for this time period ranging from written to oral history, which serve as the main sources for historical and anthropological studies, archaeology concentrates on the accompanying material record left behind. This material culture displays the impact of these macro-scale events on the daily lives of African people in a diverse array of socio-political and geographical contexts (Swanepoel 2016).

At times referred to as the archaeology of “supermodernity”, contemporary archaeology attempts to take a more critical approach to the study of the recent past. Archaeology of the past 200 years attempts to look past the picture painted by those in positions of power by focusing on the story told through material culture. Materiality and a focus on objective exploration can provide a new perspective on this time period in a multiscalar, or site-specific manner (see González-Ruibal 2008, 2013b; Orser Jr 2010).

The focus on materiality is integral to this field of study. Humans and “things” are as inextricably linked historically as they are prehistorically. Studying material culture often offers a more reliable base of understanding than pure reliance on memory, and is not tainted by the political influences that so often blur historical records. It is also important to realise that the study of the recent past does not attempt to separate past from present, but rather acknowledges that the past is an unavoidable influence on the present (González-Ruibal 2008, 2014a; Gosden 2015; Patnaik 2009; Shackel & Little 1992).

The study of the history of Cata is inseparably entwined with identity, memory and experience. This is particularly important given that the community is still present and are still struggling with the long-term consequences of Betterment planning. These case studies aim to provide an understanding of the universality of the idea that memory, physical structure and identity are intertwined. González-Ruibal’s (2005) research on the homes of Galician emigrants who settled in Europe and America between the nineteenth century and the 1960s, provides an example of how useful archaeology can be when studying the recent past. The architectural changes and household contents display the connections between the home and identity. By studying not only new homes but also abandoned buildings, the desire to move away from their ‘peasant’ identity can be seen. Abandoned homes in traditional architectural styles display negative associations just as much as new homes attempt to project the desired new identity of the owner. The practice of destroying traditional architecture has been interpreted as an attempt to not only change the future, but also partly rewrite the past (González-Ruibal 2005).

González-Ruibal (2005) approaches the abandoned homes in Galicia as a form of captured memory – a means to compose a biography of each home and how the material culture within it allows us to understand how identities were shaped in a society that actively tried to remove itself from its history. The Galicians, labelled by González-Ruibal for this reason as iconoclasts, provide a living

example of how the past informs the present, regardless of how hard a society tries to excise their history (González-Ruibal 2008).

Traditionally, the Galicians were one of the last pre-modern societies in the North Atlantic, displaying very little change in the belief systems or social organisation that dated back to the late Middle Ages. This led to a prolongation of an egalitarian atmosphere into the 1900s. The traditional ideals of equality and community were preserved through long-standing practices of work parties and collective labour in agriculture. These ideals were further emphasised through traditional stories that highlighted the need for equality and community while admonishing the ideas of greed or unfairness. This attitude clearly reflected in the original houses (see Figure 2.1). They were built using local materials, were standardised, and were humble, with facades that remained undecorated (González-Ruibal 2005).



Figure 2.1: An example of a traditional stone home in Galicia (González-Ruibal 2005)

This persisting removal from modernity eventually ended with a large migration outward across Europe and America, breaking up families and creating a shift

in ideals. This, combined with the outbreak of the Spanish Civil War in 1936, led to an unsparing oppression of these rural areas. Later years marked the return of some of those who had emigrated. Instead of maintaining the family homes of their past, these homes were either abandoned or demolished in favour of flamboyant, modern, individualistic homes – a complete departure from their past (see Figure 2.2). The abandonment of the old homes was not just structural. Personal artefacts, books, and day-to-day household goods were also discarded (González-Ruibal 2005).



Figure 2.2: A: Example of a modern home in Galicia; B: Example of a modern home built on the ruins of a traditional home (González-Ruibal 2005)

With the physical departure from the old, the attitude that new buildings were approached with was telling. Where previously the façade had been simple and had conformed with others in the community, emphasis was now placed on grandeur, decoration, and overstating the size of the exterior. Those without the means to rebuild covered as much of the original exteriors as possible with imported materials such as aluminium and brickwork (see Figure 2.3) (González-Ruibal 2005).



Figure 2.3: An example of a traditional home modified with imported materials (González-Ruibal 2005)

The façade of the home was a primary means to not only occupy space but flaunt success and further exorcise the image of the peasant past. However, regardless of their desire to erase their history from their modern identity, the archaeological record has allowed for its preservation and provides a space to understand how trauma, identity, iconoclasm and modernity are interlinked (González-Ruibal 2005).

In a similar vein, Given (2004) utilises architecture and ruins to explore the recent past. The primary focus of much of Given's work is to study history from the perspective of the ruled, rather than the rulers. He uses case studies from various countries at various points in history to illustrate the need for the incorporation of this perspective, from colonisation to the events of the second World War. Given's (2004) case study on the architecture of the Nazi regime is an enlightening example of how architecture can be used as a means to explore memory and the way experience is interwoven with physical structures.

When studying monuments such as the buildings constructed in Nuremberg and Berlin during this time, it is easy to simply view them from the perspective

of those who ordered their construction. For those in power, they served the purpose of showing the world that Germany was regaining its power and rebuilding after World War I (Jaskot 2000). The designs were expansive and dominating, and were described in a competitive manner. For example, an arch would be described as being 50 times bigger than the Arc de Triomphe, or a dome would be portrayed as greater than that seen at St Peter's in Rome. Architecture was a means to reassert dominance and rebuild national pride (Given 2004).

However, rather than focusing his research on the ruling party and the legacy they hoped to leave (which is also important to understand), Given (2004) examines how these immense architectural endeavours would have impacted labourers and the society in which they were being built. In this instance, labourers fell into two categories, for whom the erection of these buildings would serve very different purposes.

The first category of labourer consisted of working-class people who had been living in a depressed society, rife with unemployment in the aftermath of World War I (Overy 1994; Zeller 1999). The construction of these buildings was used by the Nazi Party to offer employment to the unemployed masses, while instilling the key principles necessary to their agenda, such as a well-structured hierarchy, discipline, and an unwavering sense of national pride. In many ways these labourers were made to feel that they were an integral part of rebuilding the German nation. This sense of incorporation, combined with the opportunity to provide for their families, resulted in the ability for the working class to begin to rebuild their lives and regain self-respect that the harsh consequences of the Treaty of Versailles had diminished (Overy 1994). The experience of participating in the creation of these monuments would have been positive and a sign of hope for these labourers (Given 2004).

The second source of labour for the construction of monuments during this time offers a stark comparison. This second category of labourer consisted of

prisoners of concentration camps. For these labourers, these monuments did not represent hope, and were not used as a means to incorporate or uplift those carrying out the work. Labour was used as a means of torture, made as physically punishing as possible, and often resulted in the death of the prisoners (Allen 1998).

As the architectural ambitions of the Nazi regime expanded, so did the number of labour camps in areas containing granite that needed to be quarried. These camps were intentionally primitively designed to force prisoners into brutal manual labour. Starved and exhausted, they were forced to haul large granite blocks up steep steps out of the quarry. These blocks were the building materials of the monuments constructed during this time (Allen 1998; Given 2004; Jaskot 2000).

Given (2004) uses these differing experiences to highlight how polarised the experiences associated with physical structures can be. To some they represented hope, a way out of the depression, and a means to rebuild. To those who survived the concentration camps and their families, the blocks these buildings are made from (and by extensions the buildings themselves) serve as a reminder of the horror and dehumanising acts carried out during the Holocaust (Given 2004).

Both of the case studies above illustrate the different ways the material record of the past interacts with memory, identity, and experience. This is particularly relevant when studying traumatic events. The way individuals and communities interact with the monuments and other aspects of the materiality of their past can be a significant indicator of how these past events have shaped the present. This is particularly relevant when discussing the impact of segregating and destructive policies such as apartheid.

2.2 Archaeology of farming

The combination of fields such as anthropology, history, ecology, and archaeology has provided a deeper understanding of farming communities. While the success of interdisciplinary study can be seen at numerous sites in Africa, there is still much work to be carried out, particularly in southern Africa (Davies *et al*. 2014; Stahl 2001).

Examples of this approach can be seen, amongst others, in the studies of Nyanga, Zimbabwe by Robert Soper (2002, 2006), Chirikure and Rehren (2004), and Manyanga and Shenjere (2012); the research on Engaruka, Tanzania by John Sutton (1984, 1989) and Daryl Stump (2006, 2010); and the work in Marakwet, Kenya by Henrietta Moore and Matthew Davies (Moore 1986; Davies 2008, 2009). These sites were examined from ecological, historical, anthropological, and archaeological perspectives, each field focusing on different aspects of these agricultural societies. This interdisciplinary approach allowed for a deeper understanding of the complex social infrastructure in place in these communities, ranging from the role of kinship ties to the workings underlying socio-political systems. The combining of disciplines additionally allows researchers the opportunity to shift focus from temporal boundaries to the landscape itself, as well as the interactions that occurred with this landscape (Davies *et al*. 2014).

Posnansky's (2004) research on the Ghanaian village of Hani similarly utilised archaeological methods to explore change over a long period of time. This allowed for a comparative study to be done due to the mapping and periodic study of agricultural and social practices over a period of 28 years. This information, combined with interviews regarding shifts in political, economic, and environmental vectors, allowed for well-rounded, long-term insights to be gained regarding the changes that occurred in this village (Posnansky 2004).

Hani, a village located 450 kilometres from the Ghanaian capital of Accra (see Figure 2.4), has its roots as the successor to the medieval settlement Begho. Begho was occupied between the twelfth and early nineteenth centuries, boasting a booming population of between 5 000 and 10 000 occupants at its peak (Posnansky 1987). Excavations, mapping, and the study of the material culture collected from the remaining sites were combined with the data collected through various other fields of study such as genetics, linguistic studies, oral histories, and historical records, to create a map of ethnographic continuity between the past and present communities (Posnansky 2004). Besides providing a basis for a study in continuity, this data also provided indicators for trade and establishing Begho's status in this regard. The interviews that were carried out through the use of questionnaires, provided the means to establish a base understanding on a variety of topics ranging from the life span of household utensils to land management practices (Posnansky 1984, 2004).

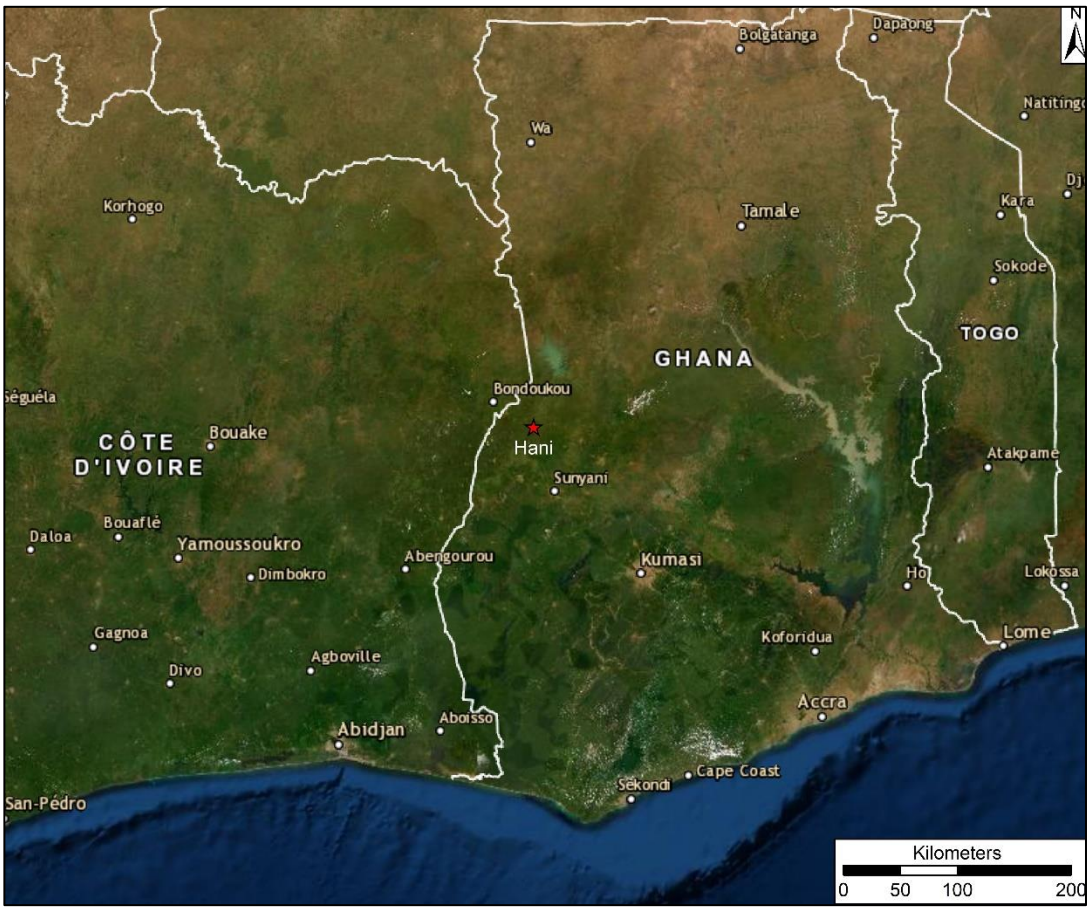

Figure 2.4: Map indicating the location of Hani, Ghana in West Africa (Google Earth)

This information on land management practices combined with environmental studies, including a 70-year rainfall record, aided in the reconstruction of farming practices of the past and led to an understanding of how they have evolved to what can be seen in present-day Hani. The compilation of the archaeological record of Begho and Hani, particularly around farming shelters, provided a firmer approximation for population sizes. Due to the practice of shifting agriculture, farming shelters were periodically abandoned. The material culture found in these areas – which had social functions as well as practical purposes – included ceramics, hoe stones, and other tools that had outlived their functionality, and this scatter contributed to better estimation of population figures (Posnansky 2004).

The multi-disciplinary research carried out in Marakwet provides another example of the successful marriage of data from different fields to create a holistic understanding of the past and how it informs our understanding of present-day communities. Marakwet is a well-researched village in the Kerio Valley, forming part of the western escarpment on Kenya's famous Rift Valley (see Figure 2.5 (see Appendix A for a larger version of this image)). Notorious for unpredictable rainfall patterns and a wide range of landscapes, farming carried out in the area requires flexibility and adaptive thinking in order to become sustainable. The Marakwet Heritage Project is the result of the work pioneered by Henrietta Moore and Matthew Davies. Their work, in conjunction with that of other researchers from the British Institute in Eastern Africa and University College London, has helped create a strong database on this area. This project has allowed for extensive mapping to be produced of Marakwet and of the irrigation network that the community has become so well-known for. The combination of anthropological (Moore) and archaeological (Davies) data has allowed for the development of a very detailed, well supported body of work on this adaptive farming community (Davies 2008, 2009; Davies *et al.* 2014; Moore 1986).

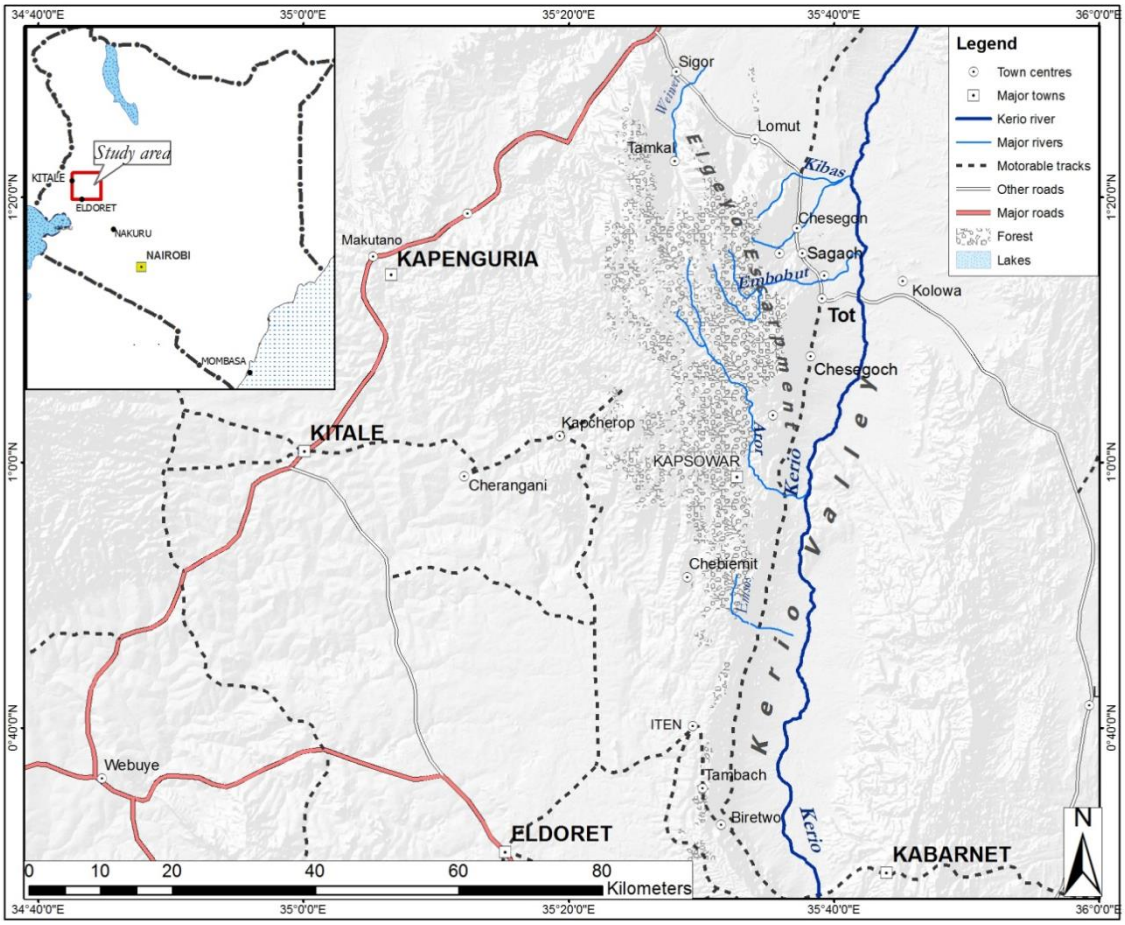

Figure 2.5: Map indicating the location of Marakwet and the Kerio Valley (http://maraketheritage.co./landscape-and-maps)

The archaeological data focuses on the long-term settlement of the area and creates a chronological record for the development of agricultural practices. Through his work, Davies (Davies 2008, 2009; Davies *et al.* 2014) illustrates the dynamic processes that occurred over time with regards to the development of agriculture in the area. He discusses the many adaptations and motivations for intensification and land use that far exceed the basic 'population-driven expansion' ideology. Davies incorporates climate change and economic data, as well as consideration of a variety of social structures into his approach to understanding land use in the area, allowing him to contribute towards the continued shift away from the previously popular notion of pre-colonial African agriculture as static. The pre-colonial irrigation networks

(see Figure 2.6 (see Appendix A for a larger version of this image)) that are still in use today, are significant evidence of this. These systems span over 40 kilometres, providing access to water sources that are fundamental to farming, and that became vital during drier periods. This was imperative to the community's survival due to the unpredictable nature of the climate and rainfall in this area. The irrigation networks and other adaptive farming strategies such as terracing, in its various forms, illustrates the flexible use of the available arable land that allowed these communities to thrive despite challenging climate and rainfall patterns (Davies 2008, 2009; Davies *et al.* 2014).

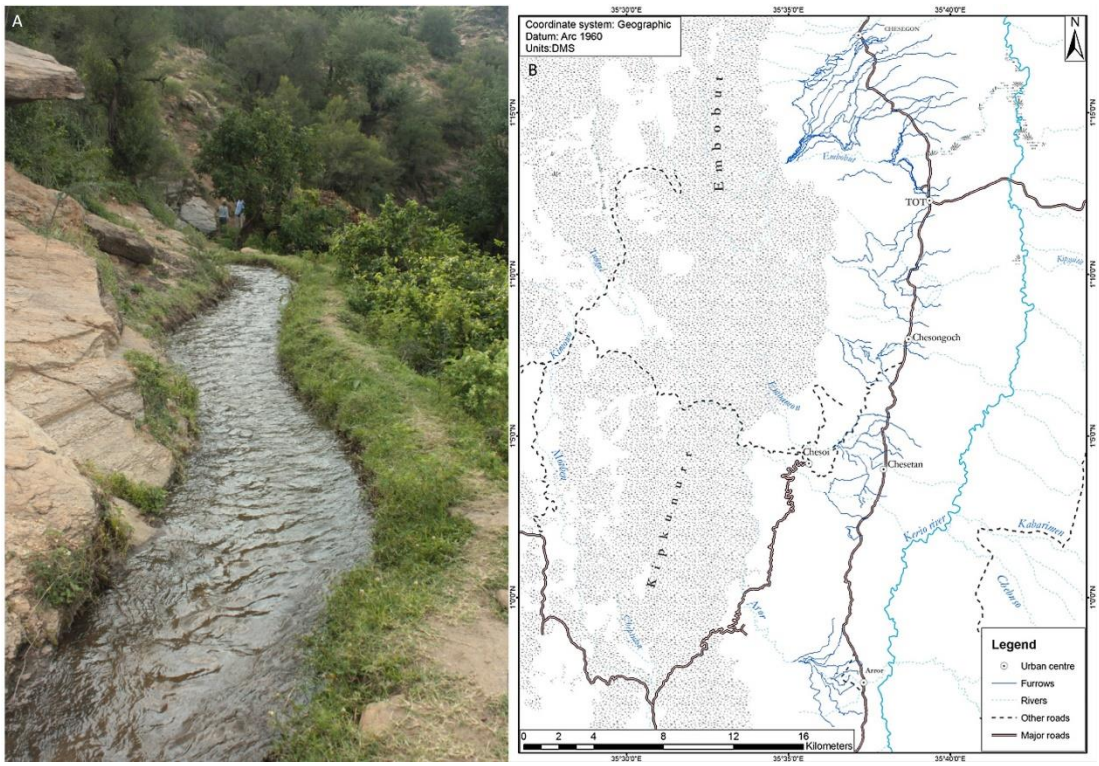

Figure 2.6: Map and image of irrigation furrows in Marakwet (http://marakwetheritage.com/agriculture/)

Moore's (1986,1996) work deepens insights into the social infrastructure that informed how the available space was utilised. Moore details the delicate dynamic between men and women in these communities, as well as the implications of the gendered division of labour. Through the exploration of

kinship, internal household politics, and broader social structures, Moore illustrates how the organisation of space can inform gender relations. This can be seen in sites around Africa where the gendered division of labour occurs. Through anthropological research, Moore demonstrates that the fact that women are responsible for quotidian agricultural practices resulted in the positioning of agricultural terraces near the homesteads. This allowed practical completion of other daily tasks (Moore 1986:101,1996).

The long-term study of the remains of Engaruka, Tanzania (see Figure 2.7 (see Appendix A for a larger version of this image)) provides further testament to the efficacy of the multi-disciplinary approach. The early research carried out focussed on singular fields. The initial investigation can be traced to German records from 1813. This was followed by a brief archaeological study by Reck in 1913. From 1936 onwards, extensive excavations by Leakey and his team provided a detailed archaeological record of the site and a large catalogue of material culture gathered through excavation (Sassoon 1967).

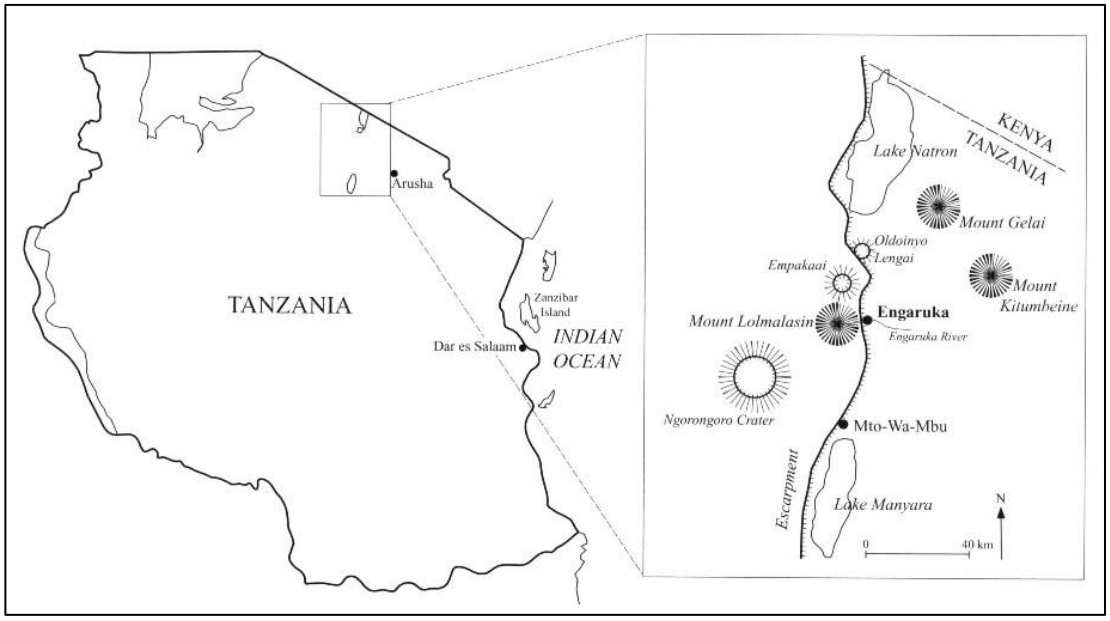

Figure 2.7: Map of Tanzania and Engaruka area (Westerberg et al. 2010)

More recent studies, beginning with the work of Sutton (1984, 1986, 2004) and later Sutton and Widgren (2004), Westerberg *et al.* (2010), and Stump (2006, 2010), combined data from a variety of disciplines to create a broader, more complex understanding of life at Enguraka. This work has been particularly useful in understanding the expansive irrigated terracing that Engaruka has become synonymous with (Sutton 1984). Westerberg *et al*. (2010) utilised data including archaeological finds, anthropological data, environmental data, sedimentary studies, and a large historical database developed over decades of study, to explore the rise and collapse (abandonment) of Engaruka.

Both Sutton (1984, 1986, 2004) and Westerberg *et al*. (2010) attempt to understand how such a complex, labour-intensive society came to be, how it was maintained – particularly the agricultural spaces that were developed so expansively – and ultimately, why such time-costly structures were abandoned.

Studying the climate data, historical records on the progression and nature of trade in the area, as well as the regional social and political structures, provides an interesting picture of the ebb and flow of this society. When these factors are combined, it becomes clear how interlinked the various influences were. The ability to adapt to a shift from a humid to a drier climate, the impact of trade, growing populations, stable political structures, and the careful management of water and soil resources, were key to the success of Engaruka (Sutton 2004). The collapse of this society can similarly be linked to multiple factors, with mismanagement of resources and an instability in local political and social structures appearing to be key (Westerberg *et al.* 2010).

Without considering data from various fields, a holistic understanding could not have been developed to the extent that has been achieved by these researchers. This data also helps us to understand potential weaknesses of existing rural farming communities in the present day, and how best to assist these communities to ensure their sustainability (Westerberg *et al.* 2010).

These case studies illustrate how useful a multi-disciplinary approach can be, particularly when trying to create a holistic understanding of an area. These studies helped to inform the methodology used when this project was undertaken- highlighting the useful contributions each field (anthropology, archaeology, history and environmental studies) provides to the production of databases. These databases were created in the hopes of expanding the understanding and source material available in the ever-expanding research area of the agricultural history of Africa.

The adoption of agricultural practices in Africa had a profound impact on the progression of technological advancement and population density in many instances, because the ability to produce a constant food source has allowed for a very revealing window into the adaptive nature of agricultural communities. This can be seen throughout the historical record up to present-day communities (Netting *et al.* 1993).

The development and advancement of agriculture in the African setting bears many similarities to global agriculture as a whole. The increase in population density associated with agricultural communities resulted in a need for agricultural intensification in some areas. Increased demand ultimately led to larger expanses of farmed land and changes or modifications to land-management practices (Pingali *et al*. 1987). Another commonality that can be seen is the occurrence of agricultural intensification when a community gains access to other markets. When agriculture becomes a deciding factor in the economic success of a community, intensification often follows (Pingali *et al*. 1987).

Through the study of communities in which intensification has occurred, the level of thought and planning that took place becomes clear. During the research carried out by Pingali *et al*. (1987), the group reviewed the agricultural practices of farming communities across sub-Saharan Africa. These included sites in, but were not limited to, Botswana, Ethiopia, Zambia, Kenya, Tanzania

and Burkina Faso. During this study, they concluded that careful selectivity occurs at sites that had practised agricultural intensification. Soils were used for specific purposes, and areas that contained soils with higher clay volumes and greater density were favoured. These soils have favourable properties for higher agricultural yield, such as greater water and nutrient retention. This soil selection is interesting as the decision to utilise these soils in order to obtain higher yields, meant that the amount of labour required was much greater for unmechanised farmers. Other practices, such as ensuring adequate access to water and the aeration of soils, would have been labour intensive, but key to maximising potential yield per capita (Pingali *et al*. 1987).

The difficulty in using the preferred soils can be seen at sites with lower population densities, and thus a limited labour force in unmechanised farming communities, where darker, denser soils are often abandoned for lighter soils with lower yield potential (Pingali *et al.* 1987).

The study conducted by Pingali *et al.* (1987), as well as other studies carried out through Africa (e.g. Berry 1993; Westerberg *et al.* 2010), found that population size has often been a critical factor in the success or failure of agricultural communities, particularly those inhabiting land that poses challenges to production. Larger labour forces enable communities to adopt land-management practices such as terracing, levelling of land, irrigation, and numerous other water-management techniques (Berry 1984, 1993; Sutton 1991).

Much of the research carried out on the advancement of agricultural intensification in Africa indicates that resilient, adaptive communities were successful and often outproduced their colonial counterparts (e.g. Berry 1993; Davidson 1978; Lloyd 1972; Richards 1985). As research into the nature of the practice of agriculture moved away from the antiquated concept of African agriculture being static prior to colonial intervention, it became increasingly

clear that agricultural communities had been adapting and thriving from as early as the sixth century (Niemeijer 1996).

Examples of the adaptive nature of African farmers can be found throughout the continent, and illustrate a shrewd understanding of business, trade, expansion, and demand. The success of the expansion undertaken by cocoa farmers in Ghana is a good example of this (Chauveau 1997; Hill 1963, 1970; Niemeijer 1996). Farmers utilised forestland for the slow expansion of crops, eventually forming smaller farms run by relatives. Their business models were so successful that colonial farmers attempted to mirror them when they struggled to flourish in the industry themselves (Chauveau 1997; Hill 1961, 1963).

Another case contributing to our understanding of the sophisticated business sense that accompanied agricultural production is that of tobacco farmers in North West Nigeria. Tobacco was grown predominately for the purposes of export. Farmers grew and then stored crops, waiting for surges in the trade price. Profits were reinvested in livestock, displaying an acute understanding of balancing business and sustainable incomes (Hill 1963; Niemejier 1996).

Not every society, however, maintained agricultural success over the long term. The Ilchamus community, residing in the Lake Baringo region of Kenya in the nineteenth century, provides a poignant illustration of the dangers of fast expansion and the risks of over-specialisation of crops. The introduction of a new trade market in the form of Swahili trade caravans stimulated this community to rapidly expand their agricultural production in order to produce a tradable surplus. This required the expansion of their irrigation systems, the utilisation of greater stretches of land, and a need for a larger labour force (Anderson 1989; Niemejier 1996).

This was initially a successful endeavour. The Ilchamus built resources, increased production, and enlisted the aid of their less economically affluent

neighbours, the Maasai and Samburu communities. The neighbouring communities were given an opportunity to rebuild their waning stocks and the Ilchamus community increased their wealth and standing in society. The community shifted its focus to the production of millet species that had a higher yield, but also a higher risk of crop failure. Failing rains and sensitive crops ultimately led to the abandonment of this agricultural intensification and a swift return to a focus on livestock rearing (Anderson 1989; Niemejier 1996). This case study does illustrate the ability for African communities to adapt in the face of economic challenge and how change can be driven by both environmental and social factors.

Trade is often a driving factor for change in African farming communities, from small subsistence farming to larger-scale surplus-producing agriculture. The responses by many African communities to the arrival of foreign trade caused substantial changes to social structures, the environment, and the landscape (Håkansson *et al*. 2008; Hill 1963; Niemejier 1996).

A glimpse of this is provided by Tanzania (see Figure 2.8). By the mid-nineteenth century, trade in this area with countries such as China, Europe, and India was substantial. Large caravans moved through the area, having a profound impact on the environment. The trade of ivory burgeoned to more than 500 tons per annum. This led to a drastic decline in local elephant populations (see Figure 2.9 and Figure 2.10) (Håkansson 2004; Westerberg *et al.* 2010).

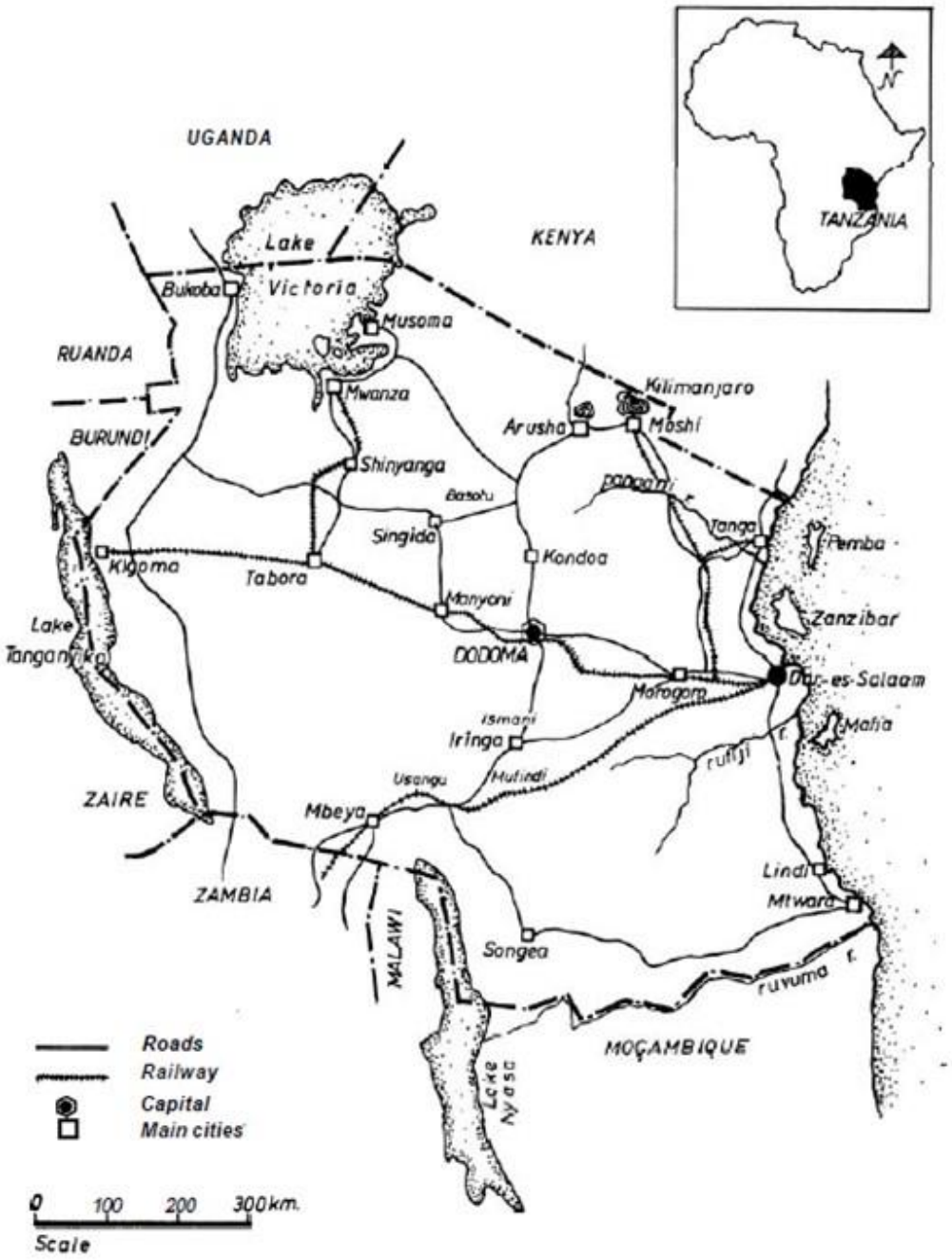

Figure 2.8: Historical map of Tanzania (Boesen & Nordiska 1986)

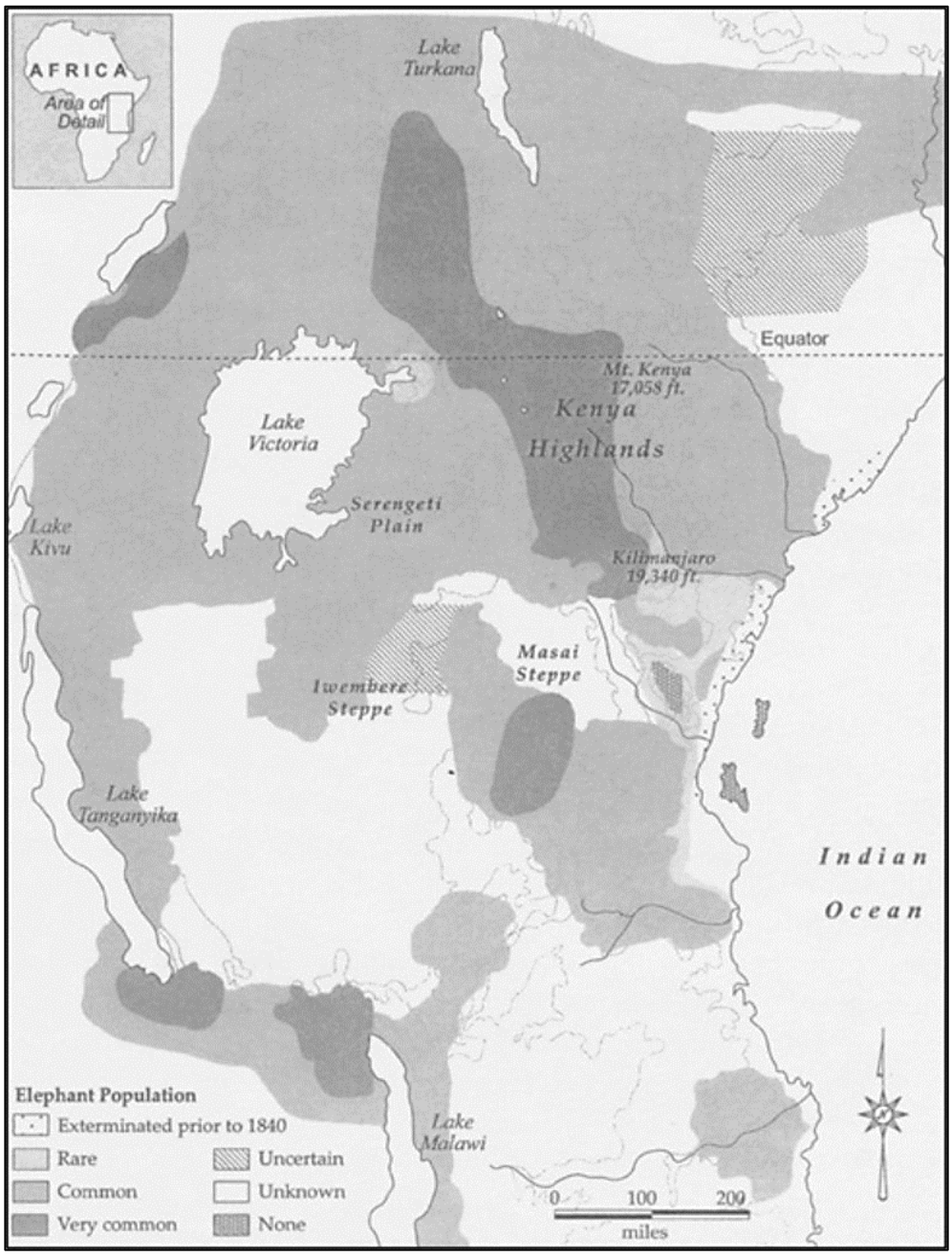

Figure 2.9: Elephant distribution in East Africa ca.1840 (Håkansson 2004, Engell 1913)

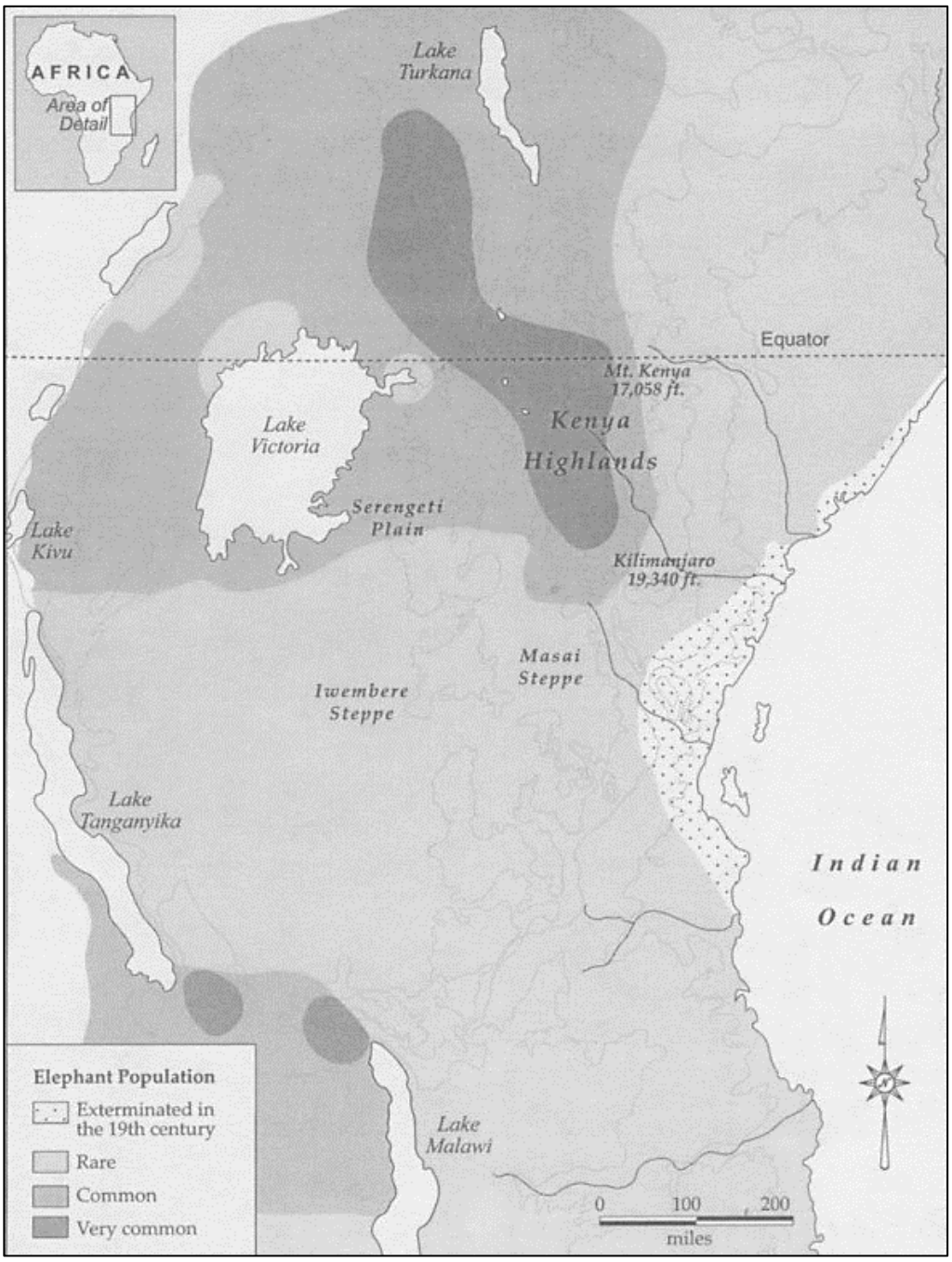

Figure 2.10: Elephant distribution in East Africa ca.1890 (Håkansson 2004, Engell 1913)

Without elephants to keep it in check, woody vegetation intruded into areas once classified as grasslands. This environmental change offered an improved environment for the breeding of Tsetse fly. These flies, notoriously known as carriers of sleeping sickness, spread across East Africa, with a disastrous

impact on both human and cattle populations (Håkansson 2004; Kjekshus 1977). In addition to local communities losing grazing land to the expanding woodlands, ongoing travel through caravan routes further destroyed potential farm and grazing resources (Håkansson *et al*. 2008).

The communities along the caravan routes found themselves in a similar position to that of the Ilchamus community discussed above. Traders required food along their journeys, which they mainly sourced from local farming communities. This resulted in the expansion of irrigation networks, the adoption of land at the foothills of mountains for seasonal production, and in some cases the use of marginal soils that were poorly maintained. This resulted in erosion and nutrient leaching, ultimately causing a cultivation steppe. The negative effects of this are still being felt today, even after the implementation of numerous erosion-control projects (Boesen *et al.* 1986). Other farming communities invested in more sustainable forms of agricultural intensification. The labour-intensive implementation of terracing allowed for longer, more sustainable land-management practices to be implemented (Håkansson *et al*. 2008).

As mentioned previously, the understanding of how agriculture was adopted and spread throughout Africa has faced challenges, not least of which has been a colonial mindset as a point of departure. As Niemejier (1996) explores in his research, much of the scholarly work produced on the subject of agriculture in Africa has approached it as a static concept, dormant until colonial intervention. As the historical record displays, European observations of African agricultural practices were largely unfavourable. Slash-and-burn agriculture and various other practices were interpreted as wasteful by European settlers, who had come from a continent with harsher climates and significantly less available arable land per family (Hunter & Ntiri 1978; Sutton 1984, 1989).

The harsh views of early settlers shaped the mindset that trickled into academia prior to the last few decades. It is important to understand the problematic

nature of these early attitudes as they inform colonial rule and land reform policies. The concept of African farmers needing intervention has proven more often than not to be destructive, in combination with all of the other ills that historically accompany colonisation (Niemejier 1996). Slavery, the reckless abandon with which local resources are utilised, and interference in local political and social structures, caused changes that have moulded present-day African society. There are few examples that better illustrate the damage caused by interfering with local farming communities, social structures, and land-management practices than the attempts of the South African government (Niemejier 1996).

This section serves to locate this thesis in the existing body of work that has been produced on the agricultural history of Africa, in a broad sense. This section also aims to highlight the widespread impact of colonialism in Africa, as well as the knock-on effect these changes can have both socially and environmentally. This is useful given the context of the history of site studied and the damaging impact of Betterment Planning. The following section creates a more specific understanding of the social history of farming in South Africa, the country in which Cata was located.

2.3 A social history of farming in South Africa

The history of agricultural communities in South Africa is at times a tumultuous one, from pre-colonial challenges, including difficult landscapes and invasions from expanding surrounding societies, to the drastic changes brought about by colonial rule. The abundance of natural resources and a moderate climate (compared to the climate in Europe), in conjunction with an observable understanding of the land they inhabited, resulted in a large number of successful agricultural communities. The adaptive nature of these communities, as well as their resilience, can be seen throughout the historical record.

A community that embodied the concept of resilience in their farming was Bokoni, located in present-day Mpumalanga. Their space and its interconnectedness with broader factors, such as politics, kinships, gender, and other social infrastructure, is archaeologically visible. Bokoni was an agricultural region that experienced success despite challenges both in the landscape they chose to cultivate, and later in the occupation sequence and attacks from surrounding communities. These stone-walled sites span Mpumalanga, from Carolina to Orighstad (Delius & Schoeman 2008; Delius *et al.* 2012; Evers 1975; Widgren *et al*. 2016). Aerial images (see Figure 2.11) allow observers a glimpse of the complex structural network created by this community.



Figure 2.11: Aerial photograph of a section of a Bokoni town (photograph: Graeme Williams)

Research carried out on these sites has allowed us to understand how social structures have informed the manner in which space was used, both agriculturally and for day-to-day domestic life. Adaptive land-management practices are evident in the form of terracing, which at some sites, such as Khutwaneng, cover all available arable land. These terraces were built

surrounding each individual homestead. Due to the gendered division of labour in this society (and many other African societies), the location of these terraces was deliberate (Collett 1979; Delius & Schoeman 2008; Delius *et al*. 2012; Henshall 2016). In addition to their agricultural responsibilities, women carried out a number of daily domestic tasks in the homesteads and were responsible for looking after small children.

Terracing is a dynamic approach which can aid farmers in overcoming multiple issues they may face with their soils. In part, it allows farmers to incorporate sloped arable land into their cultivated areas. This can be a deciding factor when it comes to the success or failure of an area. Many of the Bokoni sites are located on hillsides, making this especially true for this area (Delius & Schoeman 2008; Delius *et al*. 2012; Delius *et al*. 2014; Henshall 2016).

Terracing (see Figure 2.12) prevents mass erosion of fertile topsoil and aids in maintaining overall stability in soil structures. Furthermore, during the building of these terraces, rocks are often placed into lower levels of the soil in order to increase the porosity of dense clay soils that are often richer in nutrients but have poor drainage. In addition to terracing, it has been suggested that other practices were adopted, such as intercropping – the practice of mixing crops with different nutrient and rainfall requirements in a season in order to ensure that minimum yields are met and to help increase the sustainability of soils – as well as the use of natural fertilisers such as organic waste from the homestead and animal faeces. (Henshall 2016; Widgren *et al.* 2016).

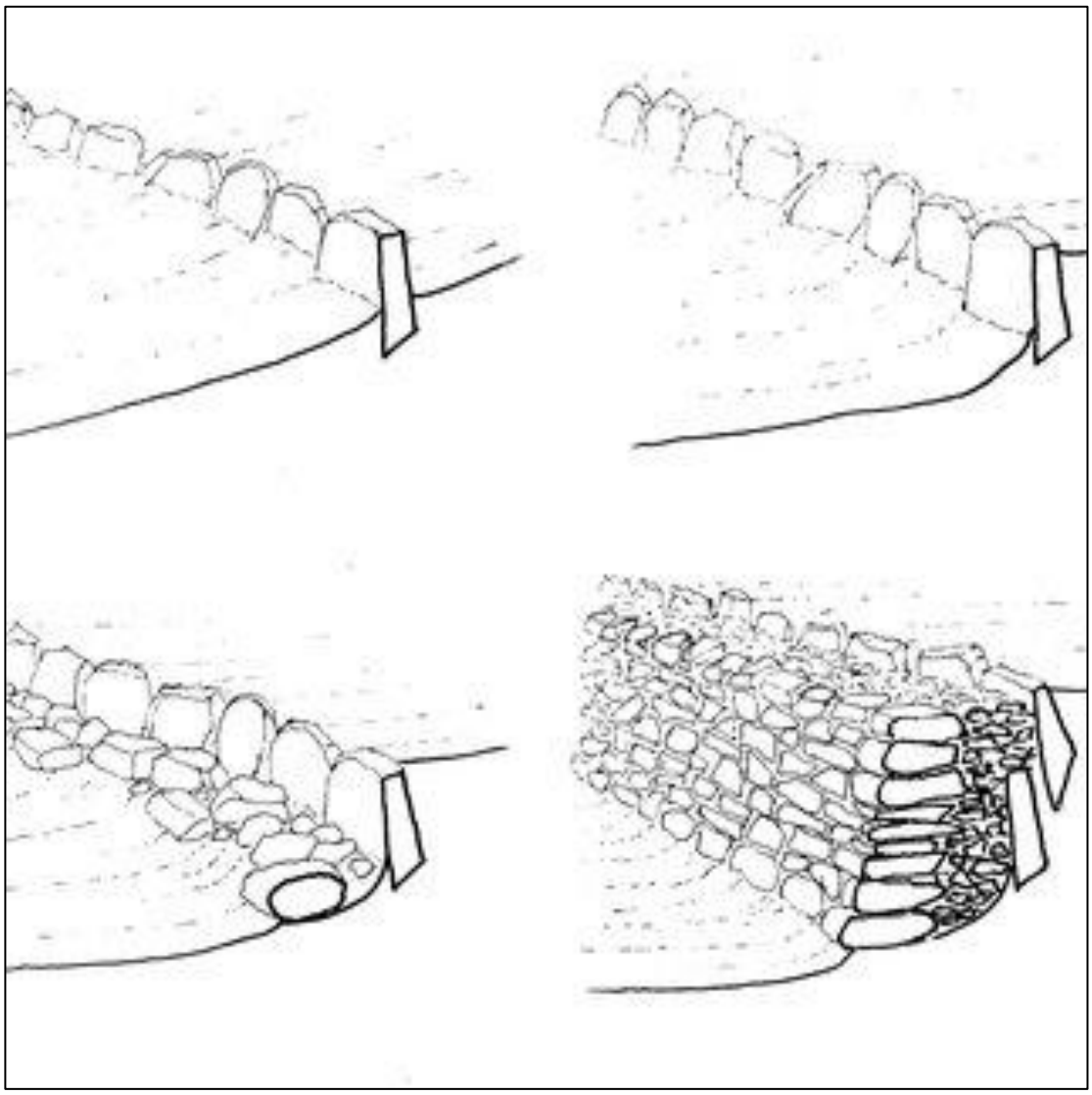

Figure 2.12: Images depicting various examples of terrace walling (Wigdren et al. 2106)

Similarly, Hall's (1998) research on stone-walled structures explores the recursive relationship between space and social infrastructure in sites in the North West province of South Africa. He proposed that the adoption of stone-walling allowed for a clearer definition of space. This inevitably illustrates the physical manifestation of changes in gender relations over time. The changes in the stone-walling, in the use of space, and in the material culture, create a narrative of the ever-changing nature of the relationship between men and women, both within the homestead and in the society as a whole (Hall 1998; Mitchell & Whitelaw 2005).

Hall divides these changes into three distinct phases. The first phase indicates spatial organisation that would lend itself to both male and female tasks being carried out within the homestead. While there is a division in the spaces used, they are not formal, but rather indicated by the location of the tools used for each task. The second phase saw the introduction of low stone-walling as a means of creating a visible distinction between male and female areas, as well as establishing a clearer boundary between spaces belonging to individual homesteads, creating a more distinct divide between private and public domains. The third phase is characterised by higher walling that defines spaces even more clearly (Hall 1998).

In addition to the increased presence of stone-walling and the compartmentalisation of gender-based activities, other changes were recorded. Male associated activities intensified and were practised closer to the chief's court. The production of ceramics, a female task, also displayed alterations in the move towards simpler decoration and increased standardisation of the vessels. A decrease in the production of ceramic bowls (produced by women) and an increase in the use of wooden bowls (produced by men) was also noted. All of this was interpreted by Hall (1998) to be indicative of pressure being placed on men as the power dynamic began to shift over time. As agricultural production, carried out by women, became more important to the survival and success of the community, the importance of women in the community understandably increased. This shift may have created a level of insecurity among the men of the community, who then attempted to reassert their control through rituals associated with agricultural practices and the production of the goods discussed above (Hall 1998; also see Mitchell & Whitelaw 2005).

There are many other sites where the impact of women in agricultural communities can be seen. In a collaborative work, Wilson (1969) outlines the historical recounting of the vital role women played in the agricultural success

of the Nguni people in Natal. Historical documents written by Portuguese sailors give an account of how the burden of agricultural labour fell to the women, and how the success of the homestead was largely based on the number of wives each homestead housed. The diversification and success of their crops is also noted, ranging from grains such as millet and maize to melons, gourds, and beans (Wilson 1969). This once again indicates the use of inter-cropping, a useful land-management practice that ensures sustainable food production in spite of poor rainfalls and shifts in climate (Prasad & Brook 2005; Silva *et al.* 2009).

Bundy (1988) outlined the key role women and families played in what he terms 'peasant farming' in the Cape and Natal between the mid-1800s and the early 1900s. Bundy (1988) also explored the impact that colonialism, and its associated changes in political structure, had on African farming communities. He depicted how imperative the production of crops was to the economy of Herschel in the Eastern Cape, and how farmers continued to adapt their farming practices in order to maximise the profitability of crop farming. In the 1800s, for example, farmers diversified and intensified their production by introducing produce such as beans, oats, and potatoes. The major challenge that these farmers faced was access to arable land, due to the manner in which this land was assigned. These allocation systems were deeply flawed and had negative impacts on the progression of these farming communities, in some cases leading to their downfall (Bundy 1988).

Beinart (1982), in a similar study on Mpondo farmers in Pondoland, suggested that they also placed the responsibility of routine agricultural labour on women. The role of women in agriculture meant that they played a vital role in the economy of their community, as well as producing the 'surplus' that was sold to traders. Female-dominated agricultural labour also impacted the amount of land each homestead was assigned by the chief. The more wives a man had, the more land he would be assigned. Because women comprised the labour

force, the number of women in the homestead dictated how much land it could cultivate (Beinhart 1982).

Morrell's (1986) study of farmers in Middelburg, Mpumalanga, explored their resilience, and highlighted the importance of developing the skills required for successful farming, as well as an understanding of the benefits of diversification. The ability, for example, to combine gardens that produced a variety of vegetables with field agriculture focused on staple crops such as maize, increased the likelihood of successful harvests, and added variety to the diet of these farmers and their dependants.

The work of historians such as Guy (1981,1987, 1990), Wright (1990), Walker (1990), Henretta (1998), Wilson (1971), and Jackson (2014) amongst others, has attempted to shift understandings of gender relations and women's role in the Zulu Kingdom, located in what was referred to at the time as the Natal colony (see Figure 2.13). Previously, the dominant theory had been that little change had occurred within the pre-colonial context regarding women's roles and gender relations. Their ability to obtain any form of autonomy or political influence had been widely dismissed, particularly during the pre-colonial period prior to the introduction of capitalism (Hanretta 1998). Moving away from the ever-shifting political context that was the 1990s, researchers began to identify and attempt to address the influence of current politics at the time of publication and how this would have skewed the approach to understanding the historical role of women in these societies.



Figure 2.13: Map of the magisterial divisions of the Natal Colony (Jackson 2014)

Jackson's (2014) thesis aimed to dispel further the concept that all women were oppressed and uninfluential, and content to remain so. She used a series of case studies to outline the political, economic, and social impact that some women had in the Zulu Kingdom. She challenged some of the ideology put forward by Guy (1981, 1987,1990) who, while still pushing for a more feminist

view of the historical understanding of gender, maintained a level of rigidity in his view of the gendered division of labour as a divisive and controlling concept (see Hanretta 1998; Jackson 2014).

Guy (1981, 1987,1990), who explored the gendered division of labour extensively in his works, concluded that while women were responsible for agricultural production and in turn played a role in the economic success of their homestead, the control over the produce remained with their husbands. He proposed that in a patriarchal society such as this, women are tools in agricultural production rather than autonomous beings. He further exemplified this by proposing that the cultural practice of Lobola, where a man pays a 'bride-price' to his intended wife's family, was a means of appropriating a labour force and ensuring the continuance of his bloodline – a form of indentured servitude, as it were. It was with this understanding that the gendered divide created limitations regarding the roles women could occupy within this society (e.g. Guy 1981, 1987,1990).

Jackson (2014) departed from this ideology, depicting a more autonomous and less constrained understanding of gender roles in the Zulu Kingdom. Her thesis includes references to female chiefs, as well as women who owned cattle, held property and had prominent political influence during pre-colonial times. She proposed that in some cases, the onset of colonialism had a detrimental impact on women in power, as colonial leaders held the attitude that they were less equipped for the task. While her work does acknowledge that there is no proof that female chiefs were common, she opened the door for much-needed further research on the topic. The move away from the idea that gender is a rigid concept that limits women to their reproductive and productive roles, is ongoing and necessary (Jackson 2014).

The case studies discussed in this section aim to provide a background on the social history of farming in South Africa, offering a background in which to locate Cata – a rural farming community. The challenges that these farming

communities faced increased significantly, due largely to the implementation of various forms of land-reform legislation over the last century.

2.4 Summary

Like many agricultural communities globally and within Africa, the village of Cata has experienced many challenges since its establishment. The influence of political policies during what was an already difficult transitional phase with the introduction of migrant labour, was undoubtedly the most challenging of the obstacles this community – and many others like it – faced. The foundation created in this chapter has aimed to create a greater sense of the context of this study and how colonialism and the events that it triggered had a long-term impact socially and environmentally on communities across the continent.

The studies discussed in this chapter make it clear that the space that people occupy is intrinsically imbued with a lifetime of associated memories and should not simply be discounted as purely material when considering their forced abandonment. It is clear that a common intersection between many of these African farming communities is that they show great resilience and will attempt to endure even when faced with extreme hardship. All the factors considered above act as a foundation upon which the data will be analysed in the chapters to come.

What is also apparent when considering the research undertaken is the lack of environmental research done on this area, as well as the minimal focus given to spatial analysis and the lack of reliable, scientific method in some of the data collection.

The following chapter outlines the methods and techniques used in the production of the data presented in this thesis.

Chapter Three – Context and methodology

3.1 Introduction

This chapter contains a description of the context of this site as well as the methods and techniques used during this thesis. The principal technique employed was remote sensing. Remote sensing entails the use of satellite imagery and aerial photographs to interrogate factors such as environmental change, soil enrichment, surface geomorphology, and settlement patterns. This was supplemented by a site visit, and the combination of these analytical tools helped establish a broader understanding of the site context and its evolution from initial settlement through the Betterment Planning period, up to the present.

The research undertaken relied heavily on a variety of historical resources, including historical imagery, surveys, and publications, to compare the three main periods of occupation in the research area. These periods – namely, pre-Betterment Planning (from the initial settlement of the Cata community up until 1963); the implementation of Betterment Planning (from 1964 until 1994 – the end of apartheid); and post-Betterment Planning (from 1994 to present day) – were explored through the analysis of available datasets, which are verifiable, with a focus on macro-spatial (village) configuration, agricultural practices, and environmental factors.

This has been achieved through the utilisation of four primary datasets; anthropological data, historical airborne imagery, current/modern satellite imagery, and aerial imagery. Using these datasets, environmental analysis was done and yield calculations were computed to obtain averaged comparative datasets. This was compared with the figures obtained from the anthropological dataset.

3.2 Land reform in South Africa

The issue of land in South Africa has long been a contentious topic. Land ownership and the rights associated with the land have been a key factor in changing the South African landscape over the last century. Land dispossession did not begin with the passing of laws from 1913 onwards. There are historical records of ongoing fighting and land disputes resulting from legislation passed throughout the 1800s, such as the Glen Grey Act of 1984 and the annexation of the Ciskei in 1847 (Thompson & Nicholls 1993; Westaway 2012; Wilson & Thompson 1969).

One of the most historically significant pieces of land-reform legislation implemented in the twentieth century was the Native Land Act of 1913. This act essentially formed the foundation for the segregational legislation implemented over the following decades (Rugege 2004). While land dispossession had occurred prior to this point in history, the Native Land Act legalised and accelerated the move to strip those classified as black[1] South Africans of their land rights. The Native Land Act of 1913 led to the development of native reserves or homelands, areas that state officials designated for the relocation of black communities across South Africa. This act designated nine million hectares of land to these reserves, constituting only 7.3% of South African territory for the intended housing of the majority of the South African population (de Wet 1997; Platzky & Walker 1985).

This Act prohibited the purchase or rental of land outside of the allocated reserves by those categorised as 'Natives', unless otherwise approved by the acting governor-general. 'Natives' in this legislation are defined as "any person, male or female, who is a member of an aboriginal race or tribe of Africa" (Native Land Act (Act 27) of 1913). The land allocated to the native reserves excluded

[1] The terminology used throughout this thesis is in line with that used in the research carried out on this period. They do not reflect the beliefs or attitudes of the author.

most of the land occupied by the affected communities at the time of the passing of the act, resulting in the vast majority of these communities facing relocation. Some of these groups used loopholes in the legislation to remain tenants on white-owned land, and others received permission from the governor-general to purchase land themselves (Cousins & Walker 2015; Kloppers & Pienaar 2014; Walker 2014, 2017).

The motivations behind the 1913 Land Act, clearly intended to benefit white settlers, may have been twofold. Prior to this Act, farming for surplus had intensified in many African farming communities. This increased production created competition in the agricultural sector between these communities and white farmers. Some white farmers were struggling to produce equivalent yields, leading to increased tension in the industry (Bundy 1972). This competition would be greatly reduced by the enforcement of this Act, limiting the arable land available to African farmers while increasing that available to white farmers. In conjunction with these events, the mining industry was rapidly developing. The drive to increase production at mines resulted in a need for cheap labour. By reducing resources and potential productivity to farmers in the native reserves, they would have to seek employment elsewhere. This led to many rural men leaving their homesteads in search of work as migrant labourers (Walker 1994, 2005, 2017).

The Natives Land Commission was established as a by-product of the Native Land Act. The commission concluded that an extra 7 million hectares should be added to the already allotted land for the establishment of the reserves. In addition, it highlighted challenges due to the scattered occupation of African communities across South Africa, making the law strategically difficult to enforce. The commission’s report was further compounded by resistance from white landowners located in the areas allocated to reserves, who were unwilling to move or give up their land. Concessions were made in the form of the establishment of five local committees that reduced the recommended extra

land allotted to 6.5 million hectares (Platzky & Walker 1985; Walker 2014, 2017).

The 1936 Native Trust and Land Act was passed following several years of discussion around the commission's suggestions. An additional 6.2 million hectares of land was added to the previously allotted land, bringing the total to 13% of South Africa's land (see Figure 3.1). This law also provided for the formation of the South African Native Trust, which was charged with administrating the newly allotted land (Piotrowski 2019; Walker 2017).

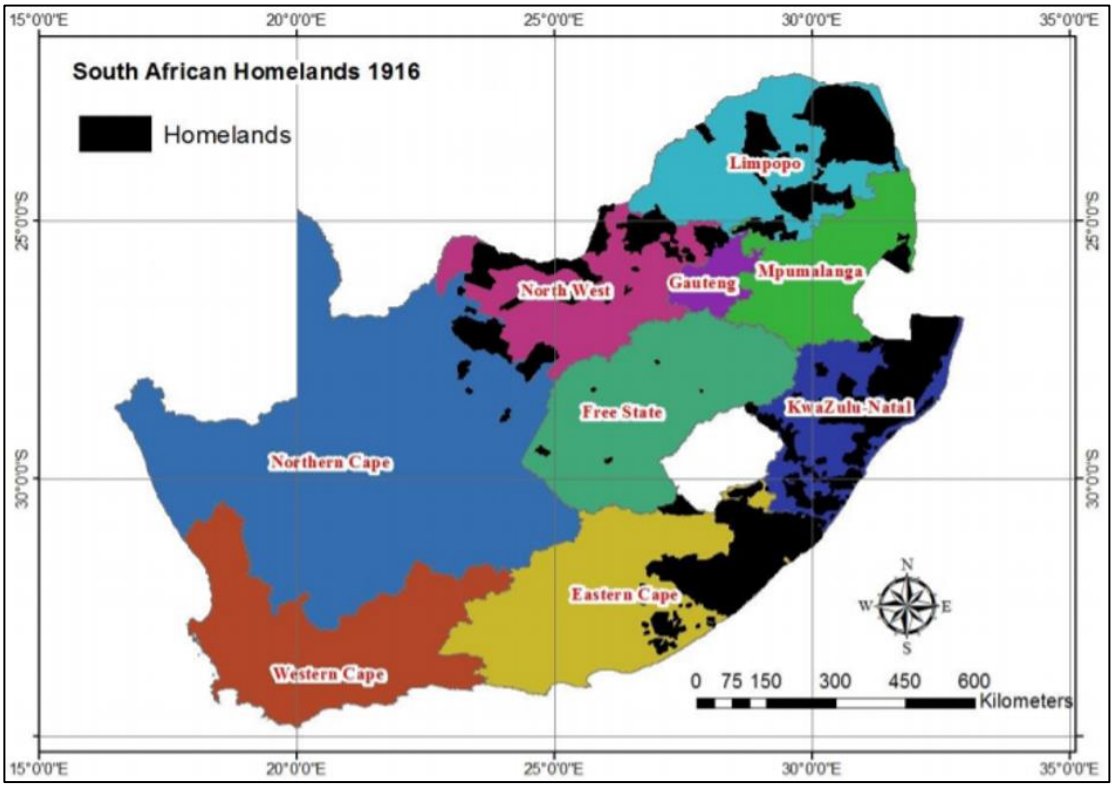

Figure 3.1: Map indicating the homelands (scheduled areas) as proposed in South Africa in 1916 (Ali 2016)

The year 1948 marked the official start of apartheid, a system implemented by the National Party to ensure the segregation of races, justified by the ruling party as a means to preserve the identity of the white population. In 1950 the

next land-related law was passed, in the form of the Group Areas Act. This Act enforced the segregation of races in all areas (Judin 1998; Peters 2007; Schlapobersky *et al*. 1994). Urban regions were zoned into residential areas for each 'racial group'. Racial classification was further defined by the Population Registration Act passed in the same year. This led to even further segregation of the different 'racial groupings' in South Africa. The years that followed were filled with forced land removals as people were relocated into racial ghettos on the outskirts of urban centres. Buildings were razed and families separated during the removals, some people undergoing several relocations (Kloppers & Pienaar 2014; Walker 2017).

The Prevention of Illegal Squatting Act of 1957 bolstered the forced removals taking place. This law acted as a proviso to the Group Areas Act, allowing for forced removals to take place with greater ease and expedience. The Prevention of Illegal Squatting Act allowed white landowners and state officials to evict and immediately remove those who did not have formal rights to the land they occupied. This essentially empowered landowners or state officials to demolish properties and forcibly remove tenants without justification or the need to undergo court proceedings (Rugege 2004).

In 1951, the aforementioned reserves became part of the Bantusan Project. The Bantu Authorities Act was passed, establishing a hierarchical system of leadership within the reserves, giving chiefs in the area perceived leadership in their areas. This however was just one more form of indirect rule on the part of the apartheid government. The Promotion of Bantu Self-Government Act followed in 1959, further dividing Africans into eight groups, namely North-Sotho, South-Sotho, Swazi, Tsonga, Tswana, Venda, Xhosa, and Zulu. Each of these groups was designated a homeland (see Figure 3.2). In the years that followed, the Ciskei and KwaNdebele were added to this list. In 1963, the Transkei was used as a test run for a self-governing state.

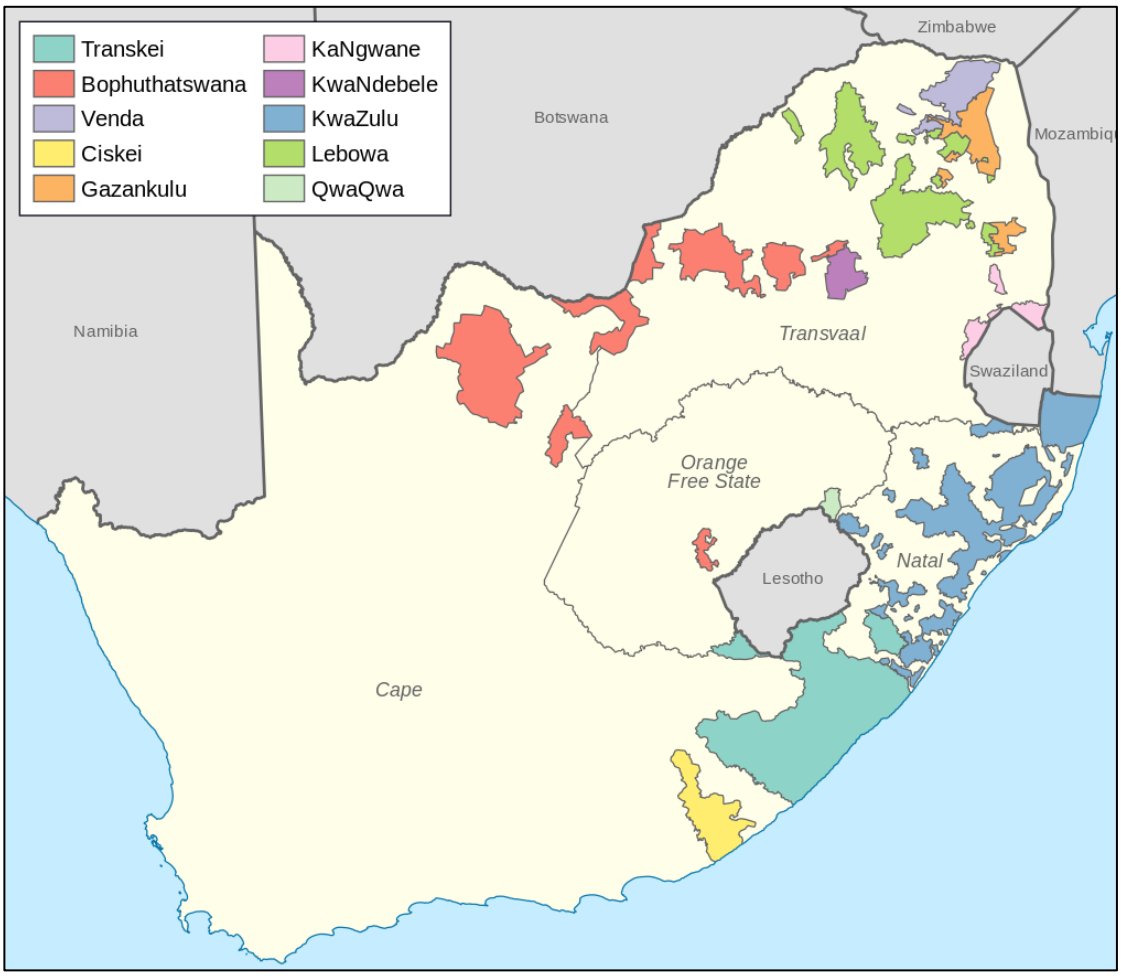

Figure 3.2: Map indicating reserves/homelands established by the South African government (using boundary data from the Directorate: Public State Land Support via Africa Open Data)

While the relocation of individuals to the reserves never reached the goals set by the government, it is estimated that over 3.5 million people underwent relocation and another 1.9 million were at risk in the years between 1960 and 1983 (Butler *et al*. 1978; de Wet 1994; Jara 2011; McKenzie 1984). Schemes such as Betterment Planning, along with other forms of forced removal, resulted in whole villages being relocated. This was often done to remove state-labelled ‘Black Spots’ from ‘white’ farming areas. Resistance to removals and Betterment Planning spared some communities and became key to slowing the progress of the apartheid government’s policies (Letsoalo & Rogerson 1982; Walker 2008).

Since the 1994 South African elections, progress around land restitution and improved reform policies has been slow. Under the leadership of Nelson Mandela, a focus was placed on developing the infrastructure required to tackle land dispossessions dating back to 1913. In 1995, the Commission on Restitution of Land Rights was established under the Restitution of Land Rights Act, to aid the processing of land claims (Southwood 2000). 1996 saw the passing of the Land Reform Act 2, a law aimed at providing security of tenure and a means to acquire rights to land by labour tenants. This was further reinforced by the 1997 Extension of Security of Tenure Act passed to strengthen tenant rights. In June 1998, Nelson Mandela redistributed 60 000 hectares of land in Kwazulu-Natal, an act that aimed to prove that restitution would be made. In 2004, under the leadership of Thabo Mbeki, the Communal Land Rights Act was passed. This law gives power to the acting Minister of Land Affairs to transfer state-owned land to communities working under traditional authorities (Hebinck 2007; Walker 2012).

Progress was slow. By October 2004 only four communities that had undergone forced removal had been granted land. By June 2006, a total of 916 470 hectares of land had been redistributed to claimants, thus making some progress (Ntsebeza 2007). By 2016, 8 million hectares had been secured by the post-apartheid land-reform programme for reallocation to black South Africans who had made land claims. While this does represent progress, it fell short of the goals set by government, causing further tension among those awaiting the settlement of their claims (Ntsebeza 2007; Pallotti & Engel 2016; Walker 2008).

3.3 Betterment Planning

Betterment Planning and land-reform policies implemented in South Africa in the twentieth century limited access to the amount and quality of land available to African people. Starting with the 1913 Land Act, these policies shaped how

land was allocated (Mager 1992; Yawitch 1981). Land distribution was linked to racial classification, thereby shifting communities over landscapes and forcing a reorganisation of spatial use and social structures. The 1913 Act went through a series of reforms culminating in the 1936 Land Act. This Act included amendments that supposedly allowed black African farmers access to more land. In reality these 'land concessions' were already utilised by them. The land generally was insufficient in size to support the communities occupying the areas. This resulted in the depletion of soils and ultimately the inability to continue farming (Walker 2017; Wilson 1969; Wilson & Thompson 1969).

Betterment Planning carried out under the guise of 'developing black agricultural areas' or 'environmental conservation' was destructive not solely due to the limitations of land access, but also as a result of the process undertaken during the development of these schemes. Entire communities were uprooted and restricted with no consideration given to the integral social infrastructure in place, spatial configurations (and the motivations behind the use of space), or pre-existing political organisation (de Wet 1989, 1995a; O'Connell 1981). The consequences of this included a disintegration of established economic networks tied to political organisation, and increased stress, related to the influence of the gendered division of labour, on spatial configuration (Cundill 2008; de Wet 1995a; Heron 1990, 1991; McAllister 1991; Mgushelo 2019).

In addition to changes in land access, colonialism introduced several other stress factors that jeopardised black African agricultural communities. Not least of these included the introduction of taxation and a cash economy. These systems forced men to leave rural homesteads in order to seek work as labourers. This, once again, impacted social structures and farming systems that had been in place for generations (Andrews 1992; Yawitch 1981).

After the election of the National Party in 1948, there was an increased focus on controlling the movements of the African population between rural and

urban centres. Increased political activity among increasingly organised African groups in urban centres as well as ever-increasing shifts in the racial population distribution were a cause for concern for the ruling party and their implementation of the apartheid system. The main means of controlling the influx of African people into urban centres were the ‘reserves’ created through the Land Acts (as mentioned above) and subjected to Betterment schemes. In 1950, the Tomlinson Commission was formed to assess the condition of the established African reserves. Their goal of the commission was to devise a comprehensive scheme for the rehabilitation of ‘Native’ areas in order to develop within them social structures in line with the culture of their inhabitants (Hendricks 1989; Letsoalo & Rogerson 1982; Platzky & Walker 1985).

The commission proposed changes to the reserves that included reducing the occupancy of overpopulated land by 50%, with the aim of providing arable land size equivalent to producing £57 per annum of income from produce. The excess inhabitants would be moved to proposed rural townships. The commission claimed that would solve the problem of large numbers of families producing less than what was required to satisfy their basic needs. The commission hoped to create an agricultural class that could be sustained, binding families to their land. Another recommendation was the condensation of scattered homesteads into villages. Most of the commission’s recommendations were ignored by the National Party government, which chose to carry out forced removals of urban-dwelling Africans to overpopulated reserves (Hendricks 1989; Houghton 1957; Ngcaba 2002).

Post-apartheid, the outlook for ‘peasant’ farmers is still uncertain. During the transition to democracy, not enough focus was given to agrarian issues, and there was a notable lack of restructuring of agricultural land distribution in order to support subsistence farmers. Support for the agricultural sector was focused on commercial or larger-scale agricultural endeavours. Since 1994, there has been heated debate around issues of land repatriation, including the issue of

reparations for those who underwent removal through Betterment Planning. The lack of support for disenfranchised farmers, and an absence of re-education, are widespread criticisms of the policies in place today (see Bernstein 1998; Hall 2007; Moyo 2007; Piotrowski 2019).

3.4 A brief history of the Eastern Cape

Of South Africa's nine provinces, the Eastern Cape, comprising a large portion of South Africa's southeastern coastline (see Figure 3.3), stands out due to its tumultuous history. Apart from being the first recorded site of interaction between black communities and white settlers (a differentiation between settlers and missionaries or traders should be noted), the Eastern Cape has also been the initial recipient of some of South Africa's most influential laws and land-reform policies. The last 300 years of the history of this area are filled with conflict, aggressive expansion, shipwrecks, land issues, and political change. (For more on the archaeology of the region see Derricourt 1976; Wilson 1969).



Figure 3.3: Map of South Africa indicating the location of the Eastern Cape (Google Maps)

Wilson (1959) combined archaeological records, oral traditions, and written evidence, mostly recorded by sailors who had survived shipwrecks along the coast, in order to create a record of occupation prior to colonialism. From this research, she concluded that from 1554, sailors had interacted with pastoralists south of the Mtata river. By 1593, records show evidence of Nguni languages being spoken in the area. From 1686 onwards, these languages are specifically identified as being Xhosa. These communities are known to have settled in various parts of the Eastern Cape, which was divided into numerous kingdoms such as the abaThembu, amaPondo, amaGcaleka and amaXhosa kingdoms (Wilson 1959). In addition to the Xhosa speakers, the land was occupied by pastoralist Khoe and hunter-gatherer San communities, prior to white settlement in the region. These kingdoms expanded their control both westwards and south along the coast, absorbing earlier farming, pastoralist, and hunter-gatherer communities in the process. While most absorbed people were given equal rights and the opportunity to fully integrate into Xhosa society, some hunter-gatherers were displaced into areas such as Nomansland

(Blundell 2004). Disputes occurred between Xhosa groups but were predominantly resolved by the paramount king. Unlike these disputes, conflicts between Xhosa and white farmers tended to escalate, resulting in cattle raids and fighting between the groups that often resulted in fatalities (Andrew 1992; Houghton 1955).

Xhosa-speaking communities were predominantly agropastoral, keeping cattle as both a symbol of wealth and status as well as a source of milk and sometimes meat. In addition, game was often hunted whenever possible to supplement their diets. The historical record describes their farming practices as shifting agriculture making use of both gardens located in fertile soils as well as fields that required intensive bush clearing and preparation. Economically, besides cattle ownership, trade was important. Initially, trade was between inland and neighbouring communities, and later expanded to trade with coastal merchants and colonialists. Goods traded included cattle, iron, copper, beads, tobacco, dagga, and sometimes labour (Andrew 1992; McAllister 1990; Nontembeko 2013; Peires 1981, 1989).

The expansion of colonial rule combined with the discovery of desirable natural resources such as gold and diamonds in Gauteng and the Northern Cape led to changes in the landscape, politics, and social structures of the communities occupying the area. Colonial rule brought land reform, relocations of black farming communities, changes in their economic systems, and shifts in the pre-established political system in place in these communities. The impact of this was further compounded by the introduction of migrant labour that followed the discovery of gold and diamonds, and the resultant onset of mining in South Africa. This will be examined further in the individual case studies of Cata and Willowvale (Andrew 1992; Peires 1989).

Climatically, the Eastern Cape offered a rich environment for habitation. The river system in the area is expansive (see Figure 3.4), providing numerous water sources for the area's inhabitants. Some of the largest perennial rivers

in the province are the Great Fish River, Sundays River, Great Kei River, Gamtoos River, and Keiskamma River (Andrew 1992; Palmer *et al*. 1992).

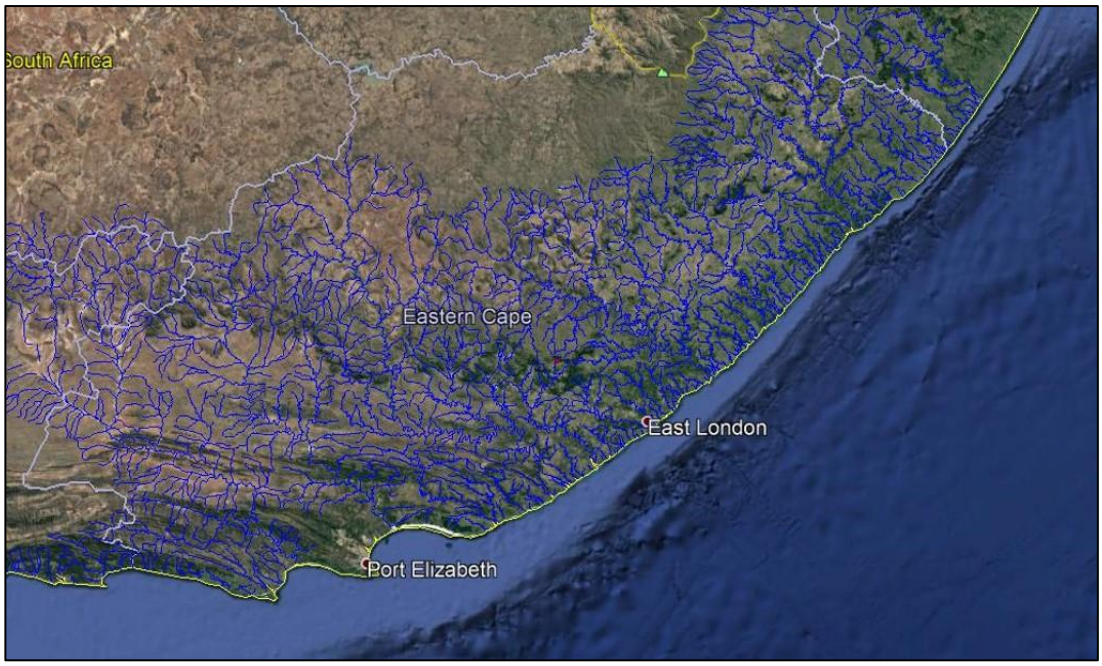

Figure 3.4: Map depicting the river systems of the Eastern Cape created using data from the South African Department of Water Affairs (Google Earth)

The landscape of the Eastern Cape is varied, and includes grasslands containing good grazing potential, forest (both dense and pocketed), thornveld, and mountainous regions. The province also supports an abundance of indigenous wildlife, often used as a food source for both pastoral and hunter-gatherer societies until the hunting of most wildlife became restricted and land access became regulated with the introduction of colonial rule (Andrew 1992; Palmer *et al*. 1992).

In addition, the region's climate is temperate. A 16-year study utilised in Palmer *et al.* (1992) places the winter maximum average at 21.5˚C with a minimum of 10˚C (see Figure 3.5). Moderate winters means there is generally no frost in the area, increasing the potential for agricultural success. Summer temperatures also show a moderate trend with an average maximum of 24˚C

(see Figure 3.5). Rainfall is within acceptable ranges for farming, averaging between 800 and 1 000mm per annum (see Figure 3.6). In times of climatic consistency, this would provide sufficient water for the production of a multitude of crops (Palmer *et al.* 1992).

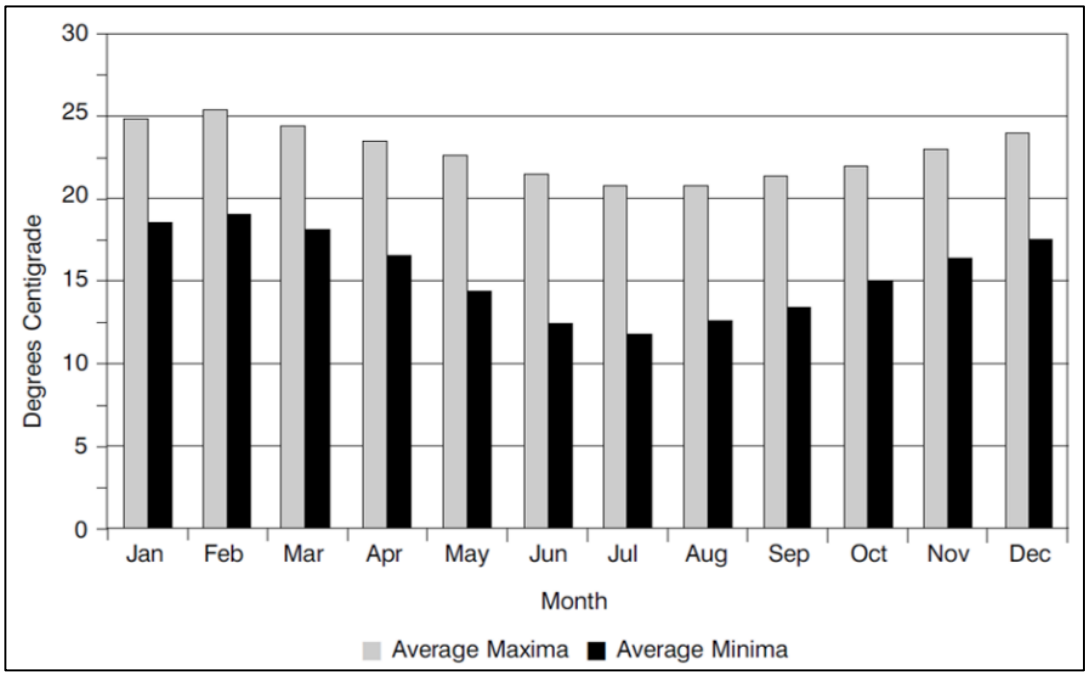

Figure 3.5: Average monthly maximum and minimum temperatures taken over 16 years (Palmer et al. 1992)

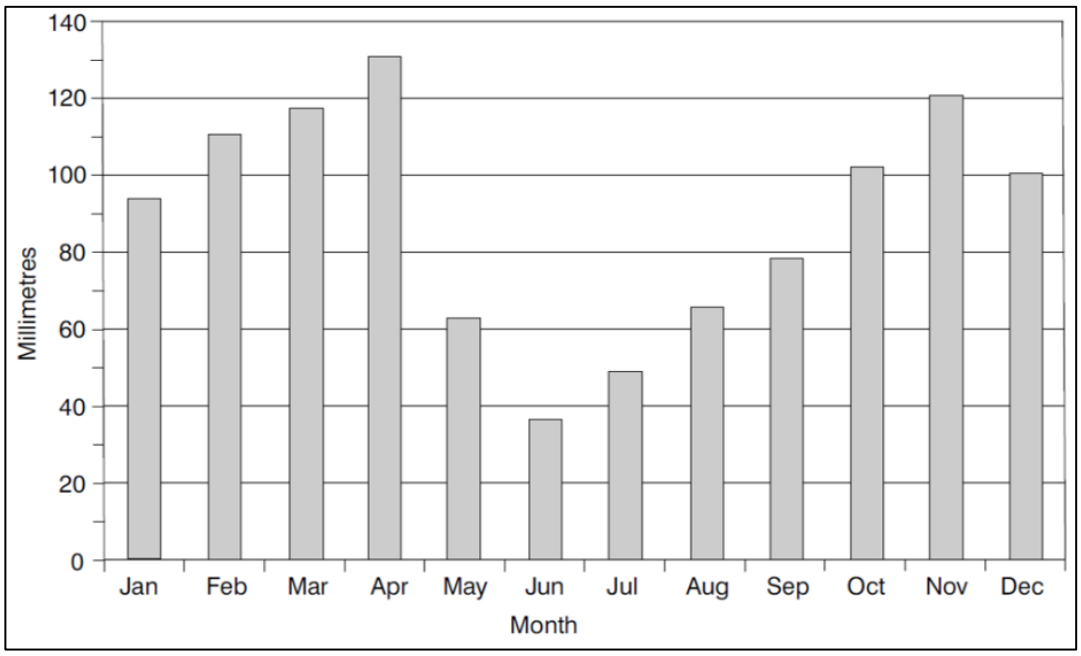

Figure 3.6: Average monthly rainfall taken over 16 years (Palmer et al. 1992)

3.5 Farming and Betterment in the Eastern Cape

The Eastern Cape includes the former Transkei and Ciskei homelands/reserves. The Transkei stretched from the Kei River (part of the derivative for the area's name) to the borders of KwaZulu-Natal in the northeast. The landscape can be divided into four main terrains; the escarpment, a large coastal belt, the highlands, and the midlands (Carter *et al.* 1967).

The Ciskei, the Transkei's neighbouring apartheid reserve, featured similar terrain. This area was bordered by the Fish and Kei Rivers (Ciskei meaning 'this side of the river', as opposed to Transkei, which means 'the area beyond the river'), the Indian Ocean, and low mountain ranges. Although assigned as a homeland during the 1913 land reform, occupation of the region that became the Ciskei predates the arrival of Europeans, as was discussed earlier (Switzer 1993).

3.5.1 Willowvale

Willowvale (also called Gatyana), one of the two districts comprising Gcalekaland (see Figure 3.7), was one of the districts created in the Transkei in order to adjust existing political boundaries and remove the power of area chiefs, placing the districts under colonial control. Each of these districts, namely Willowvale and Kentani, was then further divided into sub-wards. The focus of much of the anthropological research carried out was on the Shixini and Nompha sub-wards (see Andrews 1992; Heron 1990). Willowvale provides a useful comparative to the site of Cata, which is the main focus of this thesis. Due to the similarities that will be addressed in this thesis, this community serves as an appropriate window in to what Cata could have been like if, like at Willowvale, Betterment Planning had not been implemented.

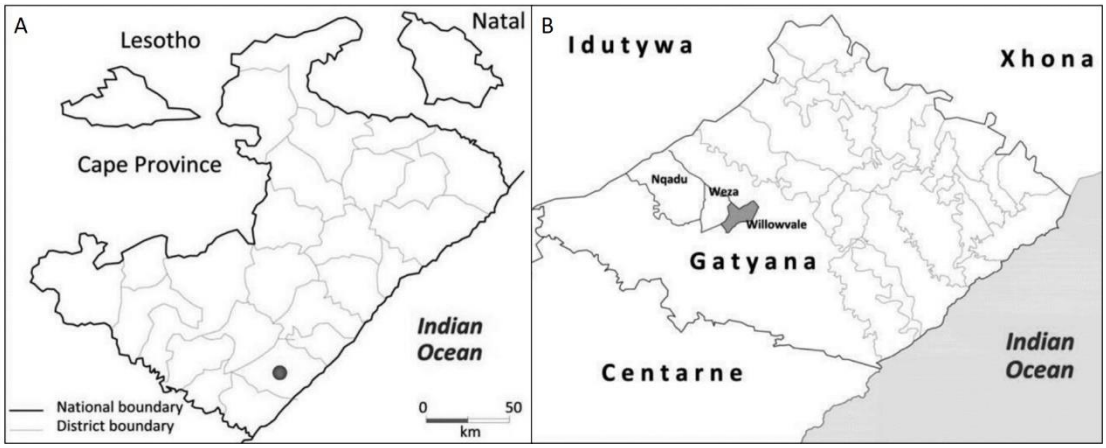

Figure 3.7: Maps indicating the location of Gatyana and Willowvale (A) provincially and (B)within the district (redrawn by Lyn Whifiled from Andrews 1992)

This area underwent periods of change in land-management practices and socio-economic structure, the most notable of which occurred during the nineteenth and twentieth centuries. These changes are most commonly attributed to the beginning of colonial occupation, and the impact that this contact had on the people of the area (see Andrews 1992; Heron 1990; Ranger 1978). Some of these changes related to a change in the dynamic of trading

and the importance of surplus. Trade of goods such as tobacco and dagga, had taken place between the people of Transkei and inland farming societies before the arrival of Europeans in South Africa. In the eighteenth and nineteenth centuries, mass-produced goods including beads, iron pots, and blankets, started to flood the older trade networks (Andrews 1992; Heron 1990; McAllister 1989).

During the colonial era, this desire to trade led to the increased willingness of wealthier individuals to trade cattle that previously would have been used to aid those in the community who had insufficient livestock to plough their land. This changed the socio-economic system in Willowvale and led to a marked widening of the wealth gap. Without oxen to plough, yields decreased and poorer homesteads could barely cover the needs of the household. The result of trade with Europeans was that the wealthier members of society were able to increase their wealth and improve their lives, while the situation for those on the other end of the scale became increasingly desperate (Andrews 1992; Palmer & Parsons 1978).

In Willowvale, two agricultural production methods were used: field and garden agriculture. Field agriculture focused largely on growing starch crops, while gardens were used for a wide variety of crops (McAllister 1989). Gardens were the domain of women, while both men and women farmed the fields. Fields were harder to obtain, and after the introduction of the migrant labour system, men were no longer around to help clear the fields. Furthermore, women felt that these fields were located too far from the homestead to be easily maintained. Soil fertility was also a constant concern, because these fields were located in less fertile areas, and were not fertilised artificially (Heron 1990; McAllister 1989).

The research at Willowvale gives us insight into how agricultural practices relying on female labour can impact settlement structures. The bulk of the agricultural produce used to sustain the community in the twentieth century was

grown in female-controlled gardens. Gardens were located close to homesteads, which allowed women to monitor and maintain their produce, while carrying out other responsibilities in the homestead, such as looking after small children. The close proximity of the gardens and homesteads also allowed organic waste and manure to be added to the soils in the gardens more easily in order to maintain their fertility, thereby increasing their yield (Andrews 1992; Heron 1990). Other benefits of practising farming in the gardens was that they allowed for an increase in diversity in the types of crops cultivated, as well as the option to cultivate crops specific to the needs of each individual homestead. Crop variability is also strategic because it reduces the chances of crop failure due to temperature or rainfall fluctuations (McAllister 1989).

While there was an attempt to implement Betterment Planning in the Willowvale area in the 1980s, two factors resulted in the scheme being abandoned before any significant change was enforced. Firstly, there was community resistance to the scheme, with the people of Willowvale actively resisting any change to their village. Secondly, by this time funds available for the implementation of Betterment in the area were low, and Betterment had proven to be unsuccessful, resulting in a slower implementation of the scheme (McAllister 1989; Whisken 1995).

3.5.2 Cata, Keiskammahoek

In order to understand the impact of the enforcement of Betterment Planning, it is imperative to explore the use of space in these communities. The case of Cata (see Figure 3.8), which is a rural village located in Keiskammahoek Eastern Cape and is the study site for this thesis, provides us with an example of the importance of spatial flexibility. The village of Cata was one of six rural villages in the Keiskammahoek district of the Ciskei (established formally in 1853 by the British as a military outpost) studied in the 1980s by anthropologists and formed part of anthropological research carried out in order

to understand the impact of Betterment Planning (see de Wet 1989, 1994, 2012; de Wet & Leibbrandt 1994).



Figure 3.8: Map indicating the location of Cata, Eastern Cape (Google Earth)

Residential locations in Cata were composed of homestead clusters consisting of between 10 and 40 homesteads distributed throughout the hilly landscape in the area. These clusters were often formed through political and kinship ties similar to those seen at Willowvale. The layout of these clusters afforded the inhabitants sufficient space for the grazing of cattle, agricultural practices, and residential expansion if required. The lack of rigid demarcation (such as fencing) allowed for a certain amount of flexibility in land use when necessary. Gardens averaging half an acre in size were used in combination with fields for agricultural purposes (Mills & Wilson 1952). Gardens were located next to the homestead, providing ease of access for agricultural maintenance. Locations for homesteads were chosen in order to have easy access to vital resources such as clean water, wood, and grazing land (de Wet 1989).

Landlessness did occur prior to the introduction of Betterment Planning; over time, between 3% and 10% of those eligible did not own land. This issue was

neutralised in part by the practices of hiring land from those with larger allotments or share cropping when possible (de Wet 1985; de Wet & Leibbrandt 1994).

A study carried out by de Wet (2009) looked at the composition of homesteads and the reliance on external funds for survival over four time periods, and compared the results. The first time period was from 1948 to 1950. Data collected from the Keiskammahoek Rural Survey shows that 84% of household members stayed at home, with 16% away from the homestead. Those who were away from home were predominantly male migrant workers. The average household consisted of 7.28 occupants. At this time the average household relied on salaries and wages for 70% of their income.

The second period was 1981. At this time, 76% of household members stayed at home, while the percentage who were away from home had increased to 24%. The average household consisted of 7.61 occupants. Ninety-four percent of households relied on cash income from salaries, pensions, and grants (de Wet 2009). By 1991, 67.4% of household members were at home, 32.5% were away, and the average household occupancy had decreased to 6.9 people. There was a heavier reliance on pensions and remittances for income, and a marked decrease in income from agricultural production. In the final year discussed, 2006, only 42.7% of household members remained at home, with 57.2% away from home, either working or studying. The average household size had increased to 8.3 occupants. Reliance on pensions had increased from 37.4% in 1991 to 64.75% in 2006 (de Wet 2009).

In the planning stages of the Betterment schemes, the 60% reduction in accessible arable land was to be offset by the proposed relocation of ‘surplus’ families into hypothetical rural townships. The smaller population that the reduced land was expected to support would have allowed for a more realistic distribution of agricultural and grazing land. This was supposed to increase the likelihood of sustainable agricultural homesteads. However, this relocation did

not occur, creating overcrowding, forced reorganisation of land use, and a decrease in the amount of accessible grazing and agricultural land (de Wet 1989, 1994; Surplus Peoples Project 1983). These changes failed to account for social infrastructure and the importance that this played in the functioning of the village. Resettlement also presented challenges in terms of access to once sufficient resources such as water and wood (Ncapayi 2013; Westaway 1993).

During the process of resettlement of communities in the reserves, fences were introduced to demarcate the substantially decreased gardens allocated to each family. Over and above the consequences of reducing the size of gardens, and in effect access to sufficient arable land, the use of fencing eliminated the practice of flexible land use and allocation. When combined with overcrowding due to overpopulation of the reserve, this led to a substantial increase in the pressure put on the soil. The inevitable consequences of this spatial arrangement were a spike in soil erosion, and nutrient depletion of soils on which families in the area depended for their survival (de Wet 1994).

The results of Betterment Planning in this area could be considered ironic. Not only did overcrowding result in the acceleration of soil erosion and nutrient depletion but it created a greater dependence on migrant labour as a means to support families that could no longer be sustained by the land (de Wet 1989, 1994).

3.6 Post-Betterment reactions and projects

The implementation of Betterment Planning resulted in a village that was bitter, divided, and stressed. Many groups have attempted to provide aid, intervention, and validation in the years since Betterment Planning was carried out. The Border Rural Committee (previously Grahamstown Rural Committee) was established in 1982, under the umbrella of Africa Groups, a Swedish organisation aimed at assisting communities dispossessed of land and

displaced during apartheid. This organisation estimated that the number of people affected by Betterment Planning was somewhere between 1.3 million and 2.5 miliion (Westaway & Naidoo 2010).

After apartheid ended in 1994, the ANC began to address the need for land reform in South Africa, culminating in the Restitution of Land Rights Act. This Act failed to recognise the rights and claims of those who had been displaced by the implementation of Betterment Planning (Ramuntsindela 2007; Westaway & Naidoo 2010).

The Border Rural Committee appealed against this disregard and championed the plight of the people who lived in the homelands via court actions. As a result, Cata became the first Betterment claim to have a successful resolution. Half of the awarded funds were paid out to the 334 families affected by Betterment Planning in the area, while the other half of the funds were reserved for community development in the Cata area. These funds have been utilised to build classrooms and a community hall, set up an irrigation scheme, create permaculture gardens, invest in plantations and, importantly, create the Cata Village Museum (Westaway & Naidoo 2010).

Other NGOs have been involved in similar projects in the village with varying degrees of success. A few of the remaining fields had formal irrigation systems installed, which have since been abandoned. BirdLife South Africa and Cata Sustainable Rural Development contributed to the development of a hiking trail through the pre-Betterment sites leading to a toposcope overlooking the old and new sites. The hiking trail, along with accommodation that was built above the village, are part of a drive towards making Cata a tourist attraction. All of these ventures are run and maintained by members of the Cata community, helping to create much-needed jobs in this generally economically depressed community (Westaway & Naidoo 2010).

3.7 Comparing Willowvale and Cata

At first glance, Willowvale was much like Cata. The settlement structures were scattered across a hilly landscape, and families were clustered into hamlets predominantly made up of agnatic lines. Gardens were also a key means of production, combined with field agriculture (see Andrew & Fox 2004; Mc Allister 1989). The people of Willowvale faced the same pressures to bring cash earnings in to support their families, resulting in approximately 80% of men over the age of 18 leaving to seek work as migrant labourers (see McAllister 1979, 1989; McAllister & Deliwe 1994). They are both Xhosa-speaking communities with similar social, political, and economic structures. The gardens in Willowvale, much like those used in Cata, played a key role in the ability of the women left behind to survive and adapt (see Andrew & Fox 2004).

The research carried out by Andrew and Fox (2004) provides statistical evidence which highlights how important these gardens were. A comparison of aerial imagery from 1942, 1962, 1982 and 1996 (see Figure 3.9 (see Appendix A for a larger version of this image)) shows how land use organically evolved without government interference.

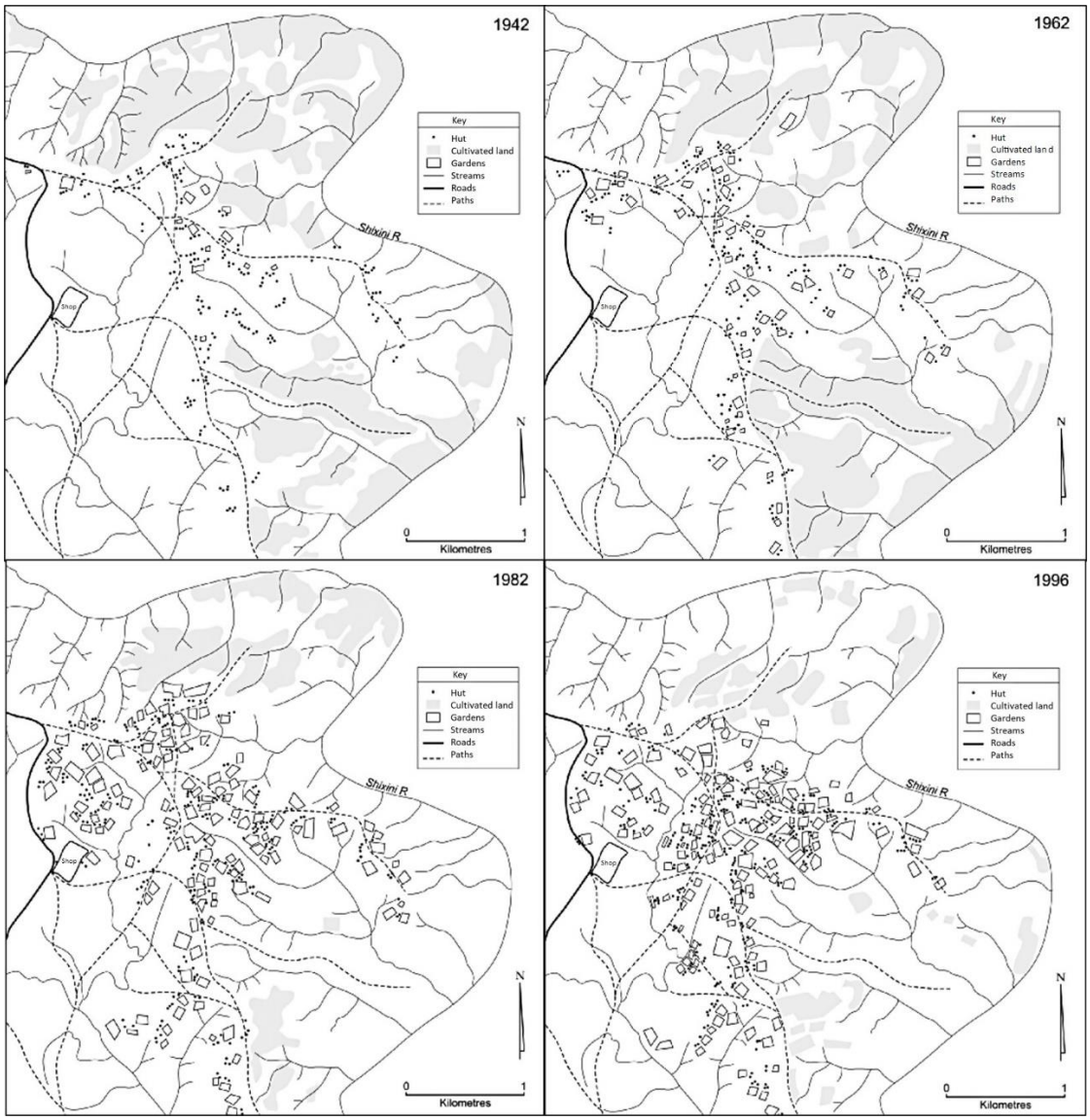

Figure 3.9: Mapped changes in Willowvale from 1942 to 1996 providing four snapshots which indicate the organic expansion of settlements and associated gardens(From Andrew and Fox 2004).

The images show that between 1942 and 1982, the use of gardens by homesteads increased from 27% to 87%. This trend continued through to 1996. The size of gardens also increased dramatically over time; average sizes increased by 54% between 1942 and 1986. This was due in large part to the scattered nature of the hamlets, allowing for the expansion of these gardens into previously unutilised spaces. The study also found that use of fields decreased proportionately. Land used for field agriculture dropped from 2 300 ha to 950 ha (Andrew & Fox 2004).

There were two main reasons for this natural shift from field agriculture. Firstly, the location of the fields became troublesome due to the need for women to carry out both agricultural and domestic tasks, and secondly, the comparative harvests were better in the gardens than in the fields, due to more nutrient-rich soils. Maintaining fertile fields was difficult due to the quantity of manure required for fertilisation and the amount of labour required to effectively weed and till the soil. The tendency to produce monocultures from fields also led to depleted soil nutrients that would negatively impact yields (Andrew 1992; Andrew & Fox 2004; Herron 1990; Mc Allister 1989).

Conversely, intercropping was practised in gardens. This meant that heavily nutrient reliant plants would be mixed with vegetables that tend to be nitrogen fixers, and would allow relief for the soil as the root systems of these plants differ significantly from cereal crops. Fertilising the gardens was also easier, as it did not require fertiliser to be transported over significant distances, and also required less labour (Andrew 1992; Andrew & Fox 2004).

Another important feature of both Cata and Willowvale was how social structures impacted agricultural production, and how adaptable these communities were. In the case of Willowvale, the formation of work parties – either between neighbours in good standing, families, or on a larger scale, inviting a whole village section to carry out a task in exchange for beer – allowed women to adapt when men left the village in search of employment (Heron 1990; McAllister 2001). In Cata, prior to Betterment, work parties and the combining of resources was carried out between families and neighbours to compensate when needed (de Wet 1985). The disruption of these social structures in Cata had significant implications for the adaptability of the community. This is highlighted by the degree to which these structures were depended upon by the community of Willowvale over time (see Andrew & Fox 2004; Heron 1990; McAllister 1986).

There was also a significant difference in financial pressures between these two villages. In Cata, people had to save up to rebuild their homes, because compensation from the government for the loss of their homes fell woefully short of the true cost. During the time it took to rebuild and resettle, harvests were lost and materials wasted (de Wet 1985). In Willowvale, those left behind could invest in their agricultural production with some, if not much, of the money that was sent home. This resulted in a better ability to manage soils and crops, leading to higher and more reliable yields (Andrew & Fox 2004).

3.8 Review of anthropological sources

The first means of data collection was through a study of the anthropological research (secondary data collected by other researchers) that had been carried out over the past four decades on two study areas in the Eastern Cape, namely Cata and Willowvale. The primary subject of this research was the village of Cata, the focus of de Wet's and other researchers' work dating back to the 1950s (Andersson & Axelsson 2005; de Wet 1985, 1995a; Mills & Wilson 1952; Wilson 1959; Wilson *et al.* 1952). The anthropological data compiled by these individuals provided an invaluable illustration of life in Cata both before and after Betterment Planning. The data in the published works covering the field area provided useful figures for comparison during the calculation of potential yield figures based on the techniques described later. The figures recorded within the anthropological data (de Wet 1985:157, 1989) were considered critically.

An initial in-depth study of the archival and published material on Willowvale and Cata was conducted. This archival research started with material in the Cory Library at Rhodes University and in the National Archives in Cape Town, followed by research on agricultural practices in South Africa, the politics of

colonial and apartheid policies, and the impact these policies had on agricultural communities.

When using historical sources, such as ethnographic texts, it is imperative to take into consideration the limitations of this type of source. In order to prevent generalisations and blanket explanations, or making incorrect assumptions, it is important to consider the relevance, validity, and credibility of the material (see Charlton 2014; Hodder 2012b; Orme 1974).

During this research, it became clear that remote sensing (utilising GIS software to analyse satellite and aerial imagery) could provide further insights into the processes described in the anthropological and historical texts. The perspective that the anthropological data provides is useful, as it reflects the viewpoint of the community affected by the implementation of Betterment Planning. This allowed the anthropologists to discuss people's agency, which is often difficult to achieve in archaeological remote sensing research. This 'human' perspective provides insights into the resilient nature of the inhabitants and a useful means to explore further the driving points of survival in small farming communities in the face of extreme oppression.

The anthropological studies compiled by McAllister and his students (see Andrews 1992; Heron 1990, 1991; McAllister 1989) provided a basis for comparison between an area that underwent Betterment Planning (Cata) and one that effectively resisted this policy's implementation (Willowvale). This served as a means to further highlight the damage caused by Betterment Planning that was imposed on the occupants of Cata, the continued effects of which are still visible today. Interaction with the large body of work compiled on this area revealed that consideration of spatial structures and an analysis of the structural patterns could potentially provide insight for further study of this area.

When considering the sources mentioned above, concepts such as multi-vocality, dissonance and resonance of the sources helped to frame my approach. There is clear dissonance between the evidence and the historical reports created to motivate for the implementation of Betterment Planning, for example. All of the sources that have been interacted with have been critically evaluated and compared to the databases produced in order to try and achieve an objective result. Multi-vocality is often a key component of contemporary archaeological research. Allowing 'more voices' to participate in the research is a key means to moving away from the practice of prioritizing a colonial perspective (Hodder 2008).

3.9 Historical imagery

Aerial photographs dating back to 1963 and 1964 were obtained from the National Geo-spatial Information (NGI), a component of the department of Rural Development and Land Reform. The NGI was initiated in 1926, with an undertaking to create a national repository of aerial photography and maps covering the whole of South Africa. Today the NGI utilises satellite and aerial imagery to create an image database, and maintains the largest repository of historical aerial photography in South Africa (Wannacott 2010). After providing KML (Keyhole Markup Language) files (created using Google Earth) to the NGI indicating the area of interest, I was able to gather all of the imagery on the NGI database that was relevant to this study. This imagery required further manipulation such as geo-referencing and processing using open-source software QGIS in order to establish relevance to this thesis.

After the historical imagery was georeferenced and processed, it was overlaid onto present-day satellite imagery. Relevant features were identified using visual interrogation and the available tools in Google Earth Pro and QGIS. These historical images were particularly useful as they were taken during the relocation process which resulted in the moving of occupants from their cultural

homesteads to the newly established site, designed according to the spatial configuration set out during Betterment Planning (de Wet 1985). These images provide a clarity to the spatial configuration of Cata that is significantly harder to establish on current satellite imagery due to the decomposition and degradation of the abandoned physical structures over time. In the historical imagery, homesteads, gardens, and some fields can be clearly identified (see Figure 3.10). See Appendix B for an annotated version of Figure 3.10.

This imagery depicts the density and spatial configuration of homesteads and gardens, which allows for reliable distance calculations from important natural resources and provides an indication of vegetation cover within the area. Basic processing of the imagery (optimising contrast and sharpening of images) was undertaken to enhance resolution and features. The original unenhanced photographs can be seen in Appendix C.

The ability to indicate the progression of erosion gullies allows for a comparison to be made between historical and current imagery. This entailed quantifying the morphological changes of these gullies over the past 56 years, and provides one means to evaluate the motivation of Betterment Planning.

There are several limitations in terms of processing and analysing historical imagery. The first is that there are gaps in the time periods for which imagery is available. There is no historical imagery available to provide a slice per decade, for example. This means we do not have a fluid timeline of aerial photographs. The second is that the imagery from the 1960s is in black and white. This limits the type of processing and manipulation that can be carried out. The last limitation is the resolution of the images, which makes it difficult to identify smaller or more obscure features in the landscape (Gilruth & Hutchinson 1990; Rambold *et al*. 2013; Soffianian *et al*. 2010).



Figure 3.10: Historical aerial photograph of Cata, Eastern Cape in 1963 (obtained through NGI)

3.10 Satellite and current aerial imagery

The imagery utilised for mapping and spatial analysis of both the old and new sites was obtained from the NGI (as described previously) and the Google Earth Engine (http://mt0.google.com/vt/lyrs=s&hl=en&x={x}&y={y}&z={z}). This allowed for the identification of key structural features for both sites and the calculation of surface area required in yield calculations. A combination of computational and analytical programs was used in the processing and analysis of this imagery. These programs included ArcGis, QGIS and Google Earth Pro.

Measurements were obtained for maximum and minimum changes in distances to basic resources such as water sources and grazing land, which are considered requirements for survival. These factors play a crucial role in understanding firstly, why a location was initially chosen for occupation, and secondly, how the change in these distances could impact daily routines, the ability for a community to thrive, and various other day-to-day logistics.

Mapping of Cata allows for a macro-scale analysis of homestead distribution and a comparison with the current site of occupation created through Betterment Planning. This allows for the comparison of variables that must be accounted for when considering the impact of political schemes such as this on the multiple facets of a community's existence, cultural practices of a region (including agricultural practices), and social structures.

Satellite and airborne imagery viewed through the time tool on Landsat Explorer and Google Earth, displays a temporal shift in imagery. This was used to identify how erosional features developed over time. This dataset was utilised to support the conclusions drawn during the analysis of the environmental data with regards to erosion in this area. Unlike historical imagery, which is predominantly greyscale in nature, modern imagery allows for colour manipulation in order to highlight relevant features.

A 3D rendering of Cata was created on Google Earth Pro and enhanced using QGIS to better understand and conceptualise the slopes encountered in the area. These slope angles have to be considered and mitigated during agricultural development and production. In addition, the angle of the slope is relevant when considering factors such the risk of natural erosion, increased accessibility challenges, distances to key resources, and adaptations required to compensate for the challenges an increased slope creates.

This 3D rendering was used in conjunction with photographs taken during a ground survey to create a complete overview of the study area.

While the resolution of the more recent imagery is significantly higher, the decomposition of physical structures makes identification of gardens and homesteads more challenging than on historical imagery. The combination of these two resources has facilitated increased accuracy and a more holistic understanding of the area.

The limitations of this dataset are the gaps that occur in the timeline. There are large gaps for which there is no imagery available. Historical imagery was irregularly collected, particularly for rural areas. As a result, there is no way to verify the anthropological data for these time gaps (see Soffianian *et al*. 2010). Seasonality can also be a limiting factor; different features can be less or more visible depending on the season during which the image is taken (Moore & McKee 2020).

3.11 Site visit

The foot survey involved walking through both the pre-Betterment and Betterment sections of the village with a guide, and taking detailed field notes of visible structures and erosion patterns. Photographs were taken of relevant visible features such as remaining hut walls, erosion gullies, slopes, and graveyards (as can be seen in Figure 3.10). The ground truthing trip was carried out in conjunction with Professor de Wet, one of the key anthropological

researchers in this area. This was extremely useful as both his perspective and translating abilities added tremendous value to my understanding of the area and the plight of the community. The guide, a member of the community who had an ancestral home in Cata, was an invaluable asset as he provided us (with the help of translation from Professor de Wet) with a detailed description of the impact that Betterment Planning had on this community and an idea of life before betterment.

3.12 Environmental study

The purpose of the desktop environmental study was threefold.

Firstly, it provided quantitative data as a reference base to evaluate the environmental justifications used for the forced removal of the Cata community (de Wet 1985, 1989, 1994). This was achieved through an analysis of natural erosion patterns, and looking at the progression of erosion over time, with an emphasis on the development of erosional features following the cessation of farming in the area, and considering the benefits that agricultural practices and field maintenance can have on stabilising soil systems.

Secondly, it provided an additional dataset to consider when evaluating the spatial configuration of homesteads in the area, prior to the resettlement caused by the enforcement of Betterment Planning, and the possible justification for the development of this spatial configuration over time. This data provides an underlying understanding (in conjunction with an extensive literature review) as to how the environment (topography) of an area can impact the way a community develops spatially.

Thirdly, this dataset was utilised to provide additional information in the consideration of agricultural practices carried out in this area. Aspects such as slope, moisture levels, natural erosion features, and geology would all have an impact on the success potential and necessary strategies implemented for the community farming there.

The environmental study is comprised of a digital elevation model (DEM), an LS-factor representation, and several false colour composites depicting specific features relevant to this study.

A DEM is a bare-earth raster, which is a representation of vertical data points (X, Y, Z) that have been filtered to exclude non-grounded points, such as vegetation and any built structures in the area. This data is then used to create a bare-earth elevation model of the chosen study area. This type of elevation model is useful when considering terrain stability, watershed flows, and natural flow directions.

The DEM created for this thesis was a Global Digital Elevation Model (GDEM), created with a dataset from the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER). ASTER is located onboard the NASA Terra satellite and uses near infrared cameras to capture stereoscopic pairs of images. These images are then utilised to measure changes in elevation over the area captured in both images. Processing of this imagery was done in SAGA (an open-source GIS program) and analysed using QGIS.

The second dataset generated represents the current LS-factor over the research area. The LS-factor generated an image based on the universal soil loss equation, which is used globally to estimate the risk of soil erosion in an area (Panagos *et al.* 2014). Two datapoints are required when rendering the image visually displaying the LS-factor: the unit of measurement (metres) and cutoff slope angle. The L-factor measures the impact that slope length would have. This is calculated using the formula depicted in Figure 3.11 (Desmet & Govers 1996; Hickey 2000; McCool *et al.* 1987).

$$L_{ij-in} = \frac{[(A_{ij-in} + D^2)^{m+1} - (A_{ij-in})^{m+1}]}{(D^{m+2}) \times (x_{ij}{}^m) \times (22{,}13)^m}$$

where

L_{ij-in} = slope length for grid cell (i,j)

A_{ij-in} = contributing area at the inlet of the grid cell with coordinates (i,j) (m^2)

D = grid cell size (m)

m = length exponent of the USLE L-factor

x_{ij} = $(\sin \alpha_{i,j} + \cos \alpha_{i,j})$

Figure 3.11: Formula for calculating L-factor (https://www2.ufrb.edu.br/gisus-m/ls-factors)

The S-factor measures the impact that slope steepness would have on the risk of erosion. The formulas used to calculate the S-factor are shown in Figure 12 (Mc Cool *et al.* 1989).

$$S = 10.8\ sin\theta + 0.03 \quad \text{when} \quad \theta < 5.14$$

$$S = 16.8\ sin\theta - 0.50 \quad \text{when} \quad \theta \geq 5.14$$

Figure 3.12: Formula for calculating S-factor (https://www2.ufrb.edu.br/gisus-m/ls-factor)

The final additions to the environmental study comprise datasets generated through the manipulation of bands captured by the Sentinel and Landsat satellites. These bands were overlain to generate false colour composites. The resultant images were used to highlight specific characteristics of the surface within the research area. The following images were rendered: a normalised difference vegetation index, a soil adjusted vegetation index, an agriculture image, a normalised moisture index, a geology image and a natural colour rendering. The natural colour image serves as a reference base.

The limitations regarding the production of the LS-Factor and DEM stem from the resolution of the satellite or aerial imagery used to produce them. Open-source imagery is not the highest-resolution imagery available. Consequently,

some data smoothing will occur during this analysis (Kok & Ramli 2007; Lindsay *et al*. 2019).

3.13 Yield calculations

Historically, anthropological figures tend to be an underestimation of the actual yield produced (Baumeister *et al*. 2007; Carletto *et al*. 2015; Sapkota *et al*. 2016). In order to establish whether patterns in yield data from Cata were linked to the suitable space available for farming or other factors, calculations were carried out in in order to create an average comparative database to use in relation to the data compiled in the anthropological research (Andersson & Axelsson 2005; de Wet 1985, 1989). The calculation used was as follows:

Total production Σ Crop Surface area x μ yield

Surface areas were calculated using QGIS by creating polygons over gardens to create an average area. The crops calculated were for starch and vegetable crops commonly grown in the gardens (see Andersson & Axelsson 2005; de Wet 1985). I do not include vegetable crops in my calculations as we did not have historic yield figures as a comparative base. Anthropological sources confirm that sorghum and maize were the predominant produce (de Wet 1985).

The figures used to calculate a maximum and minimum range (see table 3.1) for these calculations were obtained from the Food and Agriculture Organization of the United Nations (Deb *et al*. 2004; Deosthale *et al*. 2012) and the International Food Policy Research Institute (Fermont & Benson 2011). These sources were selected due to their reputations as reliable and reputable sources of data for this field.

Table 3.1: Maximum and minimum yield ranges in kilograms per square metre for maize and sorghum

Crop Type	Maize	Sorghum
Minimum kg/m²	0,12	0,07
Maximum kg/m²	0,46	0,36
Anthropological yields kg/m²	0,20	0,09

The limitations of the yield data are that we do not have exact figures for rainfall and soil quality for each year. This, combined with the reliability issues surrounding the anthropological figures, resulted in the need for a range. The variables for which we do not have precise data can have a significant impact on yield. In this instance I have used the average climate and rainfall data available. The yield datasets derived from area calculations and real-world production ranges provide a feasibility range of potential produce generated in the area. Comparing this range with anthropological yield figures from de Wet's research (1985), reconfigured in order to create a comparable dataset, allows insight into factors that impacted production, specifically whether the decrease in yield can be linked to a decrease in farming or to a decrease in the availability of suitable land for farming.

It should also be noted that these calculations are directly and linearly derived from land areas. There is room for variation in the yield figures depending on the variety of maize and sorghum grown. The species historically grown in this region – *Zea mays* and *Sorghum bicolour* (Chimonyo *et al*. 2019; Hamilton 2017) – are the focus of the calculations provided in this thesis.

The population statistics for Cata are problematic as research indicates that multiple discrepancies exist in the historical records (de Wet 1985). Surveys carried out over the 1950s indicate a population size ranging from 2 325 to 2 732 people. The average number of people per household ranges from 6.2 (with a de facto figure of 5.4 people per household, with 0.8 people not living at home) to 7.28 (with a de facto figure of 6.14, with 1.14 people not living at

home) (de Wet 1985:143). These figures were used to calculate potential starch crop requirements for Cata for comparison with yields.

3.14 Constraints of the thesis

Several challenges were encountered while researching and writing this thesis. The historical imagery is limited in availability, and the resolution is lower than that of modern imagery. The available imagery had considerable time gaps between them, which made it difficult to understand the changes during the forced moving of homes over time. The lower resolution of older images and their lack of colour reduces the amount of information that can be derived from them. This is why there are time gaps between the images and why the environmental study was carried out using 2006 imagery. Without the ability to manipulate colour bands, a fully comparative dataset is more difficult to establish.

Health concerns I experienced resulted in the abandonment of the onsite mapping and excavations that had been initially envisioned. Insufficient economic resources meant that interviews could not be carried out, as ethical practices dictate that all interviewees must be offered psychological debriefing. Instead, historical interviews were used for an anthropological dataset. This should perhaps be viewed as a positive rather than a limitation, since previous anthropological research studies recorded an abundance of interviews, and these interviews are no doubt more accurate than any that would be conducted in the present day, due to the length of time that has passed between the present day and the period of Betterment Planning, and the fact that memory fades over time. Had the extensive ground truthing been carried out, as originally planned, some clarity on the outlying gardens could have been gained.

3.15 Summary

The techniques and methods discussed in this chapter are all internationally utilised, and are tried and tested. The different processes have allowed for a multidisciplinary approach to be used in the creation of the datasets presented in this thesis. Above all, this work has attempted to adhere strictly to generally accepted scientific principles of research.

In the next chapter, the data created from the pre-Betterment time period will be presented, ranging from a study of settlement patterns to the calculation of relevant yield data.

Chapter Four – Pre-Betterment spatial and yield data

4.1 Introduction

This chapter presents the spatial information I generated on the mid-twentieth century occupation of African farming communities in the Cata area (see Figure 4.1). The analysis of spatial configuration and settlement patterns of the village as a whole and the clustering of individual homestead groups is discussed. The spatial data was primarily produced by using historical aerial imagery, satellite imagery, a ground survey of the area, and anthropological data.

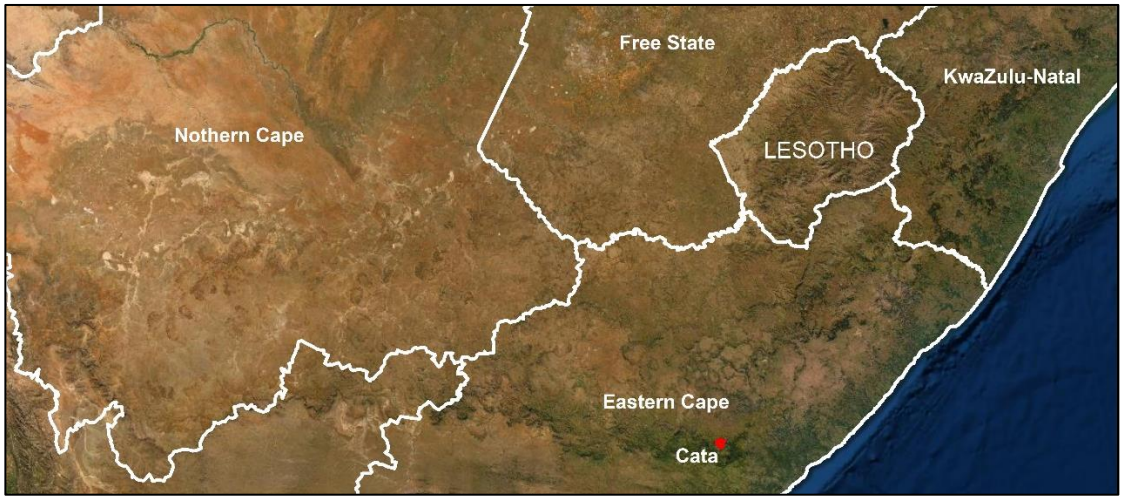

Figure 4.1: Location of Cata in South Africa and the Eastern Cape (ArcGIS)

Cata is situated approximately 12km north of Keiskammahoek in the Eastern Cape, South Africa (see Figure 4.1). The area is bound on three sides (east, north and west) by the foothills of the Amatola mountain range, with access primarily from the south. The research area is divided into two approximately equal areas by the perennial Cata River which flows from north to south. The pre-Betterment layout of settlements at Cata were distributed over both the western and eastern side of the valley (see 4.2).

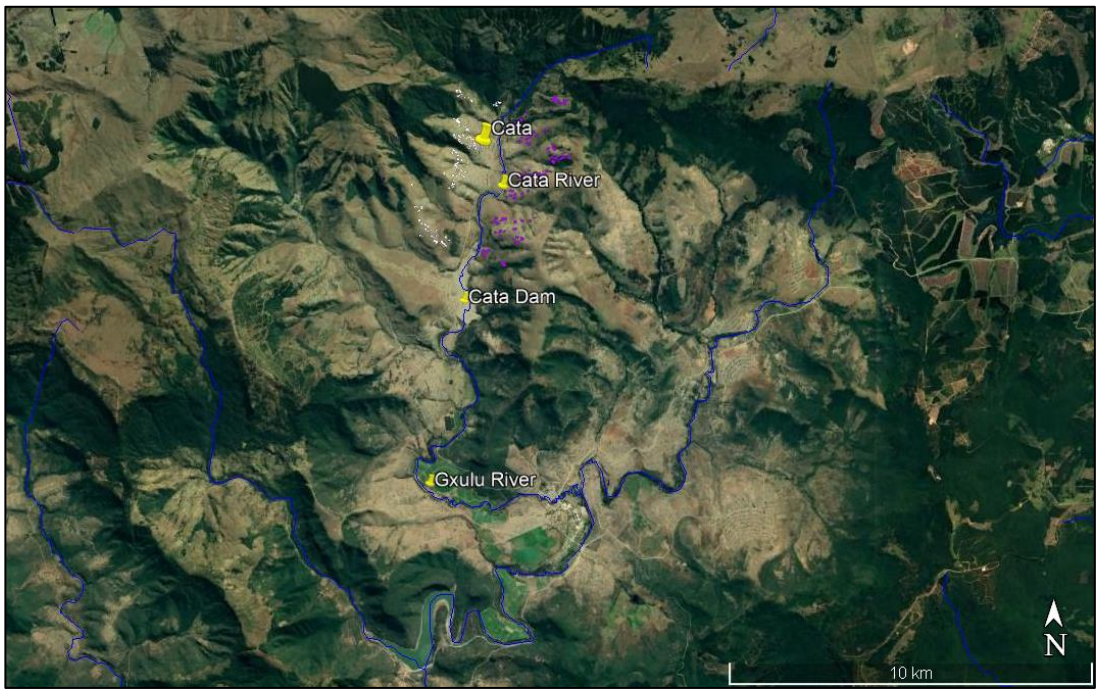

Figure 4.2: Satellite image of Cata displaying the Cata River (Google Earth)

The primary water source for the residents is the Cata River (which becomes the Gxulu River further downstream) and its tributaries, which feed the Cata dam. This system feeds into the larger water systems of the Eastern Cape (see Figures 4.2 and 4.3). The Cata River is fed by tributaries that run down the hillsides primarily from the north. This provides convenient water sources for households and grazing. The implementation of industrial-scale irrigation schemes was not possible prior to the construction of the Cata dam, which occurred after the implementation of Betterment Planning (Andersson & Axelsson 2005).



Figure 4.3: Satellite image illustrating the water systems pertaining to Cata and surrounds (Google Earth)

4.2 Settlement patterns

I combined historical and anthropological data with historical imagery from 1963 and 1964 provided by the NGI to study the settlement patterns in the Cata area prior to the implementation of Betterment Planning. The boundaries of physical features are relatively clear on these images. Many of these features have been removed by either natural or human processes since then (see Figures 4.4, 4.5, 4.6 and 4.7). As a result, some of these features – original homesteads, pre-Betterment fields and some gardens, for example – are no longer visible in more recent satellite imagery or field observations. Combining these images with more recent satellite imagery and observations made during a site visit, provides a more accurate overall view of the village over time. While de Wet (1985) did create hand-drawn estimations, the maps created here allow for more accurate analysis of the spatial data, and erosional processes.

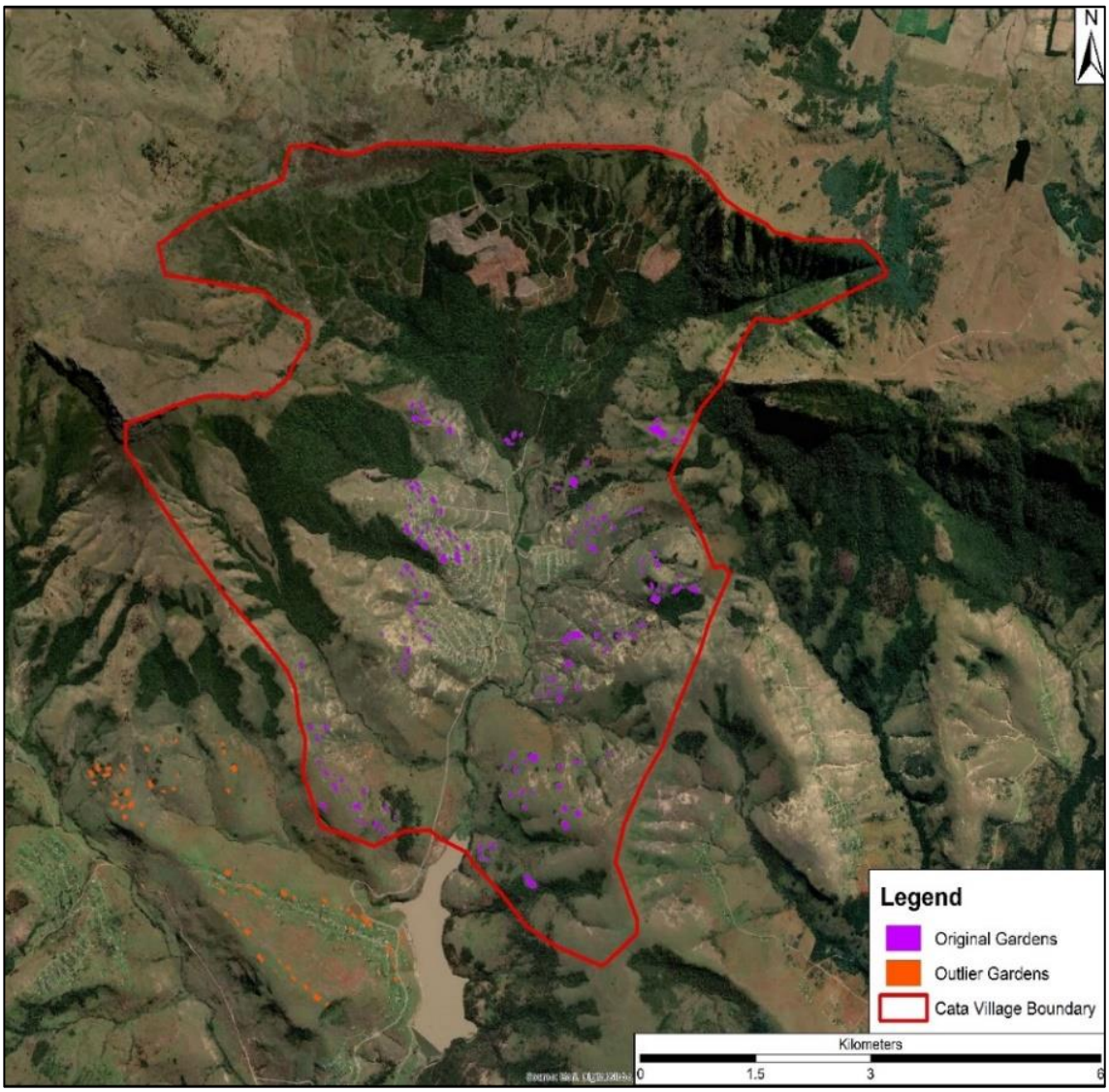

Figure 4.4: Satellite image illustrating the layout of pre-Betterment Cata (ArcGIS)



Figure 4.5: Photograph of hut wall remains degraded over time (photograph: Tiffany Henshall)



Figure 4.6: Photograph of hut wall remains (photograph: Alex Schoeman)



Figure 4.7: Photograph of a section of hut wall taken during the field visit in 2016 (Photograph: Alex Schoeman)

Image classification and a site visit informed the classification of the area into agricultural, grazing, and residential land (see Figure 4.8). This is supported by a reading of the anthropological data (e.g. Andersson & Axelsson 2005; de Wet 1985, 1995a; Mills & Wilson 1952).

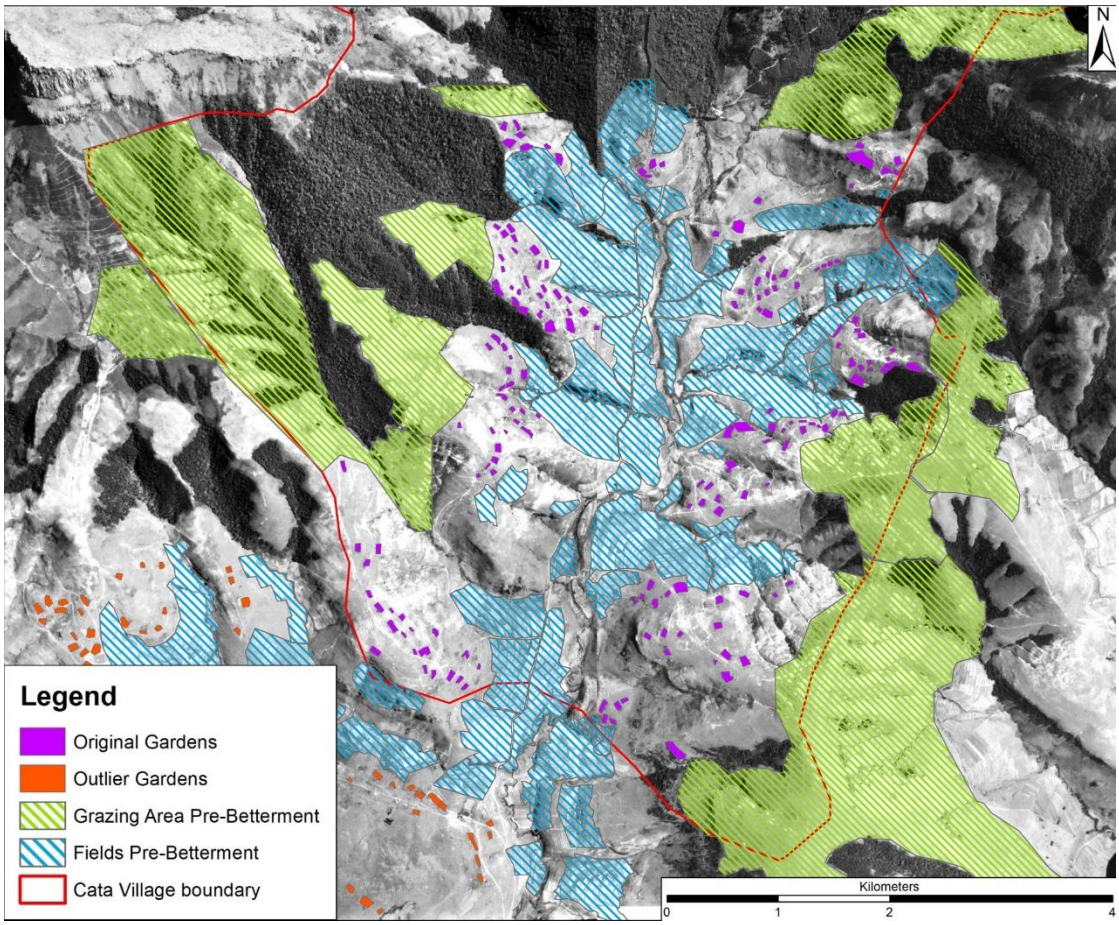

Figure 4.8: Historical aerial imagery (1964) from the NGI displaying land allocations in Cata (QGIS)

Residential land was primarily situated above the steep sections of the slopes, with fields and gardens located lower on the slopes on the steeper sections, below the dwellings. Before Betterment Planning, the original residential sites (pre-1964) within the Cata settlement area appear as homesteads scattered throughout the landscape (see 4.9). These homesteads were grouped into small hamlets or micro-villages, usually comprised of related family members (see de Wet 1985). These hamlets were scattered across the landscape, often separated by physical features such as ridges or small rivers.

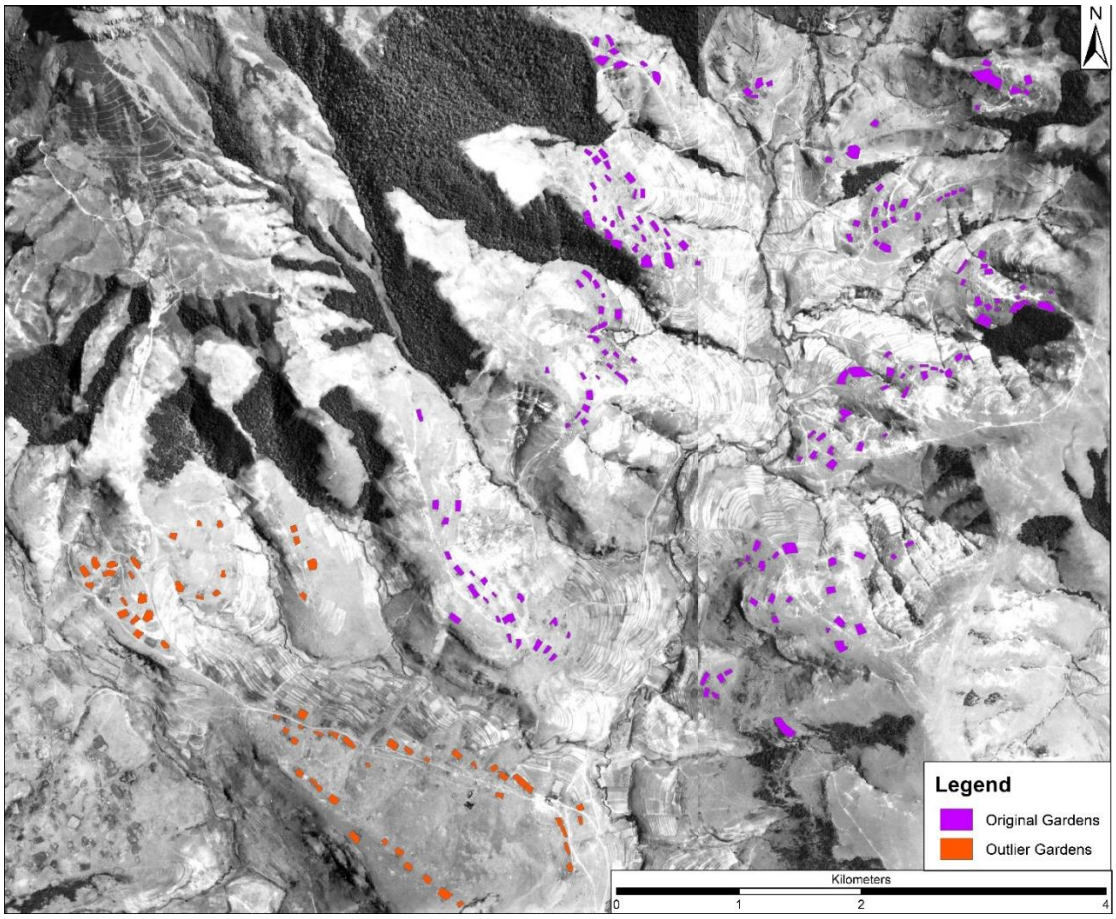

Figure 4.9: Historical aerial imagery (1964) from the NGI illustrating the location of visible gardens (QGIS)

Hamlets comprised groups of homesteads, usually one to six huts, built in close proximity to one another (see de Wet 1985; de Wet & Leibbrandt 1994; Deliwe 1995; Mills & Wilson 1952). Anthropological data based on rural surveys indicate that these settlement groups usually followed male lines. Sons would build homesteads near those of their fathers, creating kinship-based microcosms within the greater village. Daughters would usually move to their husband's hamlet, to create their own homesteads. These hamlets usually ranged between 15 and 40 homesteads (de Wet 1985). The number of people occupying the homesteads varied, and reliable figures were not attainable. De Wet (1985) provides figures from his own research of an average of 7.28 people per homestead, with a de facto average (after subtracting the number of people who were not living full time at the homestead, due to working as

migrant labourers or for other reasons) of 6.14 people per household. The Keiskammahoek Rural Survey suggests various figures, the most common of which is 6.2 people per homestead, with a de facto figure of 5.4 people per homestead. The bulk of those who remained at the village were women, children, and the elderly, as able-bodied men (and some women) sought work elsewhere to help support their households financially (de Wet 1985; Mills & Wilson 1952). The total population for Cata ranges from 2 325 to 2 732, occupying between 335 and 375 homesteads (de Wet 1985).

The spatial data supports the anthropological observation that these hamlets were spaced to optimise the surrounding areas for both residential and agricultural use. The large amount of space allowed for expansion of gardens and homesteads as the need arose (see de Wet 1985; Mills & Wilson 1952) is clearly visible. As can be seen in Figure 4.10 and Figure 4.11, homesteads are clustered in between large gardens. The space allocation is substantially greater for building gardens than building larger residential developments. Gardens were constructed between the groups of homesteads. These gardens varied significantly in size and shape (averaging 2 000 $m^{2)}$, depending on need and available labour in each homestead.

A larger family group would require a larger garden to supplement their food supply. In some instances, where fields were not owned, the homestead's garden would be the only means of agricultural production (de Wet 1985; Mills & Wilson 1952). In both instances, agricultural practices were often carried out by combining resources between families and neighbours in good standing. This entailed sharing labour, oxen for ploughing, and other resources to aid those who may not have been in a position to manage their land otherwise (de Wet 1985, 1995a).



Figure 4.10: Zoomed-in image of a homestead (examples of these indicated by A) built around gardens in Cata before Betterment (1964) (QGIS)



Figure 4.11: Photograph taken during ground truthing of remaining homestead walls (Photograph: Alex Schoeman)

Garden walls were primarily constructed using aloe hedges or timber fencing. The higher density of the materials used to construct these walls means that they are visible in the aerial photography, and these remaining walls have been used for the demarcation of the historical gardens which were being actively worked prior to the implementation of Betterment Planning.

The second form of agricultural land comprised larger bulk fields. There are many differences between these two forms of agricultural production, in terms of identifying features and uses. Anthropological sources confirm what can be seen in the satellite and aerial imagery: gardens were smaller and located next to the households, while fields were located further away from residential spaces. Gardens can be clearly seen on the historical and current imagery as they were fenced in, whereas fields are harder to distinguish (de Wet 1985, 1995a). The majority of these fields were located near the river and proceeded upslope towards the residential areas (see 4.12).

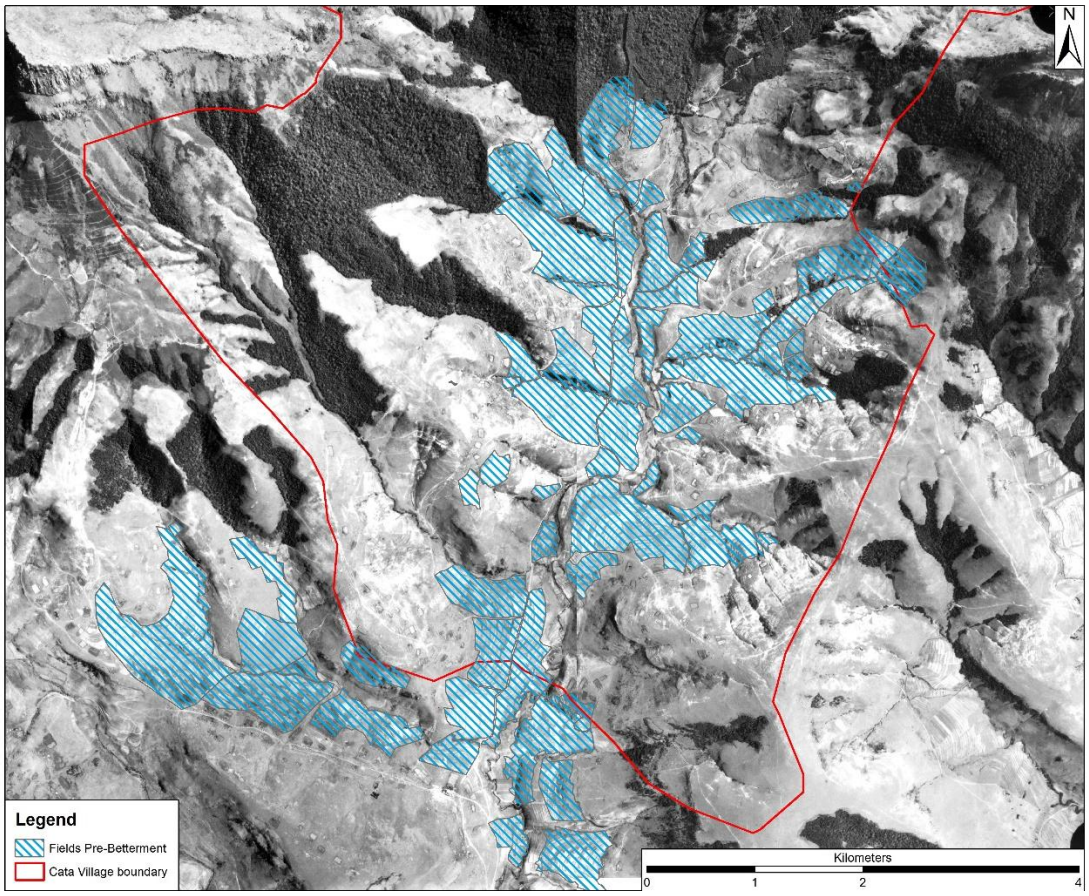

Figure 4.12: Historical aerial imagery from the NGI illustrating the approximate location of fields in 1964 (QGIS)

Field systems were far more complicated than residential land allotment due to space limitations (de Wet 1985,1995a). A request would be made for a field through the sub-headman, who would the pass the request on to the headman and his council who would make a decision. This decision would then be subject to approval by the Magistrate of the area (Wilson *et al.* 1952). This was a political process that often resulted in competing communities opposing one another's claims (de Wet 1985,1995a). Field holdings varied greatly; the size of these fields ranged between 10 acres down to less than an acre (de Wet 1985).

Allotments of areas for homesteads and gardens was comparatively straightforward as they required smaller areas and could be situated further from the primary water sources in areas less suitable for fields. This can be

seen in the locations chosen for hamlets, which were primarily along smaller tributaries rather than along the main river system (see 4.9).

Prior to 1921, the principle used for the allocation of arable land and fields was that all men who wanted land would receive it. These fields would be designated by the headman and could be inherited but not sold. After 1921, land allocation became increasingly overseen by the Native Affairs Department of South Africa (de Wet 1989). The principle of field distribution began to shift, and by 1939 had become based on the premise of 'one man one field'. This meant that only one field could be passed down through inheritance (de Wet 1985; Mills & Wilson 1952). This increased administrative control made it more difficult to obtain any land, never mind sizeable land for cultivation. Mills recorded average field sizes ranging from five acres to less than one acre (Mills & Wilson 1952).

Gendered division of agricultural responsibilities was a relevant factor (as discussed in chapter two). Gardens were the domain of the women of the homesteads. This impacted the location of the gardens as they needed to be close enough to the residential areas so that women could complete domestic duties and tend to their produce while still being able to look after small children. Men managed the fields due to their distance from the homesteads and the laborious and time-consuming nature of tilling and maintaining them. When able-bodied men started to migrate to seek work, relations with neighbours became more important. Groups of women would combine resources to carry out more labour-intensive practices, particularly in larger gardens which had become a vital resource for the family members who remained in the village (de Wet 1985).

Another form of land allocation was for the grazing and the encampment of cattle. Cattle byres were often constructed in close proximity to gardens, and in many cases these were built onto the side of a garden wall (see Figure 4.13). This was confirmed by the anthropological data and the rural survey for the

area produced in 1952 (de Wet 1985; Mills & Wilson 1952). Grazing areas were primarily situated at higher altitudes above homesteads and in ministerial forestry areas, furthest from primary water sources. These areas were less sheltered and provided open space ideal for grazing (see Figure 4.14). This was confirmed through the site descriptions in the rural surveys carried out in 1952, as well as historical and anthropological sources (de Wet 1985; Houghton 1955; Mills & Wilson 1952).



Figure 4.13: Zoomed-in image of a cattle byre (examples of these indicated by A) built onto a garden wall (1964) (QGIS)

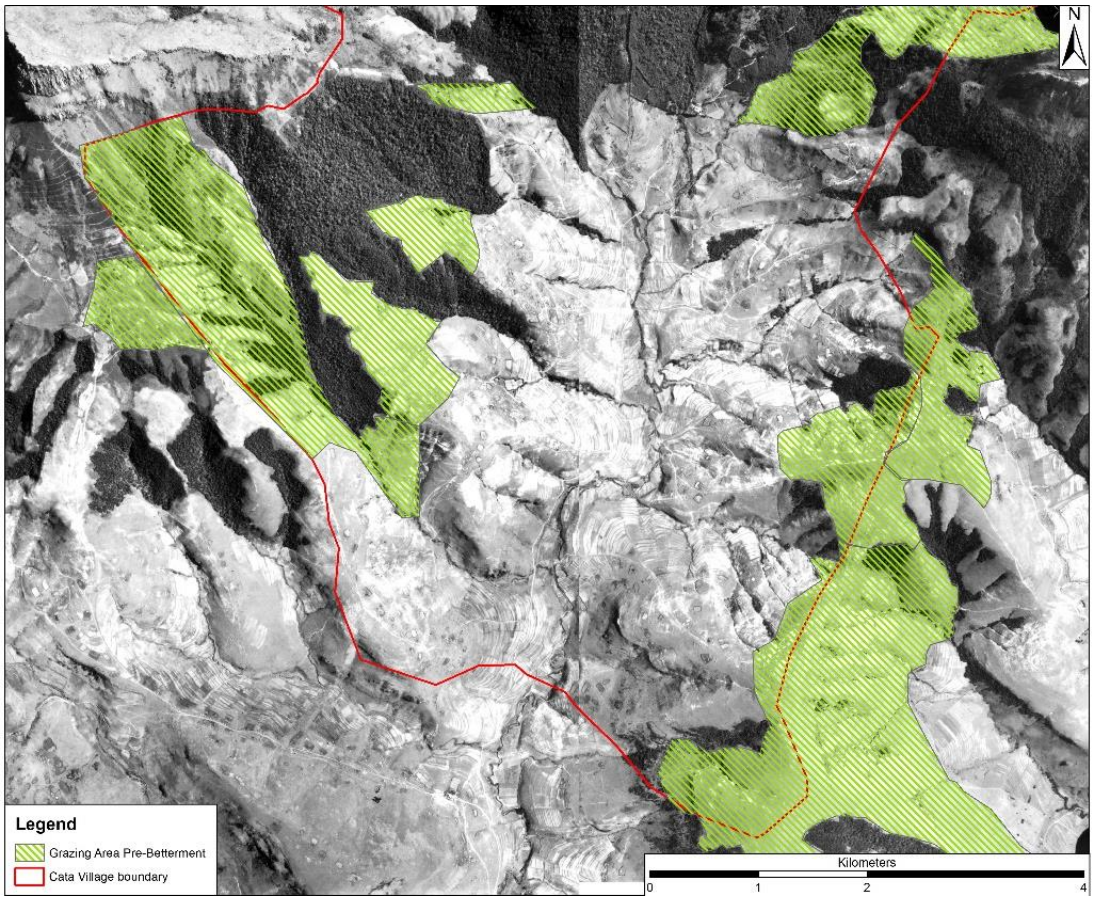

Figure 4.14: Historical aerial imagery from the NGI illustrating the approximate location of grazing land (1964) (QGIS)

4.3 Climate and environmental factors

The slope of the terrain is significant enough that erosion occurs naturally (see Figure 4.15). This may have a significant impact on agricultural potential and grazing supply, if land use is not carefully managed. Soils on slopes tend to be lower in nutrients due to topsoil wash and erosion. The poorer organic material content in the soils leads to lower-quality grass and unstable soils (Khan *et al.* 2013; Liu *et al*. 2020; Scholten *et al.* 2017).

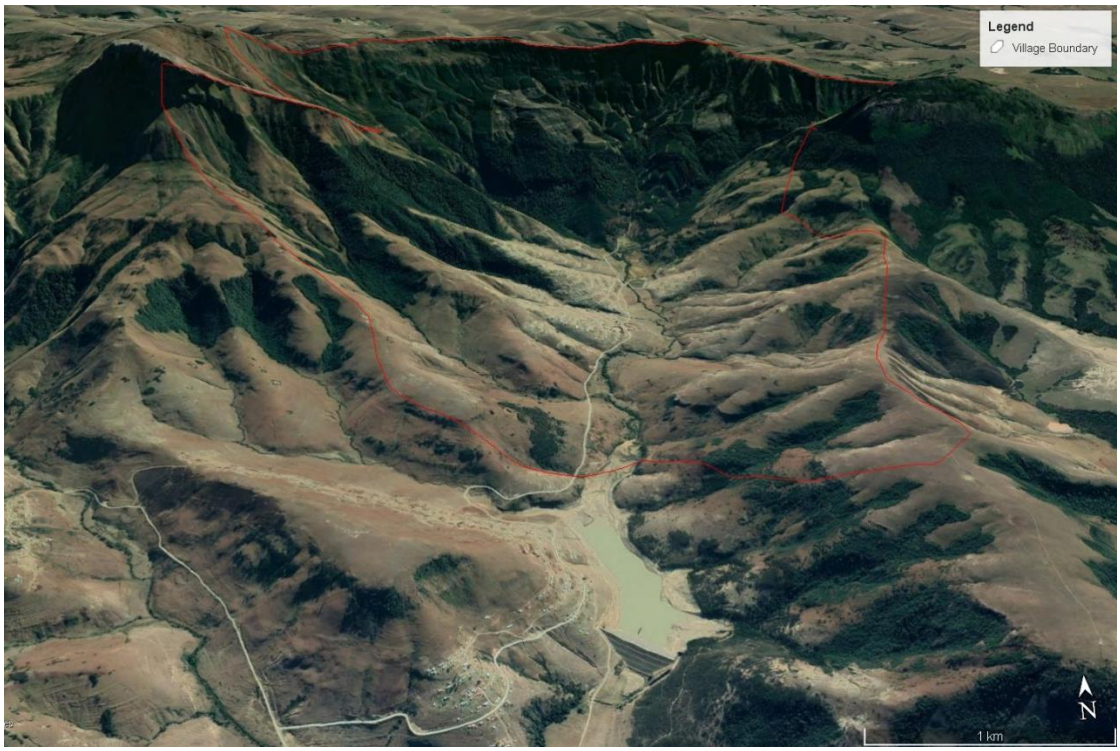

Figure 4.15: Satellite image of Cata depicting slope (elevation exaggeration of 2) (Google Earth)

Overgrazing is one of the key factors that causes natural erosion channels to develop more quickly than they would if the area were not overgrazed. The location of grazing camps in higher, flatter areas allowed for grazing in these areas to have less impact on natural erosion caused by elevation and climatological factors (*c.f.* Blanco-Canqui & Lal 2010; Kairis *et al*. 2015; Mills & Wilson 1952). Erosion hotspots in the pre-Betterment settlement could have resulted due to a variety of factors. As discussed, slope angle would be a key factor, however agricultural production can play a stabilising role in this type of scenario: roots from vegetation can stabilise loose soils, and agricultural production would lead to active soil maintenance by farmers. Denuded areas would also become erosion hotspots in a similar vein, as the stripping of vegetation from soils would deprive them of a stabilising feature making it increasingly likely that topsoils would wash downslope during rainy seasons (Khan *et al*. 2013; Rockströöm & de Rouw 1997). The nature of rainfall in this area could also mean that erosion was most likely to be more problematic

during winter, as less agricultural production would occur due to the impact of frost, but rainfall was still a factor: fallow fields would be more inclined to suffer topsoil wash (Khan *et al*. 2013).

Rainfall in the area is bimodal, occurring in both summer and winter. The environment is classified as arid to semi-arid (Zengeni *et al.* 2014). The rainfall of the area plays an important role in determining the success or failure of crops. The Eastern Cape, particularly the area under the Amatole District Municipality (within which Cata is located), is historically considered high risk for drought (Jordaan *et al.* 2017). Due to a lack of regular rainfall records, the historical annual rainfall record is presented with a wide range. Some sources allocate an average annual rainfall of 710 - 835 mm (Jordaan *et al.* 2017) (see Figure 4.16), but others estimate it as low as 350 - 550 mm (Zengeni *et al.* 2014). These significantly different ranges are probably due to the periods used for the determination of these figures. The historical record does show that rainfall levels in this region have decreased over time (Jordaan *et al.* 2017). Anthropological records illustrate that while drought undeniably occurred (particularly noting the 1948/1949 season) and impacted crop yields, there was generally sufficient rainfall for adequate production of the crops historically produced in the area. Minimum rainfall requirements for sorghum are as little as 250 mm per annum and for maize, 300 mm per annum (Christiansen 2008; Hamaamba 1989). The optimal rainfall for maximum production ranges from 400 - 700 mm per annum for sorghum and 500 - 800 mm for maize (Deb *et al.* 2004; Deosthale *et al.* 2012; du Plessis 2008; Gangaiah 2008).

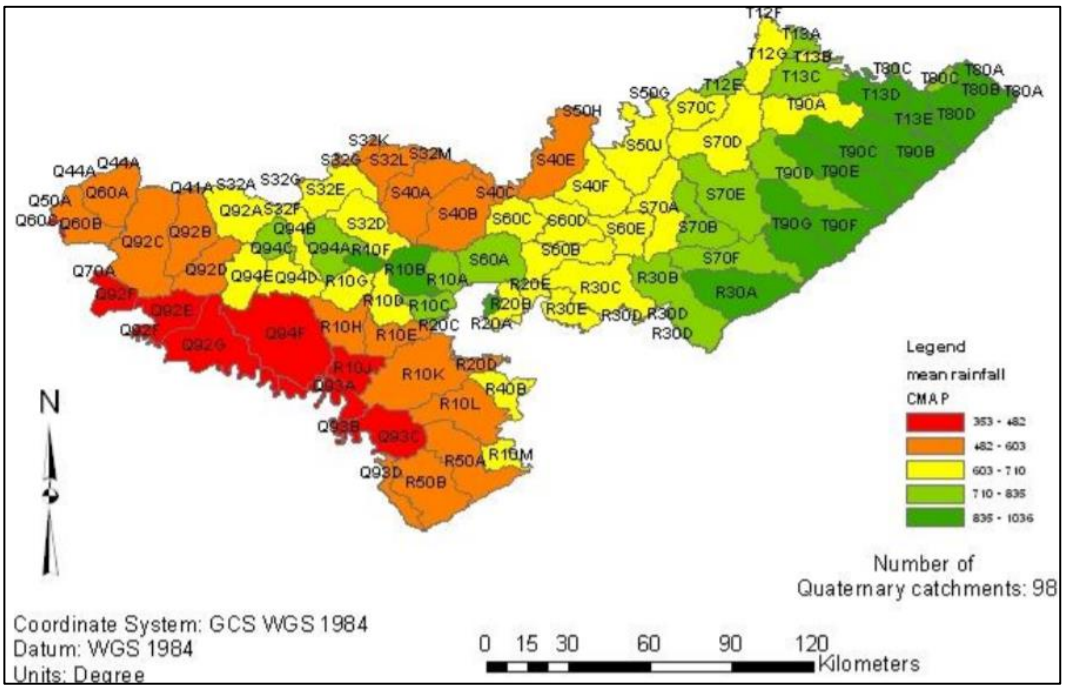

Figure 4.16: Average rainfall distribution from Jordaan et al (2017)

4.4 Yield calculations

In order to assess potential productivity, I have produced a range of estimated yields for the village of Cata based on gardens visible in aerial photographs. These figures were compared to the estimated figures put forward by de Wet (1985, 1995a) for maize and sorghum production (labelled maize anthro and sorghum anthro in the graphs – the figures can be seen in the tables in Appendix D). This comparison is valuable, as there is a historical record of verbal production figures being misleading. This is due in part to partial consumption of produce during the early stages of harvesting, as well as a result of estimation, rounding of figures, and poor recollection by individuals (see Baumeister *et al*. 2007; Carletto *et al*. 2015; Sapkota *et al*. 2016).

Sorghum and maize have been identified throughout the anthropological literature (e.g. de Wet 1985:177, 1989:340, 1995; Derricourt 1976:284; Fazan 1944; Greyling & Pardey 2019) as primary cereal crops produced in both Cata and the Transkei in general. These were supplemented with vegetables and

occasionally fruit (mostly melons). Interviews carried out by de Wet (1985:157) as well as through the Keiskammahoek Rural Survey confirmed that maize and sorghum were produced from both gardens and fields.

Although there are two forms of agricultural production (field and garden), only the garden yields could be estimated with confidence, as the physical boundaries are clear. The figures for the field yields presented below are rough estimates based on anthropological data, and are not representative of individual land holdings.

The rationale for prioritising yield calculations of gardens over fields in this thesis is twofold.

Firstly, prior to the implementation of Betterment Planning, there was an increase in agricultural production from gardens (de Wet 1985, 1995). There were several factors that contributed to this increase. Stricter allotments of fields from 1921 onwards led to less available land. There was an emerging trend of men leaving Cata to work as migrant labourers (O' Connell 1981). Taxation and general participation in the South African economy and access to formal education through missionary work created a greater need for increased household income (as discussed in detail in chapter two). This caused a shift in the composition of the available labour force, which resulted in gardens playing increasingly important roles in meeting the basic needs of households (de Wet 1985, 1995a).

Secondly, most fields do not have distinct boundaries in the aerial and satellite imagery, and this reduces the confidence in the accuracy of surface area calculations. Fields were subdivided, shifted, and fallowed throughout the pre-Betterment period of occupation, with little written record of these movements. This resulted in too many variables to accurately calculate agricultural areas required for yield figures.

The production of the yield figures required the identification and delineation of the historical gardens, calculating the surface areas of each garden (see 4.9). Once this was accomplished, a range of potential yields for cereal crops known to have been produced in the study area was generated. A total of 178 visible gardens have been delineated within the boundary of the Cata village area, as defined by the maps produced by de Wet (1985,1995a) (see Figure 4.17). An additional 62 outlying gardens were mapped as they were located less than two kilometres from the boundary line. The closest of these outlying clusters was located less than 600 metres from the boundary. The distance between hamlets located within the Cata boundary is approximately 600m, but it is possible that these gardens fall within a separate village, hence the data from these sites has been recorded separately and not included in the yield calculations.

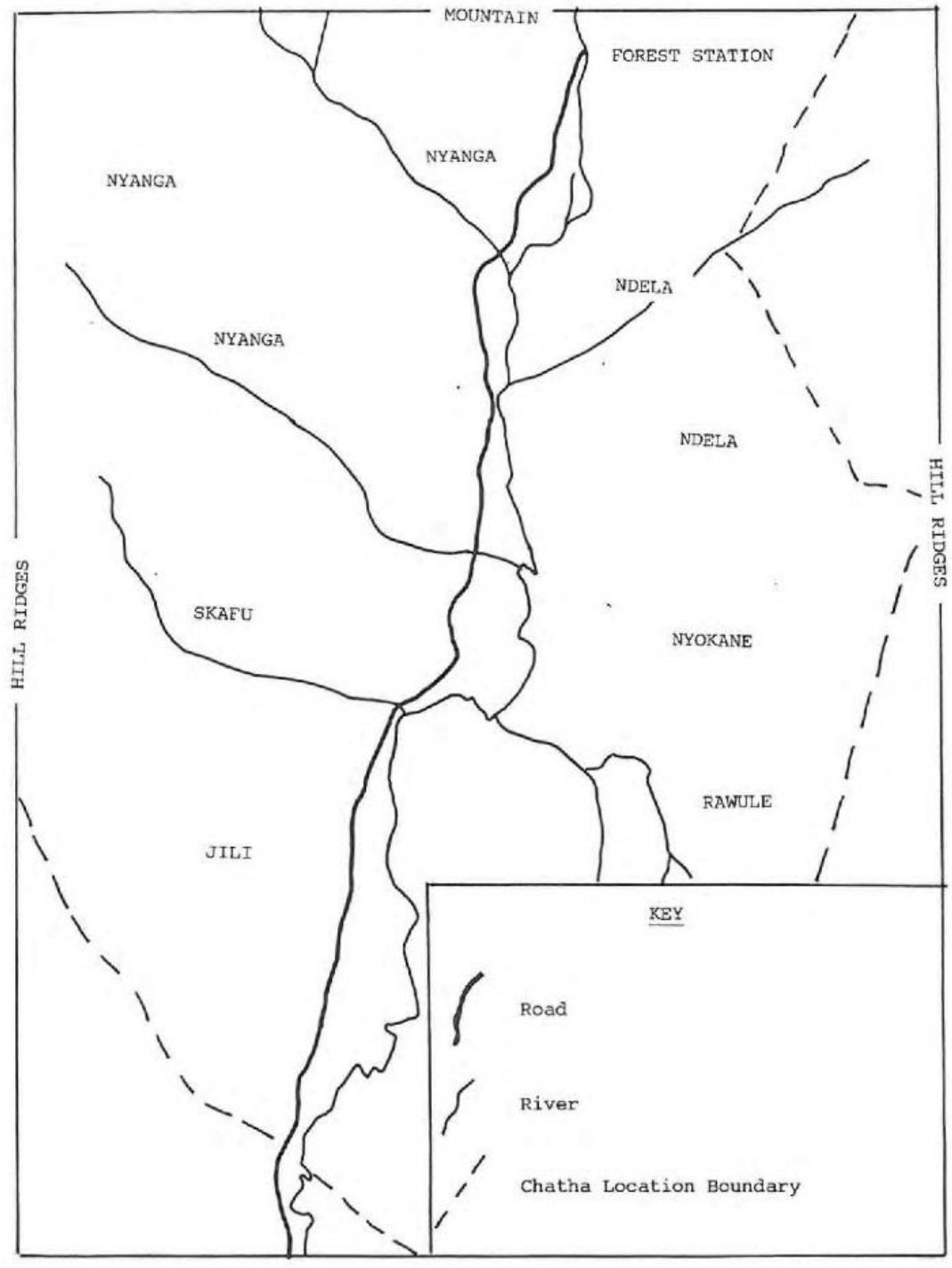

Figure 4.17: Map of Cata from de Wet 1985

Only gardens which could be clearly delineated were used for yield calculations. It is possible that there were additional less well-defined gardens within the research area. A full table of the yields for each of the 178 gardens

can be found in Appendix D. Figure 4.18 depicts the range of areas of the 178 gardens. The average surface area for the delineated gardens was 2 066.84 m².

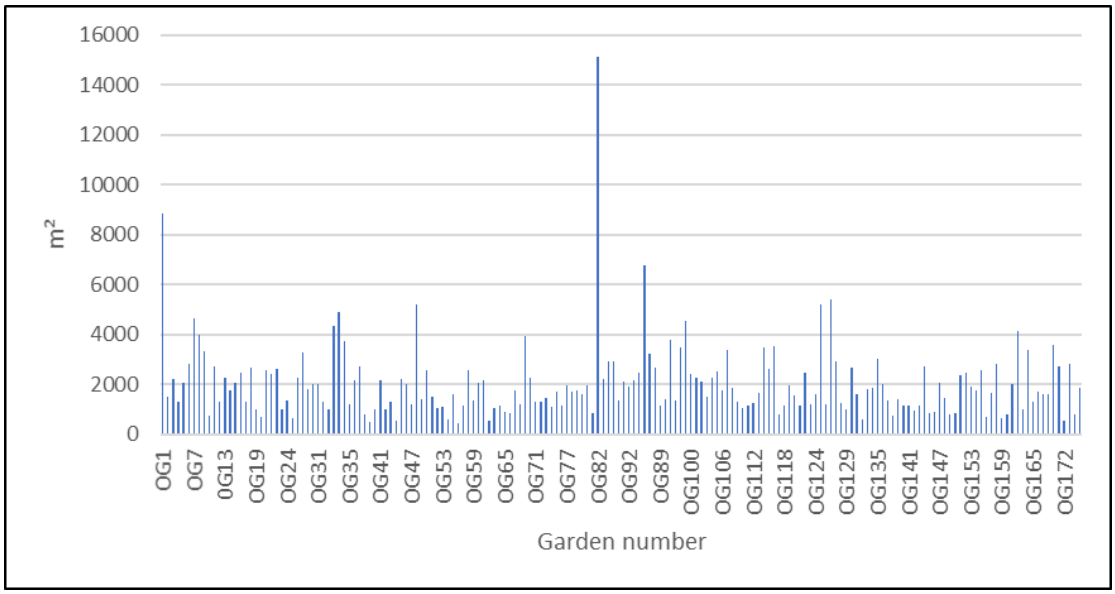

Figure 4.18: Graph depicting the surface areas calculated for the visible gardens in Cata

The figures depicted in the charts below are listed in Appendix D, and more detailed versions of these graphs are shown in Appendix E.

Three yield values were calculated for each garden for maize and sorghum production: a maximum average yield, a minimum average yield, and a yield calculated from production figures provided in the anthropological data. The reason for producing all three values is to generate a more reliable dataset of averages. Rainfall data and the historical variances in quoted production figures make it necessary to use a range, as the figures would vary greatly from year to year. Data for the figures utilised in the calculation of the maximum and minimum ranges were sourced from a combination of datasets provided by the Food and Agriculture Organisation of the United Nations (Deb *et al.* 2004; Deosthale *et al.* 2012; du Plessis 2008; Henshall 2016) and the International Food Policy Research Institute (Fermont & Benson 2011). Anthropological

yields (de Wet 1985) were listed in pounds cultivated per morgen. These were converted to kilograms per square metre to create a comparative dataset.

Figures 4.19, 4.20, 4.21 and 4.22, show that the anthropological figures fall just below midway between the maximum and minimum figures for maize and towards the lower range for sorghum yields.

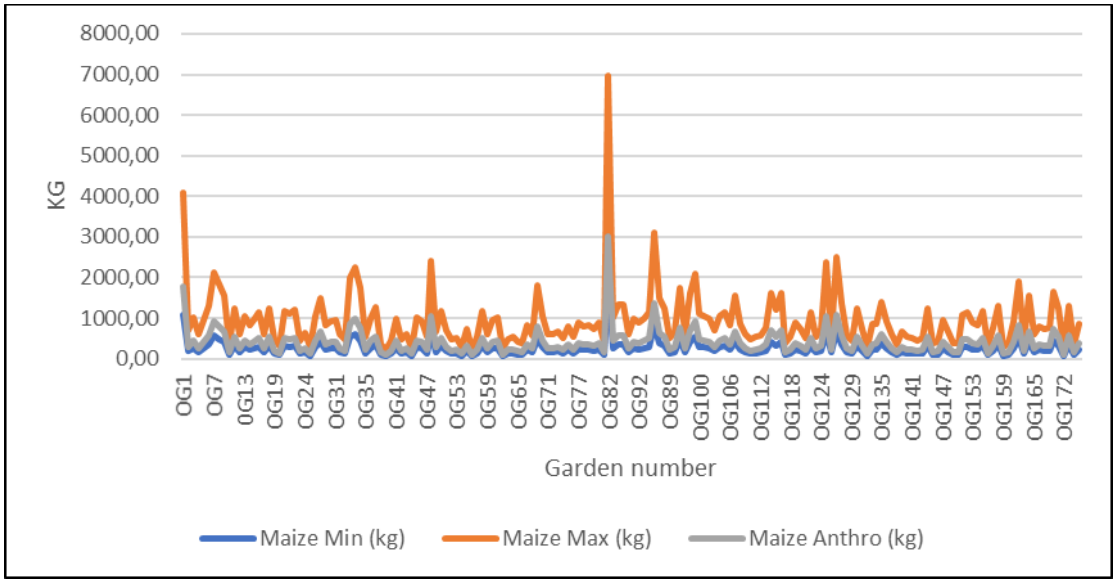

Figure 4.19: Chart depicting comparative maximum, minimum, and anthropologically based yield figures for maize production

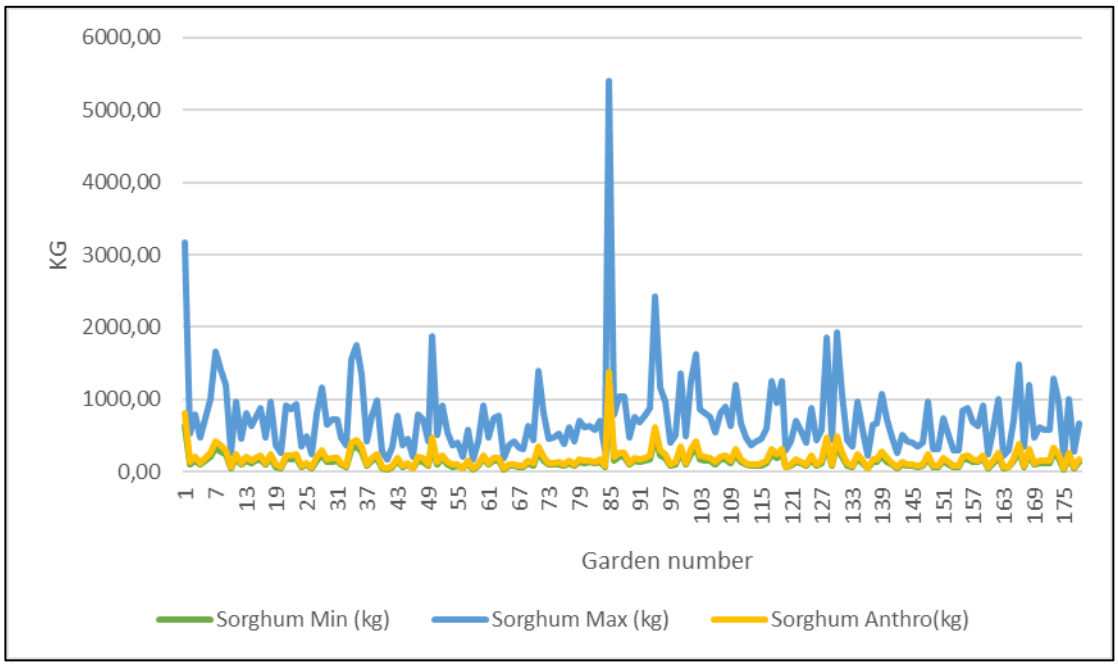

Figure 4.20: Chart depicting comparative maximum, minimum, and anthropologically based yield figures for sorghum production

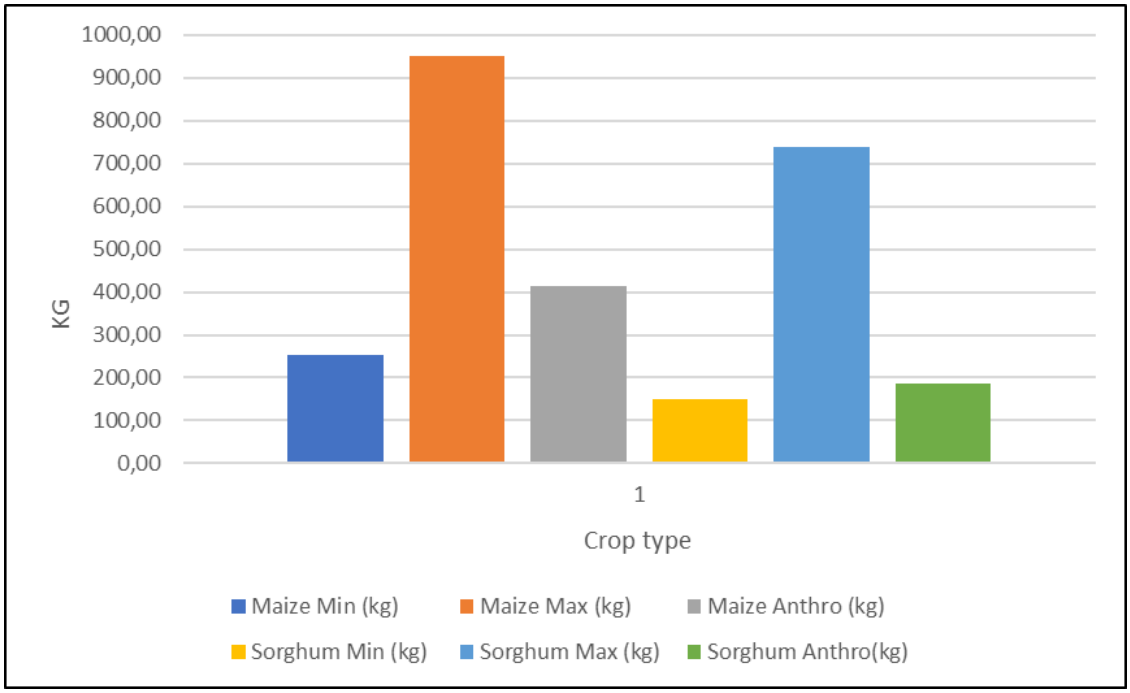

Figure 4.21: Chart depicting the mean maximum, minimum, and anthropological figures for 178 gardens mapped in Cata for sorghum and maize

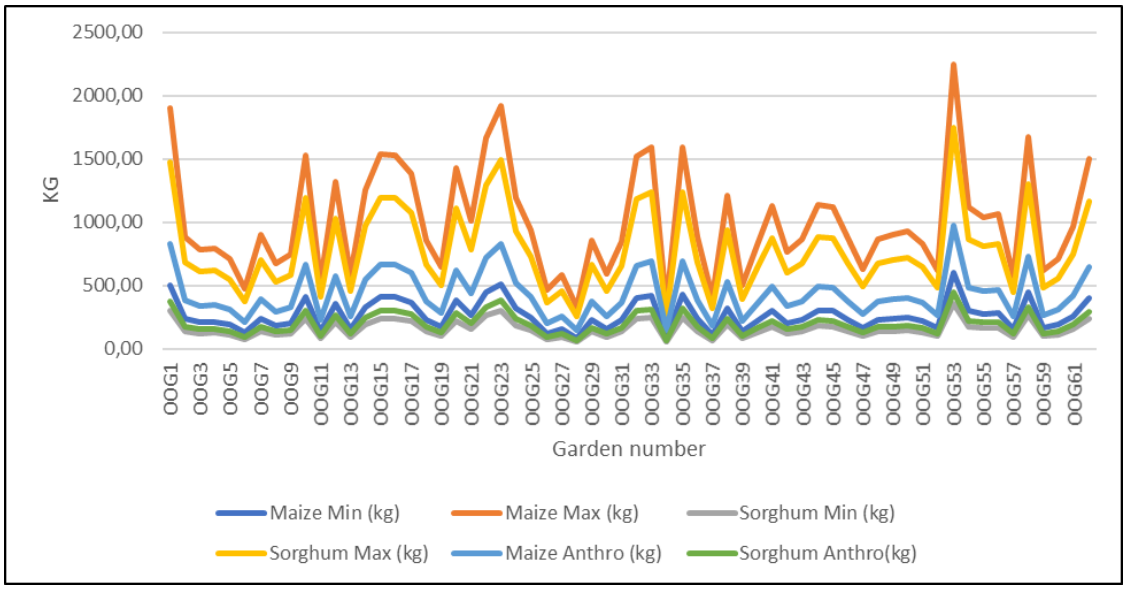

Figure 4.22: Chart depicting comparative maximum, minimum, and anthropologically based yield figures for outlying gardens for both sorghum and maize

Field yields were calculated by determining the total area assigned to field-based production as per de Wet's (1985) maps as well as the supporting anthropological and historical resources (de Wet 1985, 1995a; Mills & Wilson 1952). The total area allocated to field production was calculated at 7 795 346 m². Yields for maize and sorghum production (see Figure 4.23:) were then worked out in the same manner as for the gardens: maximum maize yield, minimum maize yield, maximum sorghum yield and minimum sorghum yield. These were compared to the anthropological yields [these are the yields calculated using production figures from de Wet's (1985) research]. Once again anthropological yields fall just below midway between the maximum and minimum figures for maize and towards the lower range for sorghum yields.

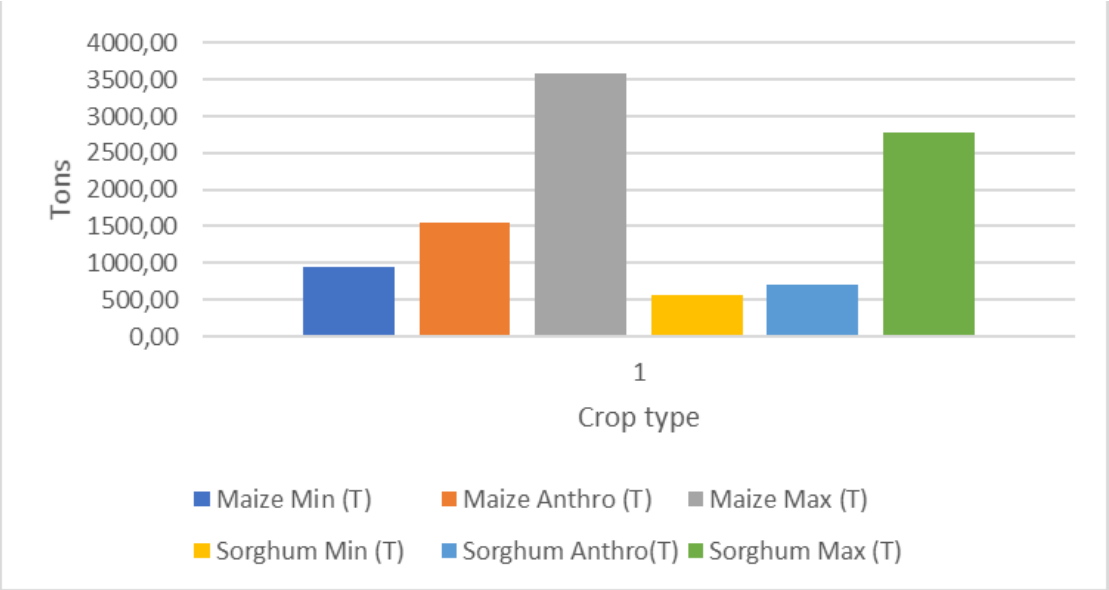

Figure 4.23: Chart depicting the mean maximum, minimum, and anthropological figures for total field area mapped in Cata for sorghum and maize

The figures produced in the tables below are based on the range of annual average consumption requirements for humans to survive (keeping in mind that different requirements exist for an individual depending on stage of development, level of activity, etc.) provided by the International Crops Research Institute for the Semi-Arid Tropics, ranging between 65 kg and 100 kg of carbohydrates per annum (Deb *et al*. 2004; Deosthale *et al*. 2012). The figures in Table 4.1 are based on the yields calculated for garden production.

Field production would have added to the available yield per household, but this figure could not be calculated as there is not enough available information about the field allocation per family. The average number of people per homestead ranges from 5.4 people (de facto figure provided by de Wet (1985) for the number of individuals in actual fulltime occupancy per household) to 7.28 people, giving a total population figure ranging between 2 325 and 2 732. The average number of people that each of the measured gardens could feed is shown in Table 4.2. Given that most hamlets had multiple gardens, this indicates that a significant portion of the required food could have been

produced by the gardens. This would have also been supplemented by field production.

Table 4.1: Table of proposed potential number of people sustainable according to yield produced from identifiable gardens

		Carbohydrate requirement per person per annum	
		65kg	100kg
Crop type (kg)	Maize (minimum)	690.87	449.07
	Maize (maximum)	2 603.60	1 692.34
	Maize (anthro)	1 129.62	734.25
	Sorghum (minimum)	406.39	264.15
	Sorghum (maximum)	2 021.28	1 313.83
	Sorghum (anthro)	513.47	333.76

Table 4.2: Average number of people a single garden measured could feed per annum at 65kg per person p/a and 100kg per person p/a

		Carbohydrate requirement per person per annum	
		65kg	100kg
Crop type (kg)	Maize (minimum)	3.88	2.52
	Maize (maximum)	14.63	9.51
	Maize (anthro)	6.35	4.13
	Sorghum (minimum)	2.28	1.48
	Sorghum (maximum)	11.36	7.38
	Sorghum (anthro)	2.88	1.88

4.5 Summary

This chapter presented the datasets that were created through mapping, yield calculations, and an examination of the anthropological and historical data. These datasets have been combined to create a base from which comparisons

can be drawn, in order to understand the changes that occurred over time as a result of Betterment Planning. The data outlines the potential ability for gardens to be a substantial means of production when considering the average needs of a household. The data also outlines the relationship between the social structure and the success of agricultural production.

In the following chapter, the same datasets are created for the period of occupation under Betterment Planning (post 1963).

Chapter Five – Betterment Planning spatial data

5.1 Introduction

This chapter presents spatial data on, and yield calculations for, the occupation of the Cata area during the implementation of Betterment Planning. The spatial data has primarily been produced by the utilisation of historical aerial imagery, satellite imagery, a ground survey of the area, and anthropological data.

5.2 Betterment in Cata

The anthropological research on Betterment Planning carried out predominantly focuses on two perspectives. The first is that of 'officialdom'. This was obtained through interviews and correspondence with government officials and the administrators of Betterment Planning, as well as through the study of official government documents. The second is the perspective of those who underwent Betterment Planning, i.e. the inhabitants of Cata. This was obtained through anthropological research (e.g. de Wet 1985, 1987, 1989, 1994, 1995a; Houghton 1955; Mills & Wilson 1952).

Three locations in Kieskammahoek were targeted by the government for the introduction of Betterment Planning: Catha, Gxulu, and Mnyameni. The proposal for the concept of Betterment Planning was presented to a small group of villagers, with the stated aim of improving crops and grazing – ultimately a gross misrepresentation of the full process. The initial agreement, between the Native Commissioner and a committee of selected individuals chosen by the people of Cata, was intended to fall under the provisions of Proclamation No. 31 of 1939 (see Bernstein 1998; de Wet 1985, 1987, 1989, 1994, 1995a; Hendricks 1989, 1990). This was later changed by the government, and the end result was an introduction of Betterment Planning under the terms and provisions set out by Proclamation No. 116 of 1949 (further influenced by the Tomlinson Commission). This change was significant as the

later terms allowed for the areas targeted to be divided according to function, specifically grazing, arable, and residential. This allowed for the removal of people from their land under the guise of restructuring for optimal functionality, and relocation to land deemed ‘more suitable’ according to terms laid out in Proclamation No. 116 of 1949 (de Wet 1985; McAllister 1989; Ngcaba 2002; Seneque 1982; Yawitch 1981).

The official report compiled by the government planning committee justified the reallocation of land based on the results of surveys conducted on the area in terms of population, soils, topography, agriculture, and existing infrastructure. These surveys (Report on Cata Location, 1952 by the planning committee) concluded that the land was overgrazed, and slopes used for cultivation needed to be removed due to ‘erosion concerns’ (de Wet 1985; Hendricks 1990; Viedge 2001). Based on these findings, several changes to the proposed Betterment Plan were put forward, starting with the creation of eight grazing camps for cattle. Any remaining arable land would be divided into one-morgen lots. Following this, a suggested cull of cattle from 1 256 to 740 animals was proposed, among a list of other adjustments.

The headman of Cata submitted objections to the land size and extreme nature of the cull, and raised concerns around the demolition of the mission school.

Cattle played a dual role in Cata society. Firstly, on a practical level, milk-producing cows were a valuable resource for families, reducing the amount of money needed to sustain a family’s basic needs. They were also used for ploughing fields. Secondly, cows were an integral part of how one’s wealth and status was measured in pre-colonial African societies. They had a central role in marriage rituals as well as other social and political transactions. The forced reduction of cattle numbers was therefore quickly rejected by the Cata community (de Wet 1985, 1989, 1994, 1995a).

These grievances, as well as those raised by the surrounding communities, were considered in the report (Report on Chatha Location) submitted by the Native Commissioner in 1958. The report highlighted potential agricultural issues if land allotments were not increased. Additionally, soils would need manure for fertilising. This would have been an issue if the proposed cull would have been carried out, as manure was produced by combining organic waste from household consumption with livestock manure. The greatest concern raised in this report was around the lack of basic facilities if the plan were to be implemented. The report concluded that the plan had a high probability of resulting in a slum occupied by women, children, and the elderly, as the able-bodied men would be forced to find migrant work. The concept of creating a forestry town in Cata, supported by irrigated gardens, was put forward as a means to avoid negative outcomes and a worsening economy for the village (de Wet 1985, 1989, 1991, 1994, 1995a; Nieuwenhuysen 1964).

While it appears as though some thought was given to this and other potential solutions, Betterment Planning in Cata, and the rest of South Africa, ended up being implemented amid a wave of vague answers and haphazard plans in the years that followed (Hendricks 1990; McKenzie 1989; Ngcaba 2002; Platzky & Walker 1985). In 1958, the conditions of the scheme were reconsidered by the Chief Native Commissioner. Land allocations were proposed based on economic units, resulting in a suggestion that one-and-a-half morgen be allocated per family for those who had already owned land and two cattle units. This proposal included the creation of a township to house the ‘surplus’ families that could not be accommodated in this scheme (de Wet 1985; Hendricks 1990; McKenzie 1989; Ngcaba 2002; Platzky & Walker 1985).

This proposal was short lived, as no township ever materialised, resulting in the resizing of designated lots to half-morgen blocks. These were demarcated between 1961 and 1962, along with the erection of boundary fencing. The allocation of land was carried out haphazardly, resulting in the separation of

family units that had comprised the original hamlets. Field allocations were done in the same problematic manner. Many people lost rights to arable land and those who obtained it received fractional portions of what they had once had (de Wet 1985, 1995a, 2011, 2012). With the exception of 24 families that were involved in a small-scale irrigation project, the majority of people lost out on land (de Wet 1985). According to the interviews carried out by de Wet (1985), it appears that the greatest issues the community had were the separation of kinship units and the great reduction in land size. This resulted in increasing tensions between different groups, often resulting in fighting between neighbours in the Betterment settlement (de Wet 2012:402). This was problematic given that neighbouring women had previously combined resources to compensate for the lack of able-bodied men in the village on a permanent basis to carry our labour-intensive agricultural tasks. Poor relations between neighbouring households and the separation of families across the villages became made it difficult for those who were residing in the household (predominantly the women and children) to adapt in order to maintain arable land (de Wet 1985). The process of moving all of the residents into the new demarcated zones was slow, as residents had to save to build new houses. The majority of the relocation was only completed by 1967.

5.3 Settlement patterns

Aerial and satellite imagery from 2006 onwards was used in order to map the locations of new visible gardens (the reasons for this have been discussed in chapter three). Since Betterment Planning aimed to ‘organise’ the inhabitants of the villages chosen for its implementation (de Wet 1985; Hendricks 1990), land was dived according to function: grazing, residential, and agricultural (see Figure 5.1). I will show that the planning of this village did not take into account the impact of slope, the location of homesteads in relation to basic amenities, and realistic soil compositions, on the day-to-day functions of Cata’s inhabitants.

Previously, locations were favoured for their close proximity to sources of wood and water. Flatter slope sections had been predominantly inhabited, with steeper sections of the valley wall being used for fields (see Figure 4.9 and Figure 4.12). This was reworked during Betterment Planning, as can be seen in Figure 5.1 (also see Appendix F for larger figures).

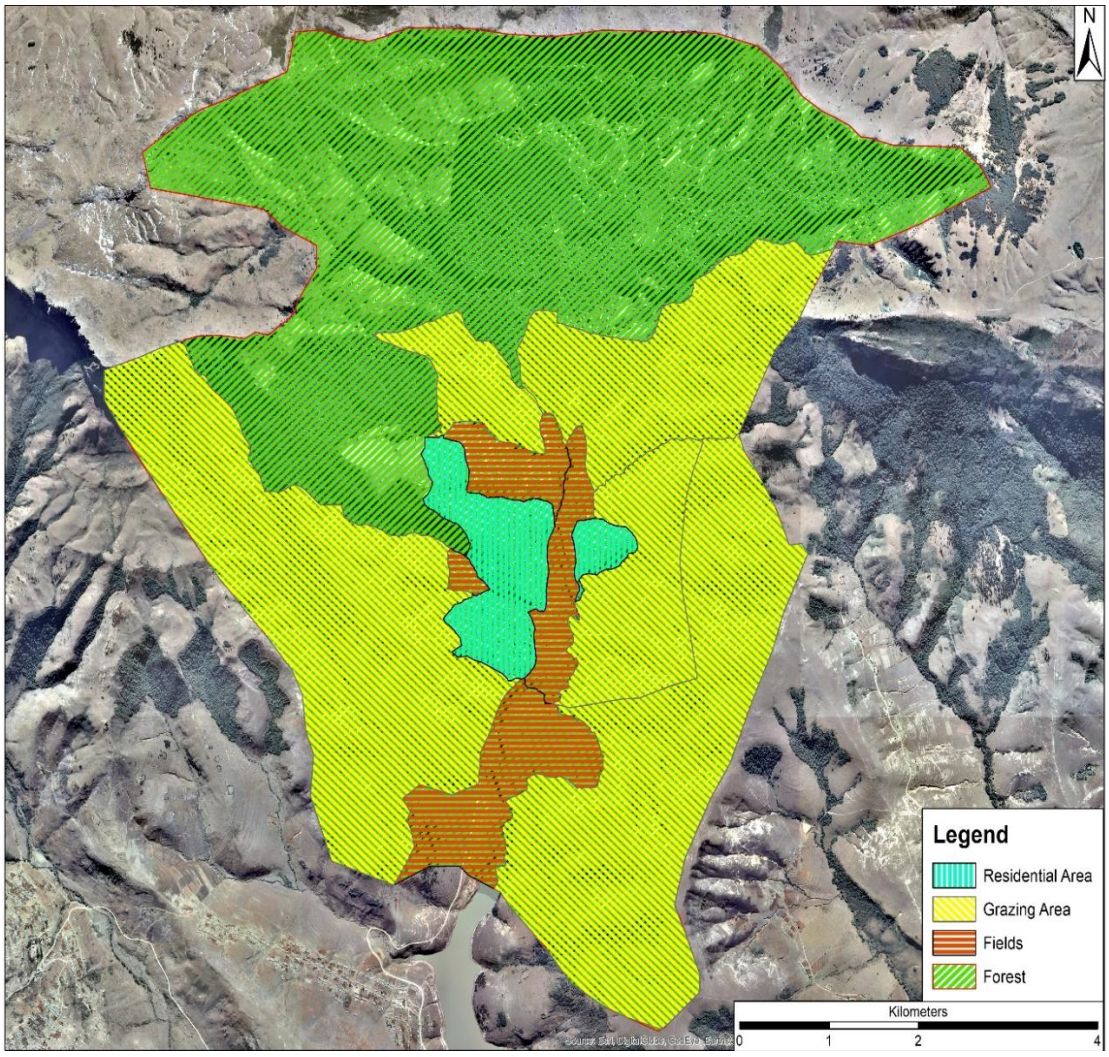

Figure 5.1: Map of Cata showing division of land use after Betterment Planning (interpreted from de Wet 1985) (ArcGIS)

Residential areas were restructured, resulting in houses and their gardens being placed directly next to one another in a grid-like pattern (see Figure 5.2).

Land that until 1963 had been used as gardens, livestock pens, and fields, accounted for the bulk of the land allocated for residential use (see Figure 4.9 and Figure 4.12). Houses were built in strips along one side of the property with gardens directly next to them, as was the case in the original hamlets (as discussed in chapter four). Where individuals had control over the way their space was used, there appears to have been an attempt at replicating as much of the previous spatial layout as possible. Some properties dropped fences to maximise useable space. This was common practice in the instances where families had been able to acquire neighbouring plots (de Wet 1985, 1995a).

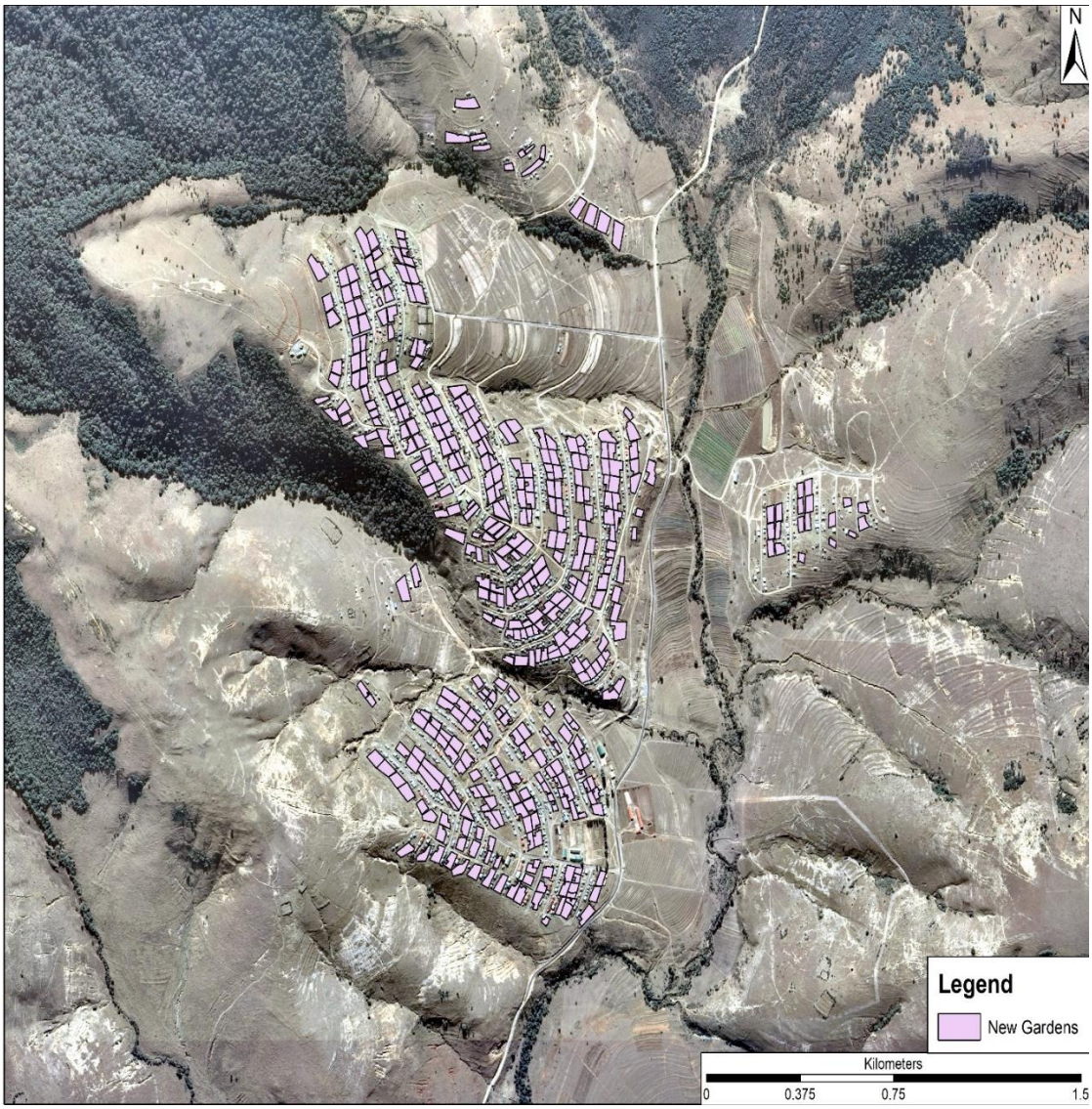

Figure 5.2: Aerial imagery illustrating mapped locations of gardens (QGIS)

Many of the women and children occupying these homesteads now had to travel much further to access water and collect wood, putting further strain on the inhabitants. Those who had been placed in the more central section of the village faced greater challenges with regards to access to water, wood, and roads, depending on where in the village the homestead was located. Proximity to grazing and field sections also shifted, as these also became more generalised. The grazing land available was divided into fenced camps. These were located along the top sections of the valley walls bound by forest on some

of the boundaries, as indicated in Figure 5.3. The bulk of the newly allocated grazing land lay over the old residential area. This was no longer always convenient as it lay on the upper sections of the valley opposite the bulk of Cata's residential land.

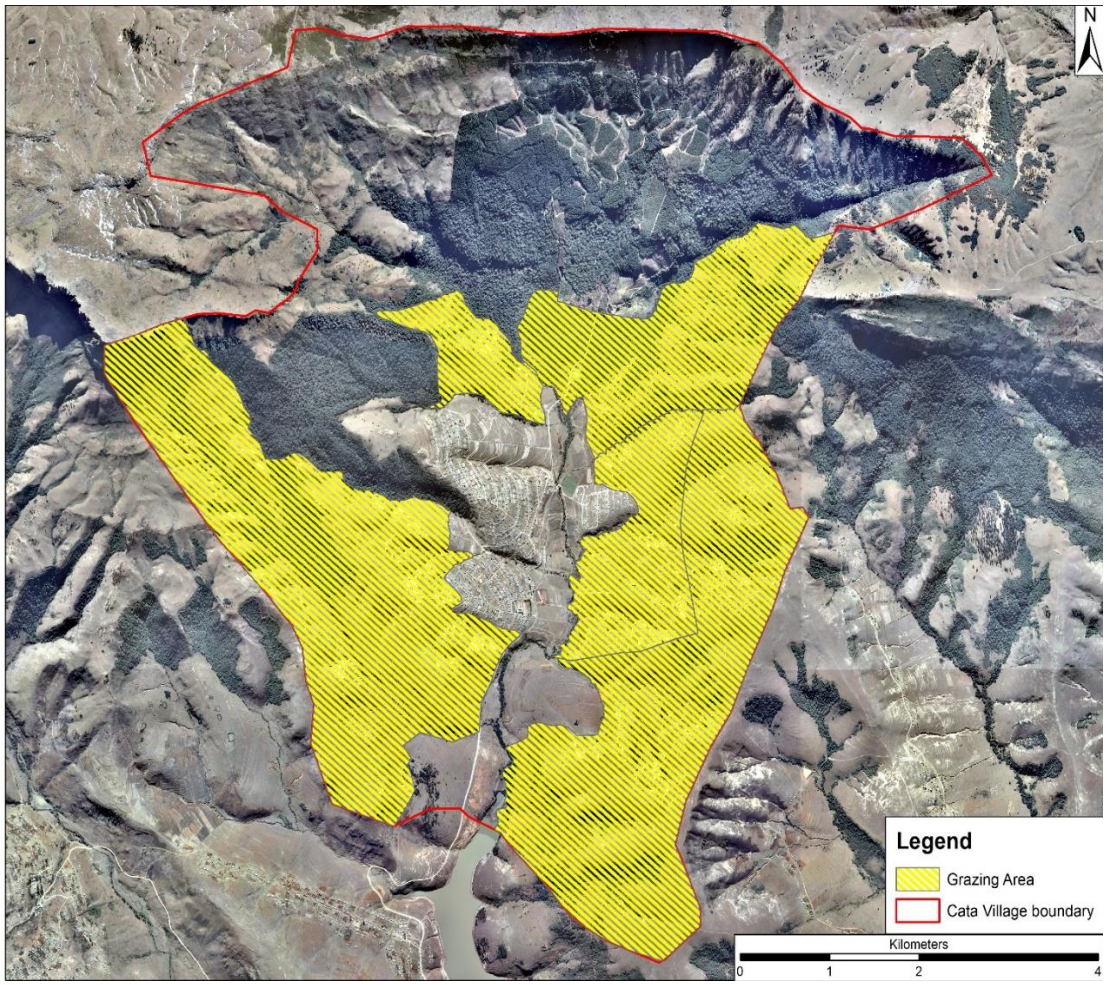

Figure 5.3: Aerial imagery illustrating mapped locations of grazing areas (QGIS)

Fields were also reallocated. They were moved downslope, with many of them located along the river, up some sections of the hill, or moved up from the road located at the base of the valley. The allotted land was a smaller fraction (67% less) compared to the previous land resources available (see Figure 5.4). The few higher sections of dry, arable land were eventually used as residential

space. During our field visit, fields not being cultivated anymore lining the Cata River were noted.

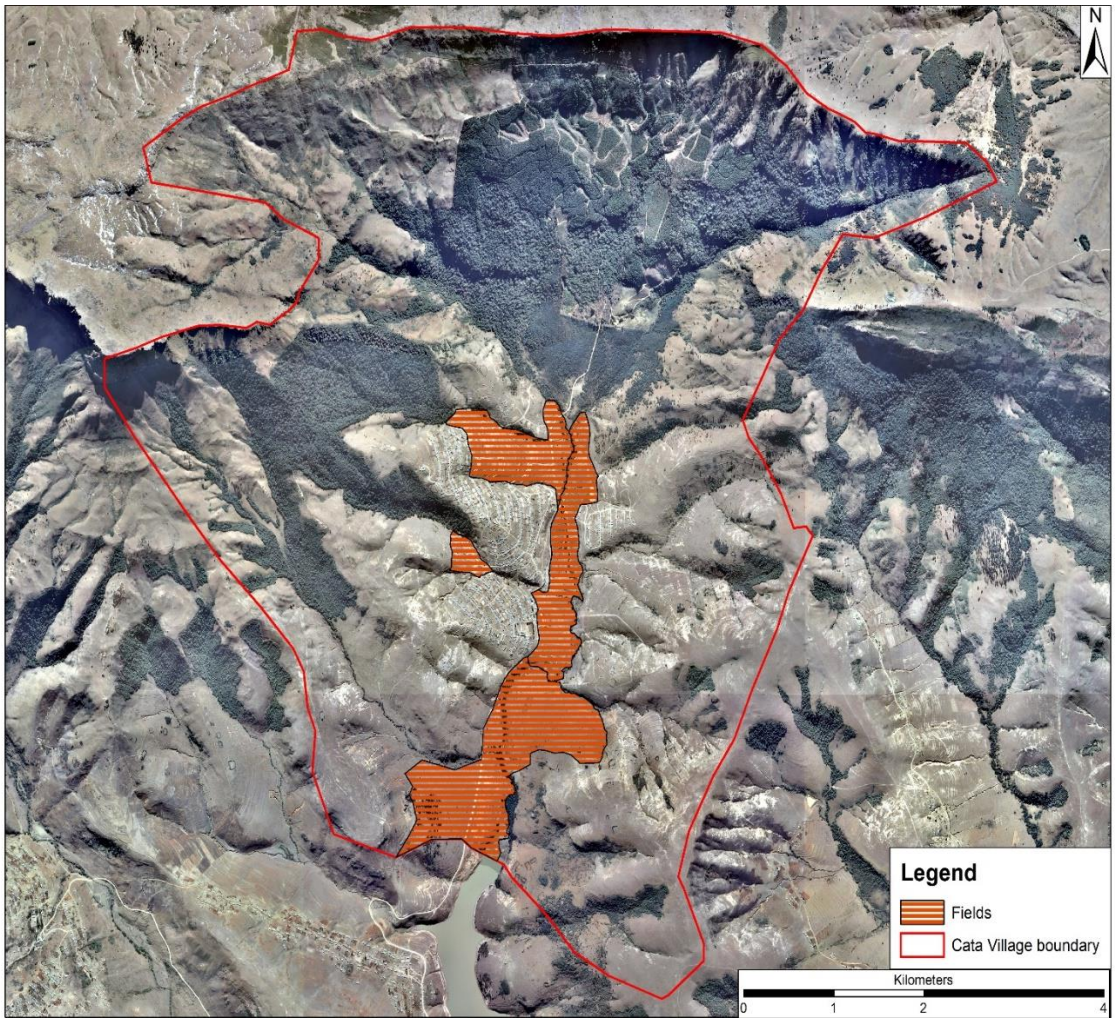

Figure 5.4: Aerial imagery illustrating mapped locations of fields (2006)(QGIS)

5.4 Yield calculations

I produced a range of estimated yields for the village of Cata after the implementation of Betterment Planning. This involved identifying all visible gardens, calculating their surface areas, and creating a range of potential yields for cereal crops that were known to be produced. These figures were compared

to the estimated figures put forward by de Wet (1985, 1995a) for maize and sorghum production.

During the course of Betterment Planning, many people lost access to their once-cultivated fields. Those who did not completely lose access received much smaller field allotments, and many of these sites were eventually abandoned. Gardens, although also greatly reduced in size, still offered some hope in terms of potential production (de Wet 1985, 1995a).

A total of 418 visible gardens were identified on the east and west sections of the valley wall within the boundary of Cata, as defined by the maps produced by de Wet (1985,1995a) (see Figure 5.5). The majority of these are located on the west wall. It must be noted that some of these gardens and homesteads may have been added in the post-Betterment phase. It is impossible to know, as the earliest available useable imagery following the completed relocation is from 2006.

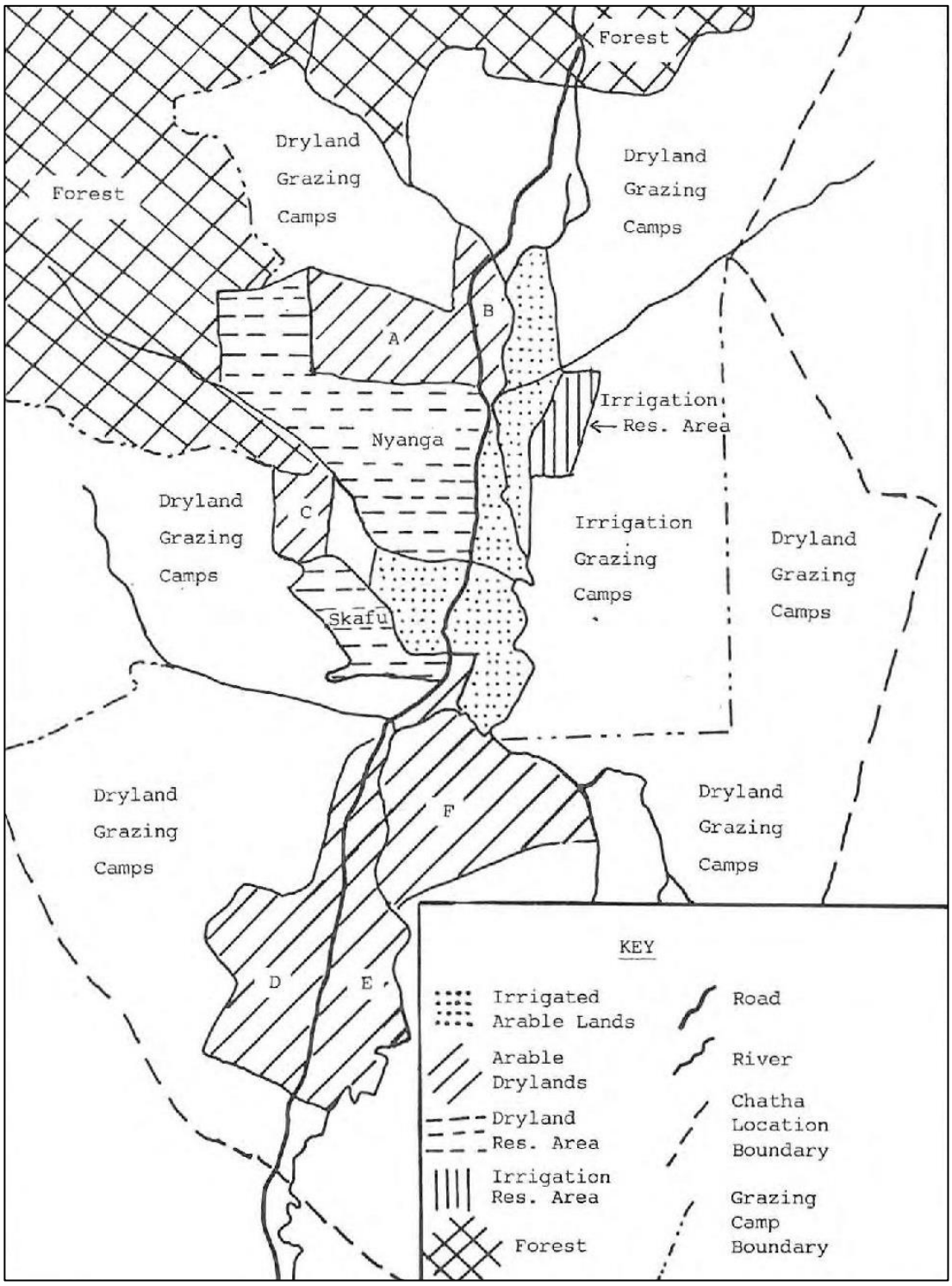

Figure 5.5: Map of Cata after Betterment from de Wet 1985

Only gardens that were visible in the aerial and satellite imagery were mapped. It is possible that more gardens existed. A full table of the area and yields for

each of the 418 gardens can be found in Appendix G. Figure 5.6 depicts the range of areas of the 418 gardens. The average surface area for the delineated gardens was 1 014.05 m².

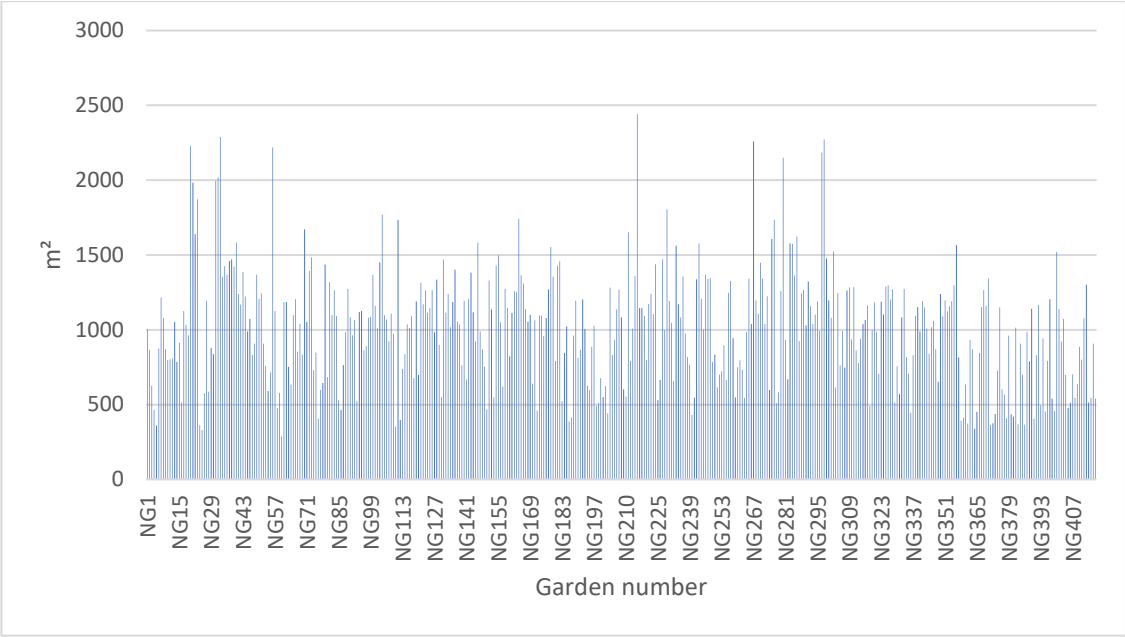

Figure 5.6: Graph depicting the surface areas calculated for the visible gardens in Cata

The figures depicted in the charts below are listed in Appendix G and more detailed versions of these graphs are shown in Appendix H.

Three sets of figures were calculated for each garden for maize and sorghum production: a maximum average yield, a minimum average yield, and a yield based on figures provided in the anthropological data (these are the yields calculated using production figures from de Wet's (1985) research). Data for the figures used to calculate the maximum and minimum range were sourced from a combination of datasets provided by the Food and Agriculture Organisation of the United Nations (see Deb *et al.* 2004; Deosthale *et al.* 2012; du Plessis 2008; Henshall 2016) and the International Food Policy Research Institute (Fermont & Benson 2011). Anthropological yields were listed in

pounds cultivated per morgen. These were converted to kilograms per square metre to create a comparative dataset.

As can be seen in Figures 5.7, 5.8 and 5.9:, anthropological figures fall in the lower quartile of the maximum and minimum range figures for sorghum and below the halfway mark of the range for maize yields. This means that it is likely that production figures were in the lower quartile of the range estimated for maize and sorghum production.

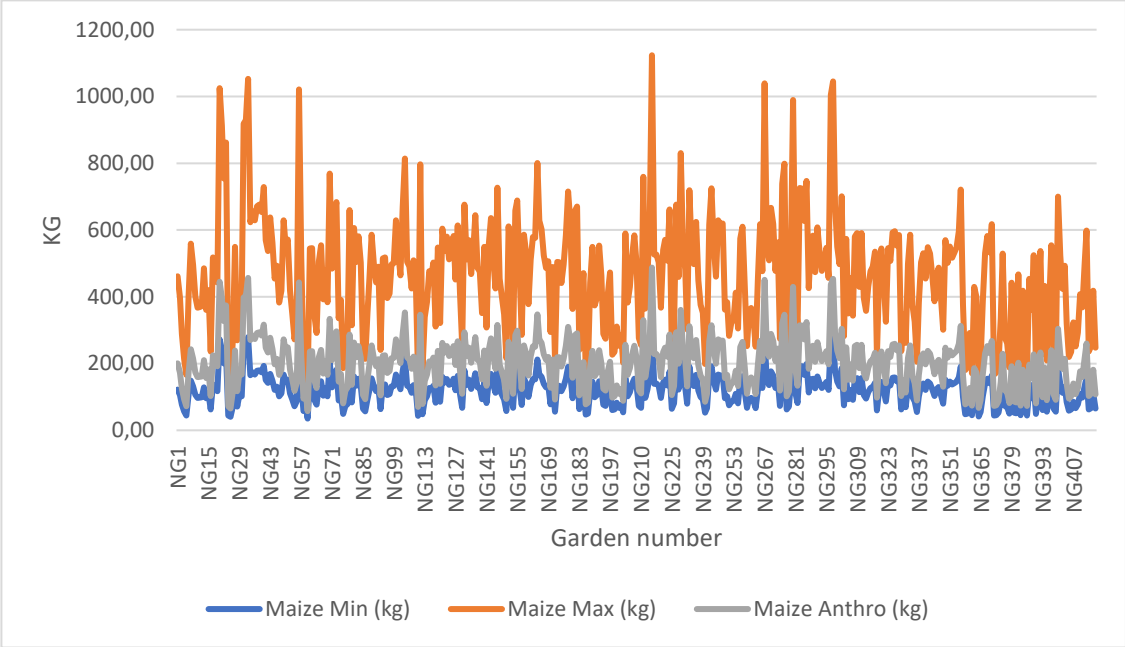

Figure 5.7: Chart depicting comparative maximum, minimum, and anthropologically based yield figures for maize production after Betterment Planning (from satellite imagery (2006))

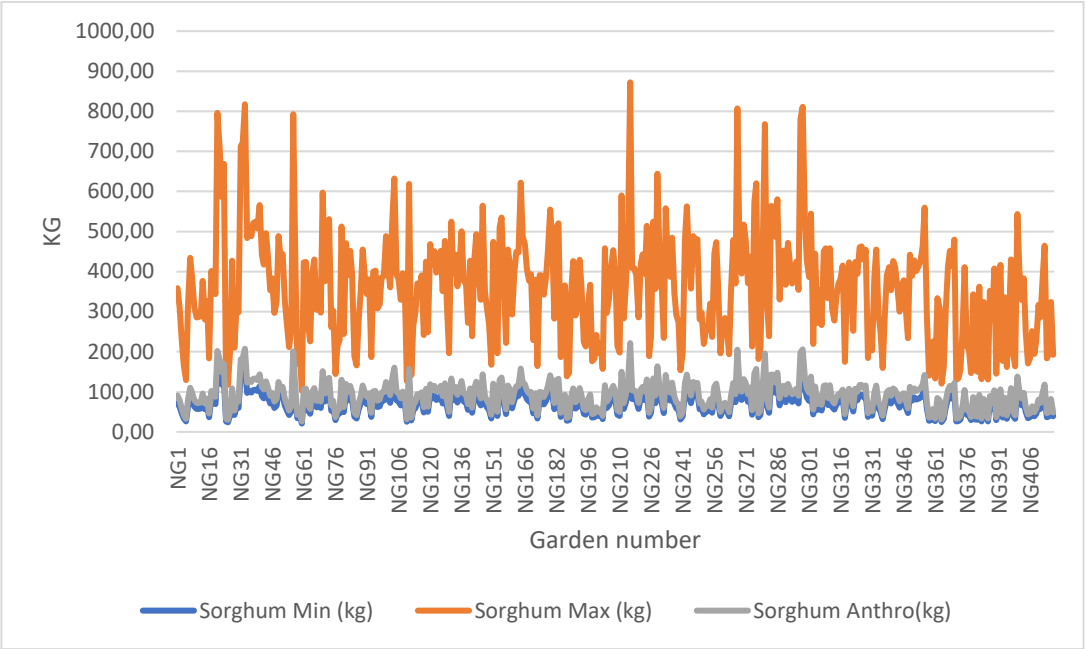

Figure 5.8: Chart depicting comparative maximum, minimum, and anthropologically based yield figures for sorghum production after Betterment Planning (from satellite imagery (2006))

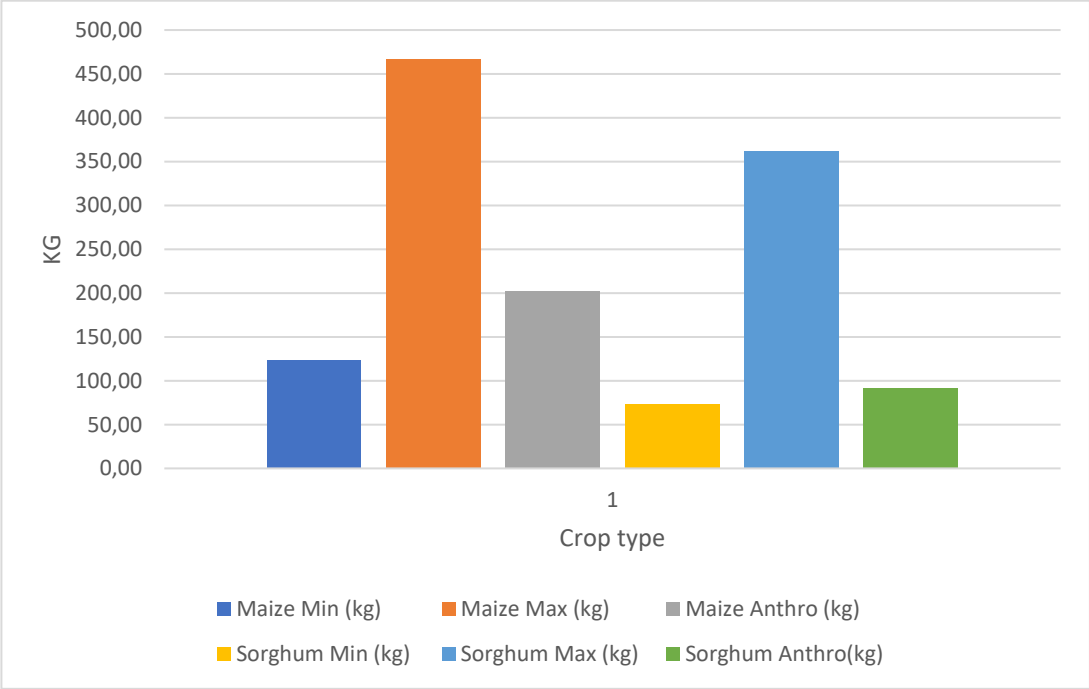

Figure 5.9: Chart depicting the mean maximum, minimum, and anthropological figures for 178 gardens mapped in Cata for sorghum and maize

Field yields were calculated by determining the total area assigned to field-based production as per de Wet's (1985) maps. The total area allocated to field

production after Betterment Planning was implemented was calculated at 2 543 399 m². Yields for maize and sorghum production (see Figure 5.10:) were then worked out in the same manner as for the gardens: maximum maize yield, minimum maize yield, maximum sorghum yield, and minimum sorghum yield. These were compared to the anthropological yields (these are the yields calculated using production figures from de Wet's (1985:157) research). Once again anthropological yields fall just below midway between the maximum and minimum figures for maize and towards the lower range for sorghum yields.

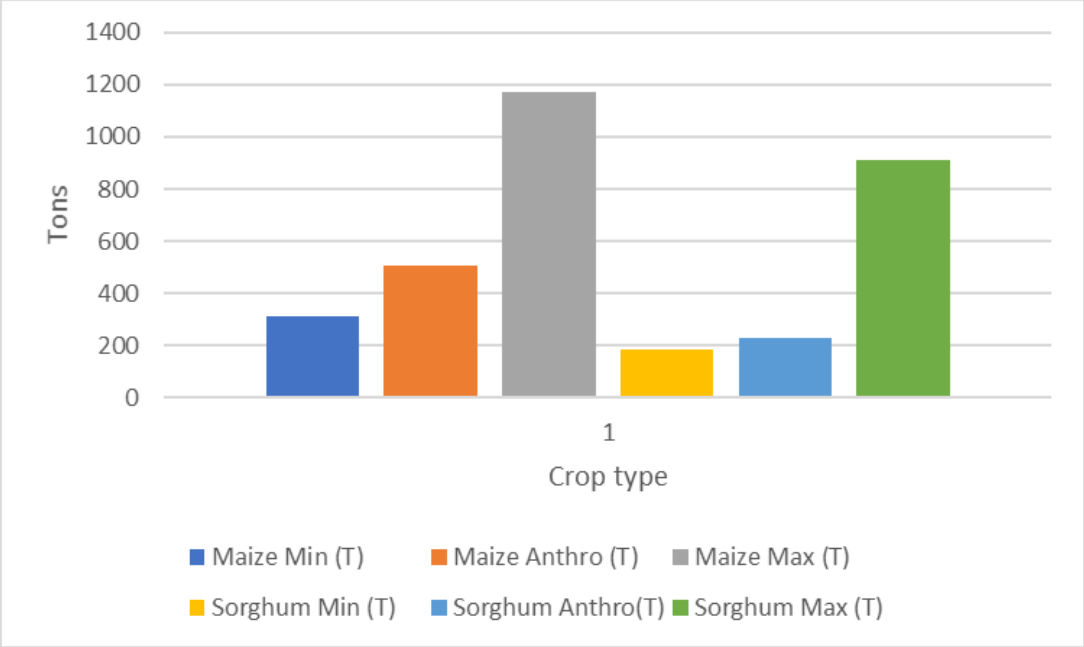

Figure 5.10: Chart depicting the mean maximum, minimum, and anthropological figures for total field area mapped in Cata for sorghum and maize for post-Betterment fields

The figures produced in the table below are based on the range of annual average consumption requirements for humans to survive (keeping in mind that different requirements exist for an individual depending on stage of development, level of activity, etc.) provided by the International Crops Research Institute for the Semi-Arid Tropics, ranging between 65 kg and 100 kg of carbohydrates per annum (Deb *et al*. 2004; Deosthale *et al*. 2012). The figures in Table 5.1 are based on the yields calculated for garden

production. Field production would have added to the available yield per household, but this figure could not be calculated as there is not enough available information about the field allocation per family. De Wet (1985) did a survey of the village during his research and provided the following figures: the average number of people per homestead was stated as 7.98 people to 7.28 people per household giving a total population figure ranging between 3 144 and 3 477. The average number of people living at home on a permanent basis was 6.26, with 1.72 people working away from home. Total population figures range between 2 505 and 3 448. The average number of people each of the measured gardens could feed is shown in Table 5.1. This shows an average decrease of 49% in potential production compared to pre-Betterment figures.

Table 5.1 Average number of people gardens measured could feed per annum at 65kg per person p/a and 100kg per person p/a

		Carbohydrate requirement per person per annum	
		65kg	100kg
Crop type (kg)	Maize (minimum)	1.90	1.24
	Maize (maximum)	7.18	4.66
	Maize (anthro)	3.11	2.02
	Sorghum (minimum)	1.12	0.73
	Sorghum (maximum)	5.57	3.62
	Sorghum (anthro)	1.42	0.92

5.5 Changes in land areas

Land area pre-Betterment and post-Betterment changed drastically. This is particularly clear when comparing field and garden allocations. The mean area for post-Betterment gardens amounts to 49% of the pre-Betterment mean (see Figure 5.11:). Similarly, field allocations post-Betterment covered only 33% of the area previously allocated to fields (see Figure 5.12:). This decrease in land

had serious consequences for agricultural production and the economic needs of the household.

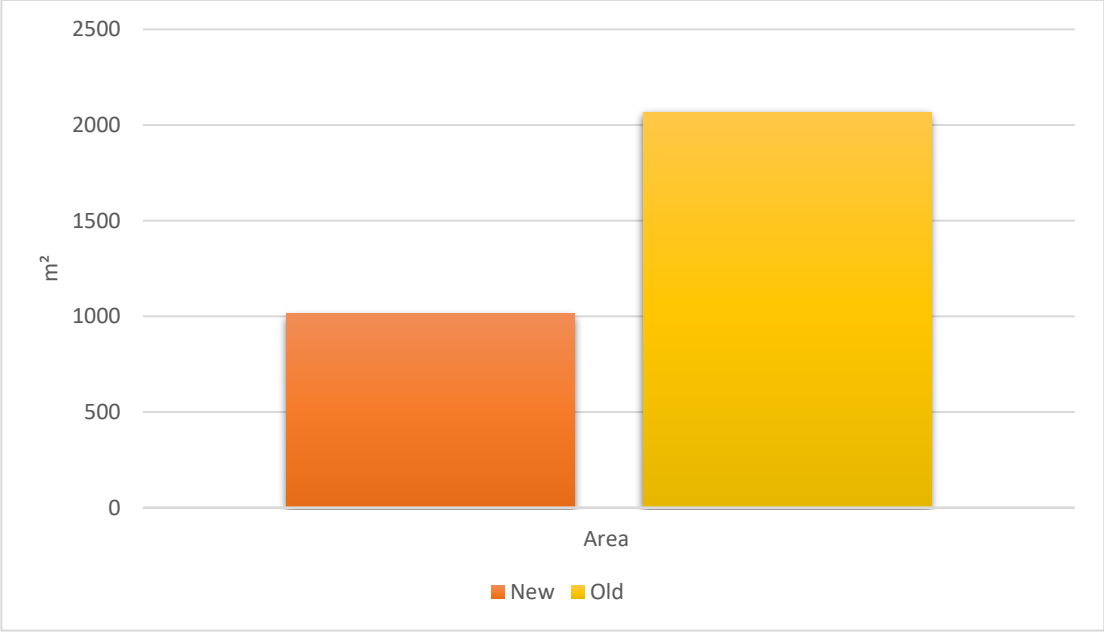

Figure 5.11: Chart depicting comparative mean areas for pre- and post-Betterment gardens in Cata

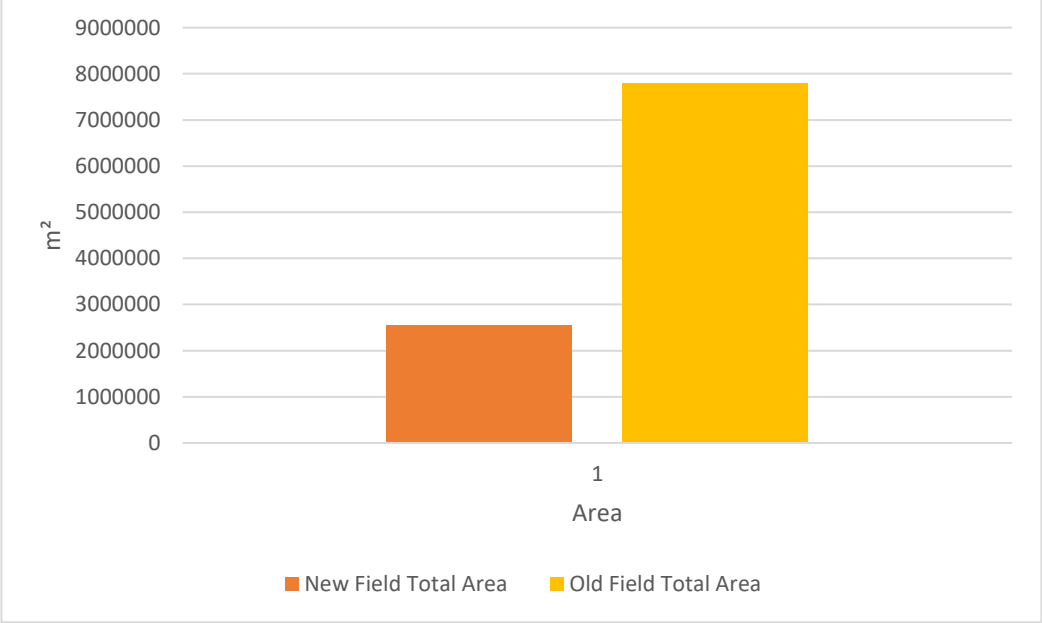

Figure 5.12: Chart depicting comparative mean areas for pr-e and post-Betterment fields in Cata

5.6 Summary

This chapter presented the datasets that were created through mapping, yield calculations, and an examination of the anthropological and historical data. These datasets have been combined to create a comparative to the data presented in chapter four. The decrease in available arable land has been presented and discussed (comparing this data with population requirements), providing empirical data to aid discussions on the negative impact of Betterment Planning.

The following chapter compares the datasets from chapters four and five, and also discusses the long-term environmental impact of the changes brought about by Betterment Planning.

Chapter Six – The long-term impact of Betterment Planning

This chapter presents spatial data for the period post 1994, and highlights the long-term impact of Betterment Planning. The data produced for the periods before and after the implementation of Betterment Planning will be compared.

6.1 Settlement patterns

Post-Betterment settlement patterns are condensed in terms of space, distribution and location (see Figures 6.1, 6.2 and 6.3; see Appendix I for larger versions of these images; also see Appendix J). The post-Betterment settlements follow a rigid predetermined layout and only allowed a few lucky homes to be located near water and wood resources. Water was sourced from the Cata River and its tributaries. Wood resources come from the forested areas, meaning that those living in the residential sites located at certain sections of the foot of the valley had a long walk to collect wood.

The most significant changes to the settlement patterns are the surface area allocated to each individual. Before the implementation of Betterment Planning, few limitations had been placed on residential land, allowing large gardens and large spaces between neighbours (see de Wet 1985; Mills & Wilson 1952). In 1985, when de Wet was doing fieldwork, the post-Betterment settlement design resulted, on average, in a downsizing of garden areas by more than 50%. Neighbours were also now only separated by a fence (de Wet 1985). Close confined spaces and limited arable land had the potential for serious consequences across a variety of social and physical aspects of daily life in Cata.

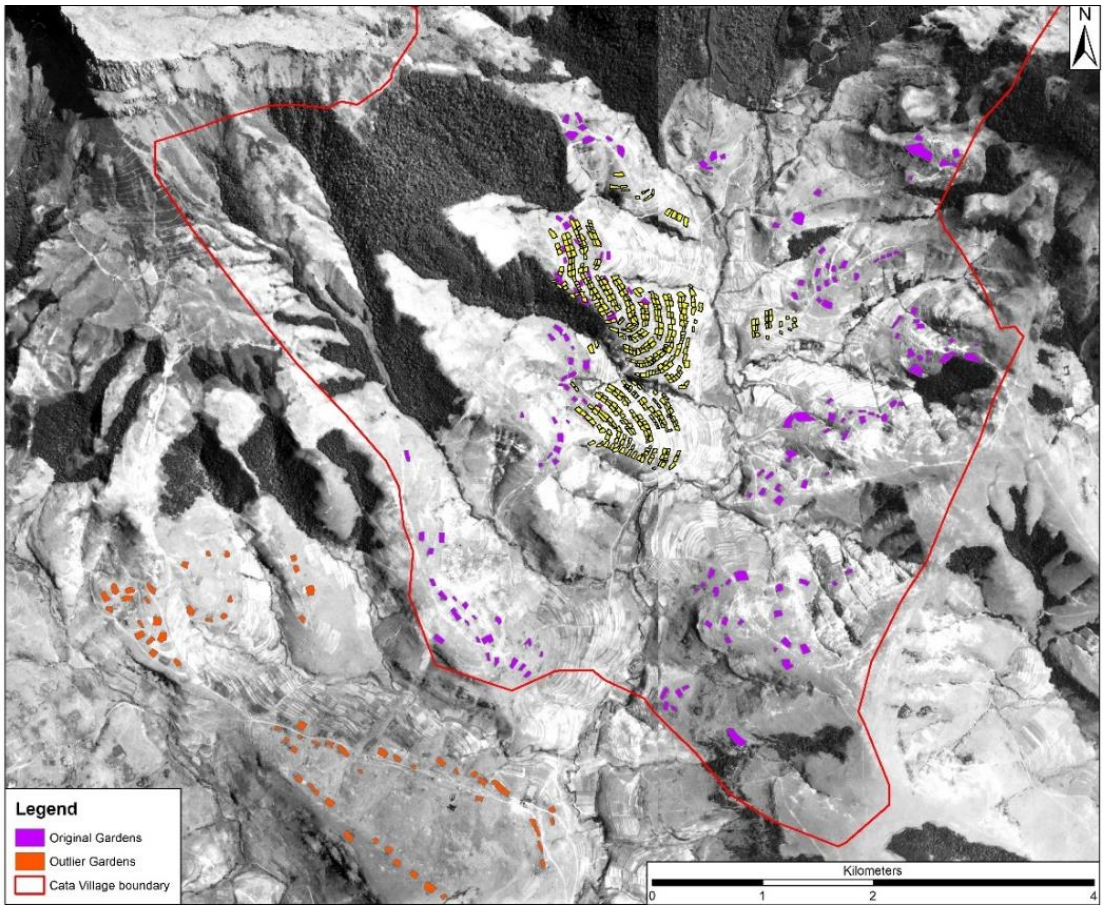

Figure 6.1: Aerial imagery illustrating mapped locations of gardens pre- and post-Betterment (1964) (QGIS)

During the third phase of occupation, additional “outlying” gardens were added. These break away from the structured grid pattern laid out by Betterment Planning. They are situated around basic amenities such as areas where wood and water could be collected, in order to make it easier to carry out basic tasks. The outlying gardens are also significantly larger than the Betterment gardens and are more organically built according to the natural flow of the landscape (see Figure 6.2).

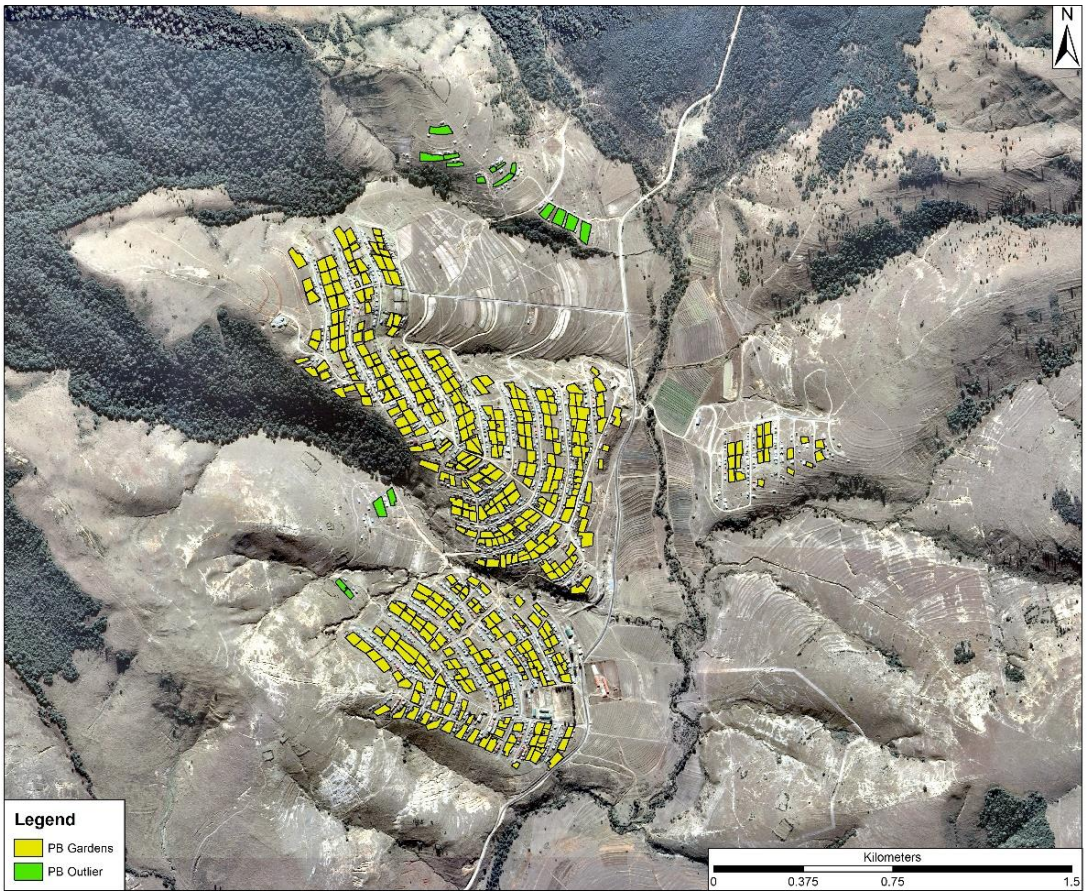

Figure 6.2: Aerial imagery illustrating mapped locations of post-Betterment gardens indicating outliers (QGIS)

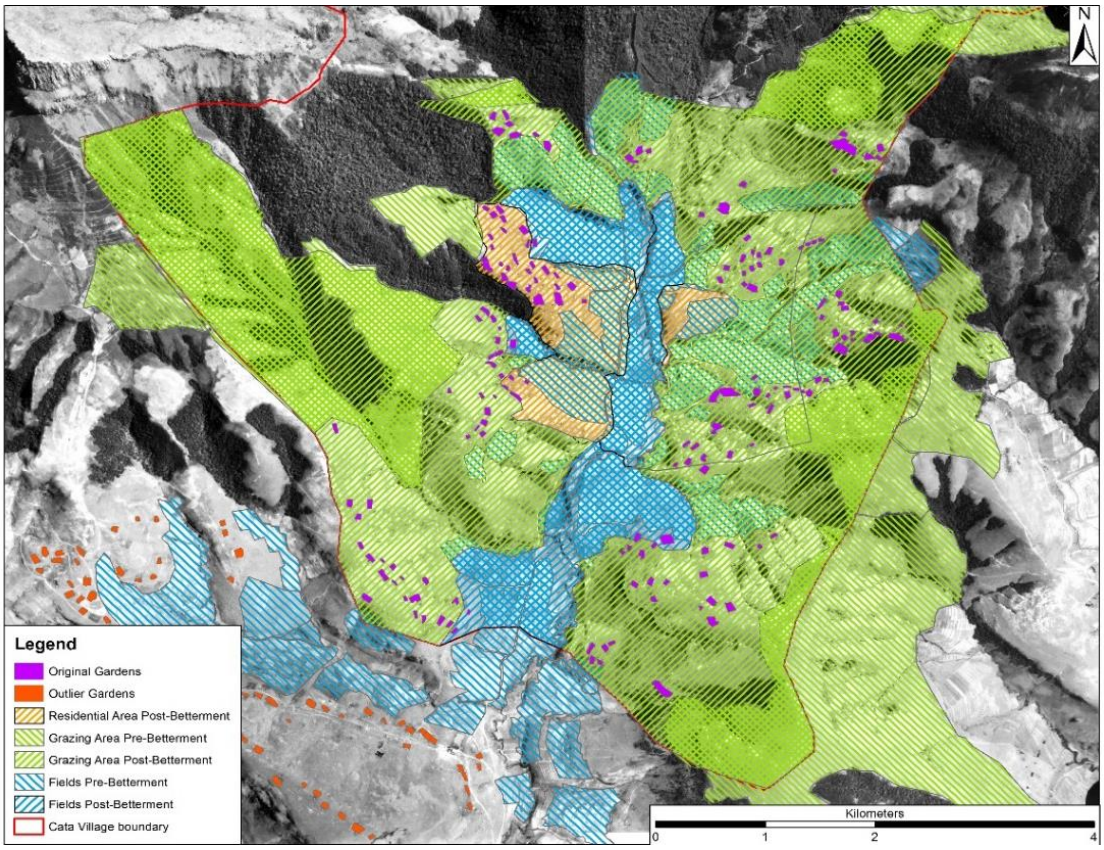

Figure 6.3: Aerial imagery illustrating pre- and post-Betterment gardens, fields, and grazing areas (1964) (QGIS)

Land designated for crop production in cultivated fields also changed significantly. Delineated fields covered almost 70% less surface area post-Betterment than was the case pre-Betterment. These agricultural fields were also predominately located in the lower areas of the valley along the river rather than up the valley sides (although a small portion of fields remained on small sections of the hillside) as had previously been the case in the pre-Betterment settlements (see Figure 6.4).

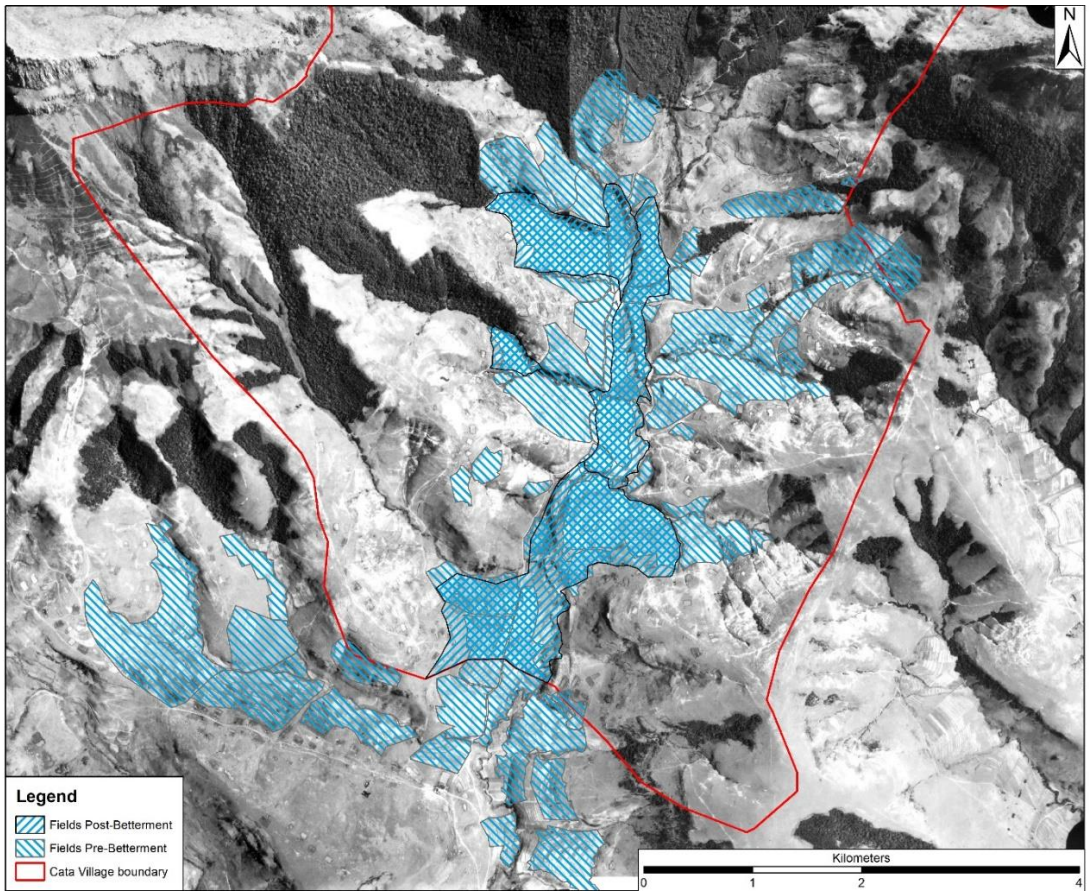

Figure 6.4: Aerial imagery illustrating mapped locations of field areas pre- and post-Betterment (1964) (QGIS)

Land allocations for grazing, while proportional to pre-Betterment grazing land in surface area, also posed challenges, as grazing on exposed valley slopes resulted in more denuded areas with a high erosion risk factor. This can be seen in the large, denuded patches with erosion gullies running through them, visible in the satellite imagery in Figures 6.5 and 6.6. This is a potential factor to be considered when evaluating the erosion increase visible in the area, which is more notable on the eastern side of the valley.

The mapped gullies were identified on high-resolution satellite imagery and confirmed through ground truthing (see Figures 6.7 and 6.8). These gullies are often very deep, particularly on more steeply sloped sections of land. These gullies are large and identifiable, particularly when combined with areas of

extreme denudement. The majority of the reallocated grazing area was situated on the now sparsely inhabited eastern section of the valley (see Figure 6.9).

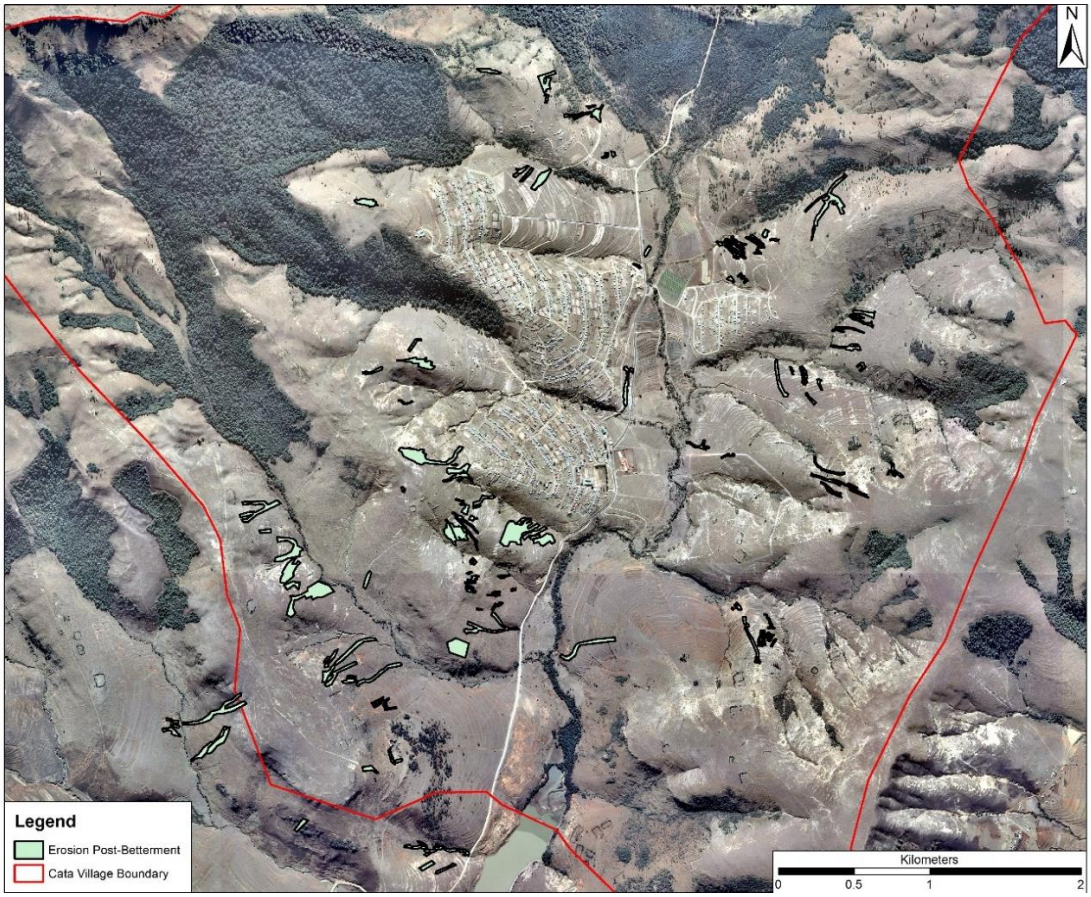

Figure 6.5:Satellite imagery indicating erosion gullies in Cata (2006) (QGIS)

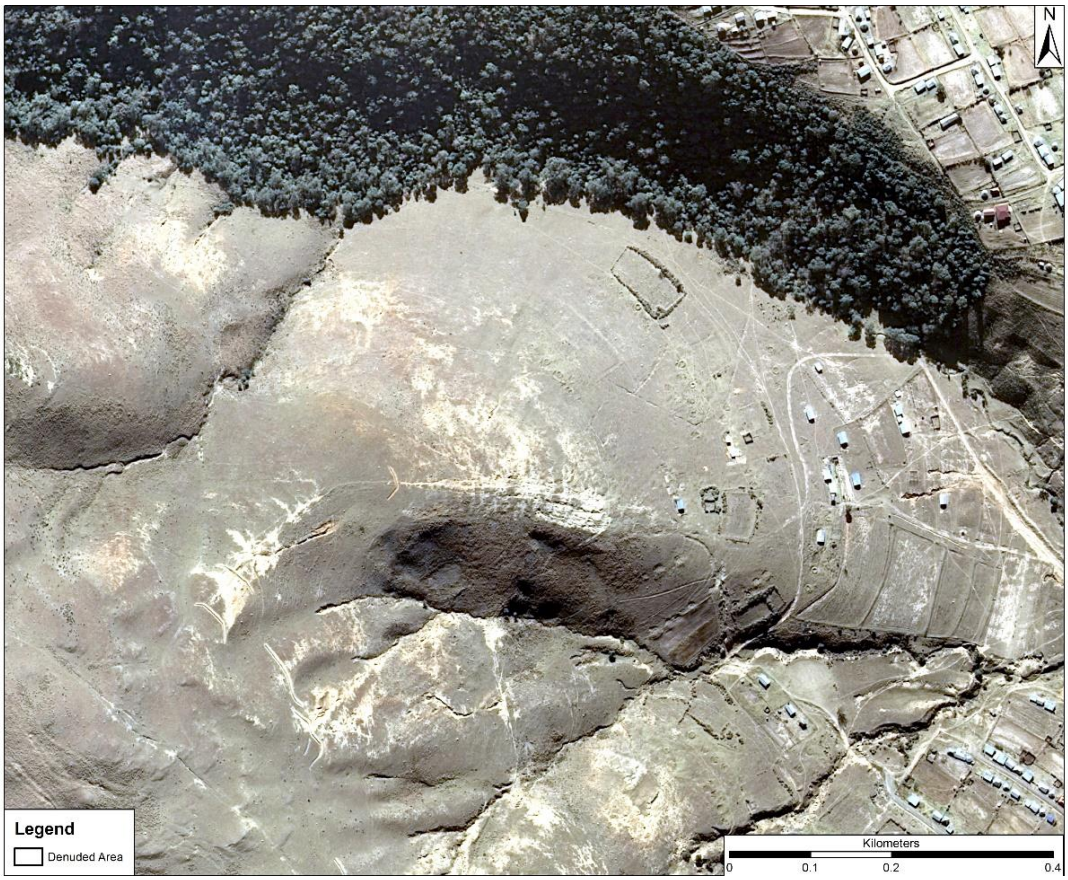

Figure 6.6: Zoomed-in image of a denuded section of Cata grazing land post-Betterment (QGIS)

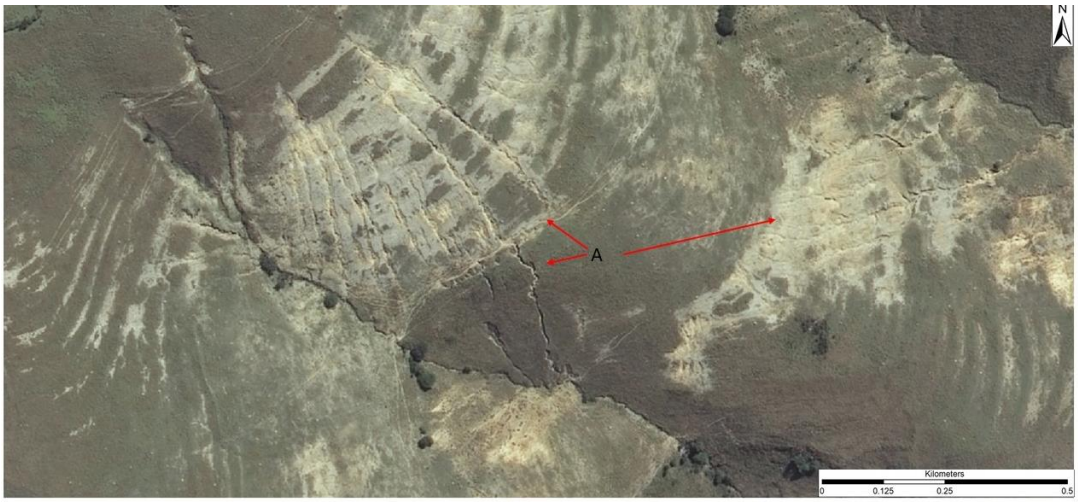

Figure 6.7: Zoomed-in image of erosion gullies (A) in Cata post-Betterment (QGIS)



Figure 6.8: Image of clear sections of erosion (A-erosion gullies) in Cata (Photograph: Alex Schoeman)

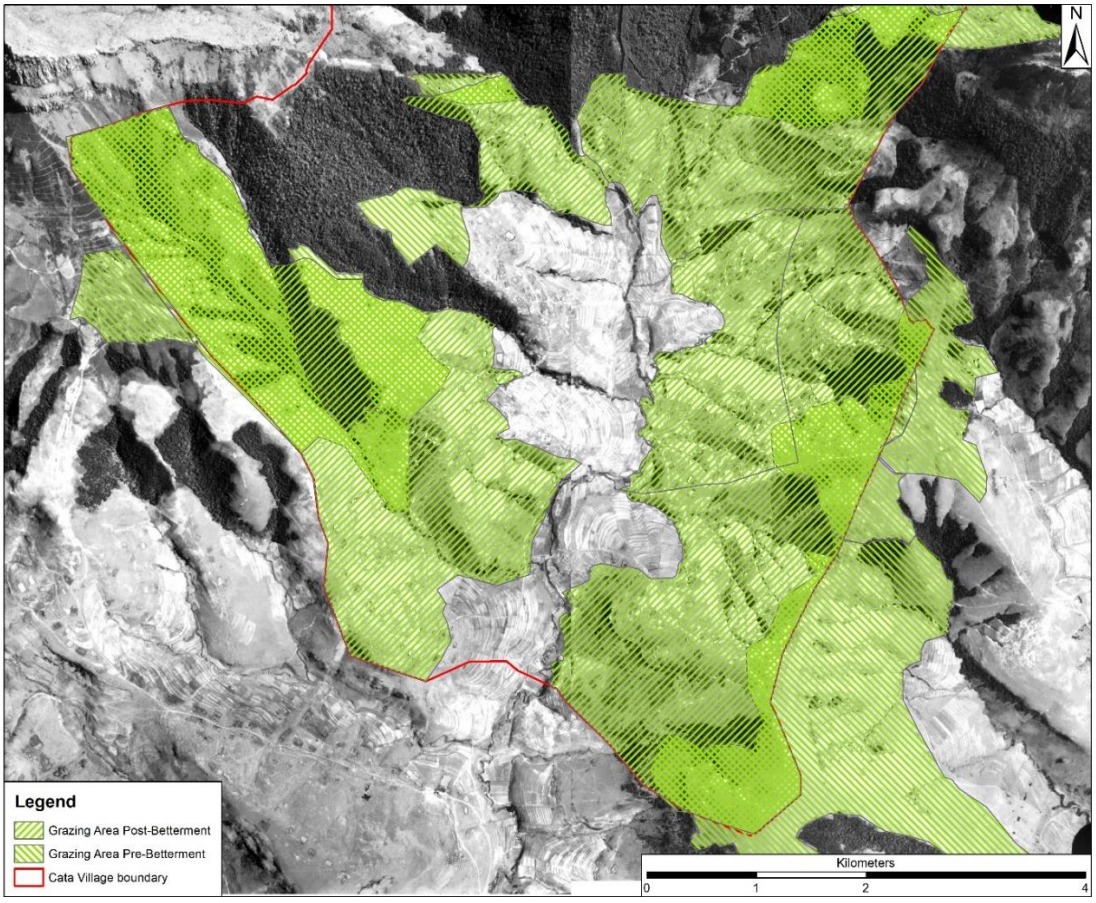

Figure 6.9: Aerial imagery illustrating mapped locations of grazing areas (QGIS)

6.2 Environmental study

Multiple environmental factors have been considered when exploring the erosion patterns in the Cata area as well as the broader consequences of Betterment Planning in relation to agricultural production. Erosion was used by the apartheid government to rationalise the implementation of Betterment Planning such as in the reports compiled by the Tomlinson Commission (see de Wet 1985; Hendricks 1990; Viedge 2001). Consequently, I examine erosional processes in Cata before and after the implementation of Betterment.

The methodology used to assess the potential an area has for the occurrence of natural erosion processes rests on the LS-factor. In order to perform this calculation, I generated a DEM from a bare-earth raster, which is a representation of vertical data points (X, Y, Z) that have been filtered to exclude non-grounded points, such as vegetation and any built structures in the area. I used this data to create a bare-earth elevation model of the chosen study area, which is useful when considering terrain stability, watershed flows, and natural flow directions (see Figure 6.910).

Erosion has two primary natural causes: wind erosion and water erosion. The impact and severity of erosion can be determined by a number of features, the most prevalent being gradient, plant cover, soil type, density of vegetation, and level of grazing.

Gradient is a key factor, particularly when considering water-driven erosion. The gradient of a slope can increase erosion by approximately 35%. The steeper the slope, the more likely it is that erosion will occur. Plant cover and vegetation density are important considerations as plant root systems can have a stabilising effect on soils and help protect soils from topsoil wash. This is clear when overgrazing occurs (as can be seen in Cata), and there is a consistent, visible increase in erosion over denuded patches of land. Type of soil can also be a major determining factor in the level of erosion that an area experiences.

Soils with low organic matter content lack the resistance to minimise topsoil wash during rainfall or strong wind exposure (O'Keefe 1983; Renner 1936).

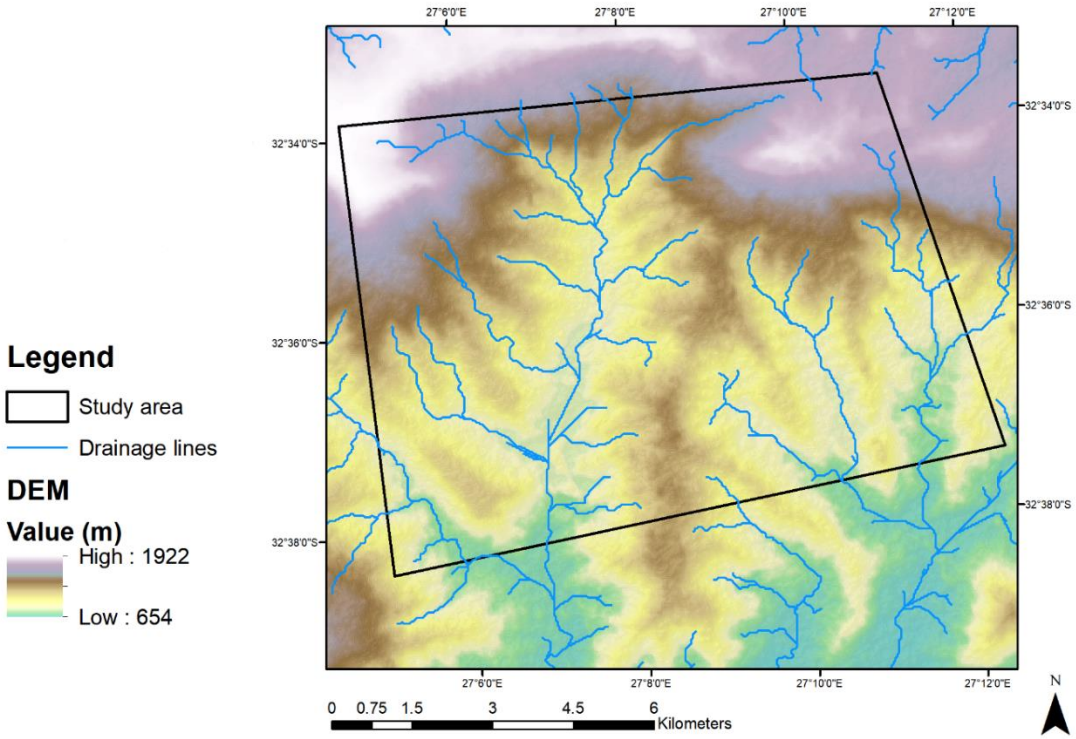

Figure 6.10: Digital Elevation Model of Cata (QGIS)

The DEM for the Cata area depicts elevation through a colour change scale (see Figure 6.10). Low values are represented by green and high values by purple. I used this data to calculate the LS-factor, which accounts for slope length and steepness as key variables in soil loss and stability (see Figure 6.11). The level of risk is displayed using a colour scale, ranging from red (high risk) to green (low risk). The erosion gullies and patches of denuded land fall across the entire range, from low- to high-risk areas.

The pre-Betterment hamlets were located in low-risk areas (see Figure 6.12 and Figure 6.13) whereas the sites created during and after the implementation of Betterment were located in higher-risk areas. This led to increased erosion in and around the occupied areas, as a result of their slope length and steepness.

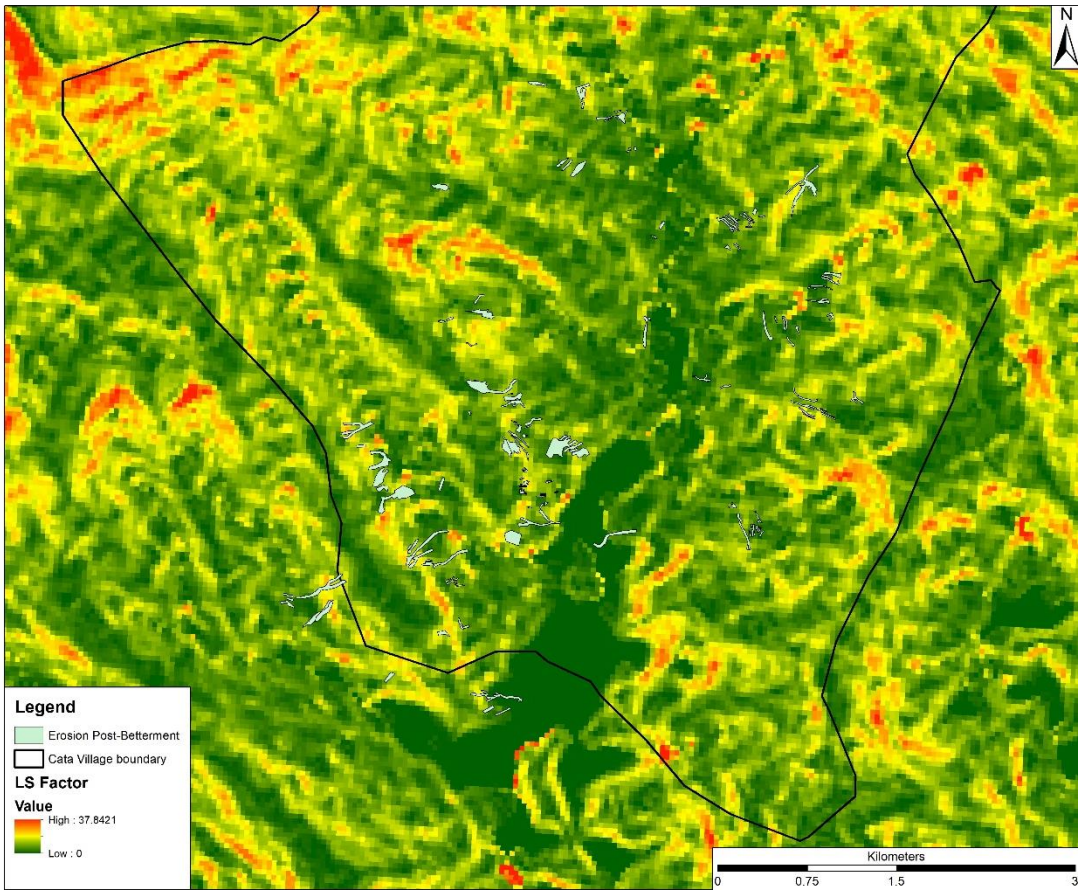

Figure 6.11: LS-factor of Cata with post-Betterment erosion gullies indicated (QGIS)

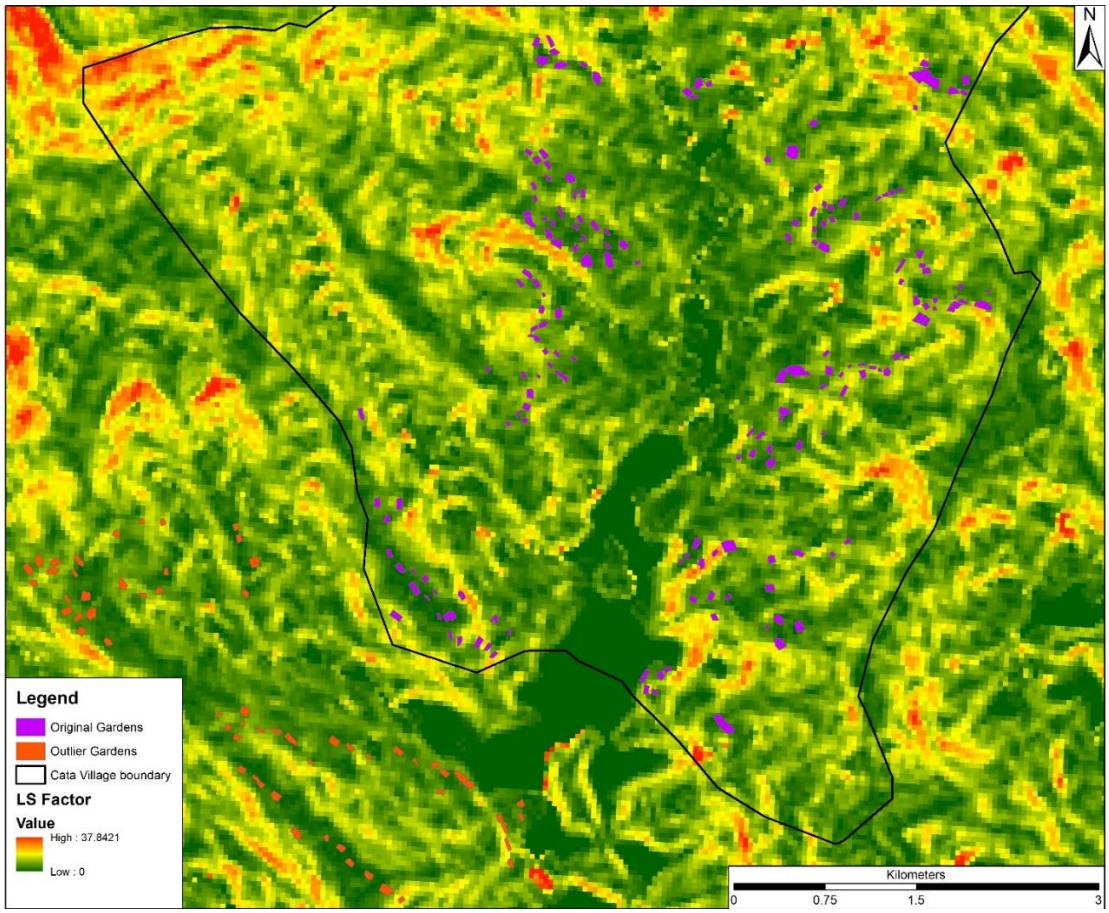

Figure 6.12: LS-factor of Cata with the location of pre-Betterment gardens (QGIS)

Erosion was mapped on both historical and more recent imagery in order to identify areas of concern and measure how erosion has progressed between the implementation of Betterment Planning and 2015. Deep erosion gullies have formed across the landscape. Several patterns are visible in the location of the erosion gullies. Firstly, many occur near the tributaries on the valley slopes. They also occur more abundantly on more steeply sloped sections of the valley. Many of the mapped gullies also formed over areas previously occupied by gardens, homesteads, or fields. This erosion can be evaluated by exploring the stabilising effect vegetation (such as agricultural produce) has on soils that are naturally at risk of erosion.

The only areas which appear to have had little to no increase in erosion processes are the pre-Betterment grazing areas. These are some of the only

areas where land use was not changed drastically with the implementation of Betterment. These areas are situated in the sections of the valley at higher elevations.

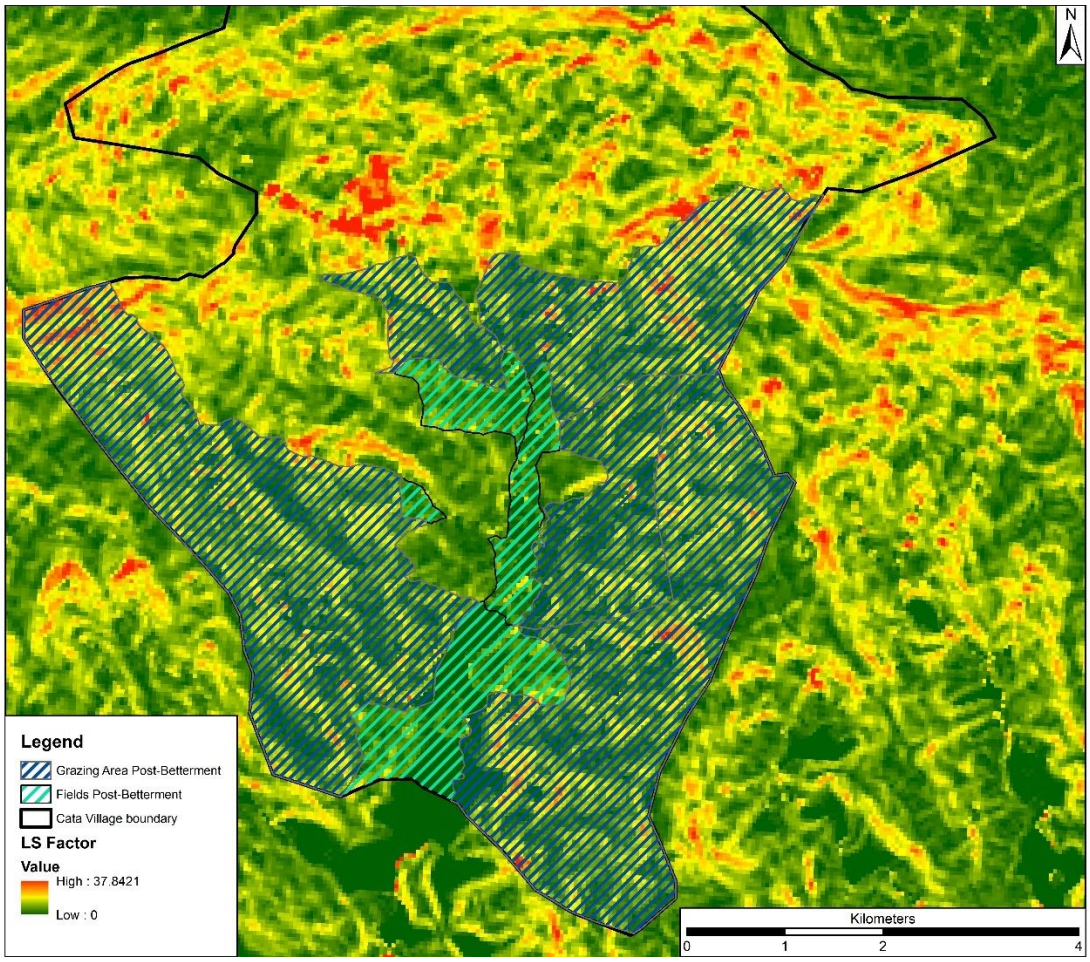

Figure 6.13: LS-factor of Cata with the land allocations indicated (QGIS)

Another factor to be considered is the correlation between slope and nutrient deficiency because gardens in Cata were relocated to more steeply sloped sections during the implementation of Betterment Planning. This was not ideal because research has shown that there is high correlation between slope steepness and nutrient deficiency in soils (Khan *et al.* 2013; Rockström & de Rouw 1997). Soils located on slopes have a higher tendency to lose nutrient-

rich topsoil during rainy or windy periods. These soils are also less able to absorb nutrients and water due to the natural tendency for downward run-off to occur. This can be improved by the root systems of plant life creating larger openings in the soil matrix, which allows for faster absorption of nutrients and water, reducing the impact of slope on loss of these resources (Khan *et al.* 2013; Rockström & de Rouw 1997). Consequently, Khan *et al.* (2013), Rockström and de Rouw (1997) recommend increased fertilisation on sloped agricultural areas to further combat this.

The final additions to the environmental study comprise datasets generated through the manipulation of bands captured by the Sentinel and Landsat satellites. The first of these images is a normalised moisture index (see Figure 6.144). This is derived from near-infrared and shortwave infrared channels. The shortwave infrared reflectance displays changes in the mesophyll structure of dense vegetation covering as well as vegetation water content. Therefore, the image produces an estimated moisture level contained by visible vegetation (Gao 1996). This is depicted using a colour scale, in which deserts or areas with little to no moisture content appear as brown, whereas water or areas of high moisture content would appear as blue. The area used for residential land post-Betterment is largely brown to yellow, indicating low to no moisture (Jackson *et al.* 2004). The eastern valley wall however displays larger areas with medium to high moisture content in vegetation, this was the location of a large percentage of the pre-Betterment hamlets. Forested areas can clearly be seen as the density of the vegetation appears in dark blue. Seasonality can play a role in the level of moisture present, however in this case, much of the habited and agricultural areas in post-Betterment Cata are so sparsely covered that this had little to no impact on the overall representation.

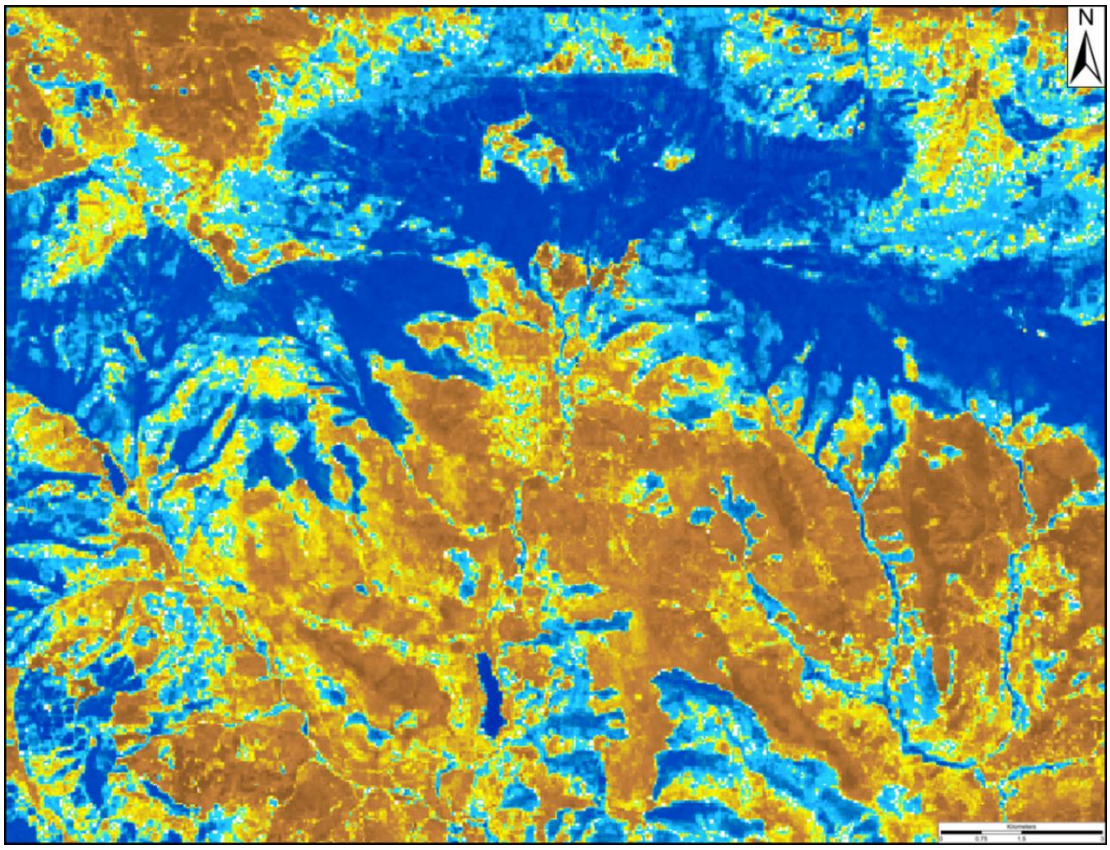

Figure 6.14: Normalised moisture index of Cata (Landsat)

A normalised vegetation index was generated for additional data regarding the vegetation cover over the project area (see Figure 6.155). This is important as it provides an overview of the vegetation cover in the area. The level of vegetation cover impacts the soil in multiple ways. Lack of vegetation leads to increased evaporation (leading to drier soils), reduces the stability of the soils (resulting in a higher propensity for erosion), results in an inability to carry out nitrogen fixing, or provision of organic matter in the soils. A lack of vegetation cover in an area also reduces the carrying capacity of the land (insufficient grazing) which has a knock-on effect economically and in terms of household holdings (Bogunovic *et al*. 2020; Laker 2004; Mills & Fey 2006; Roy *et al.* 2016; Sugihara *et al.* 2014; Zhou *et al*. 2008).

The image uses a colour scale to indicate differences in vegetation cover depending on the normalised difference vegetation index (NDVI) value, which

ranges between -1 and +1. Low values are depicted as brown, representing bare areas such as sand or rocks. High values are depicted as dark green, representing forested areas (Roy *et al.* 2016). The majority of the Cata valley slopes appear light green, which represents grassland or light shrubbery. This confirms that the area is covered by light vegetation, as was verified by the site visit. The brown areas indicate denuded areas resulting from decades of overgrazing, as well as patches of land that experienced high levels of erosion. The deep gullies do not possess the nutrient-rich topsoil required to maintain healthy ground cover in the form of grasses or shrubbery, as is seen in areas that have not been as severely impacted by erosion.

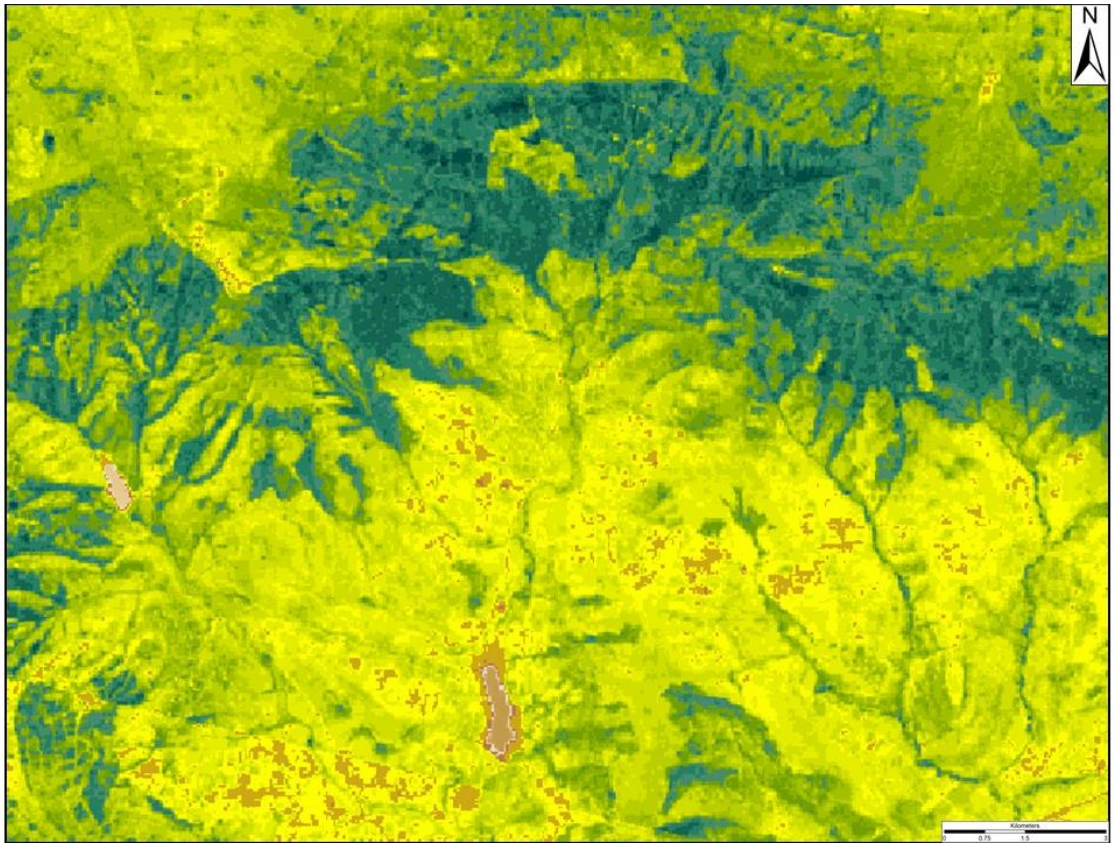

Figure 6.15: Normalised difference vegetation index of Cata (Landsat)

A natural colour rendering of the area was produced as a basis for comparison (see Figure 6.166). The colour band combination is intended to render an

image in the spectral array of the human eye. Unhealthy vegetation ranges from yellow to brown in colour, healthy vegetation appears green, and physical features such as roads appear grey. The overwhelming presence of brown vegetation in the imagery available (2001 to present), on both valley slopes, is a good indicator that these areas are covered in poor or unhealthy vegetation.

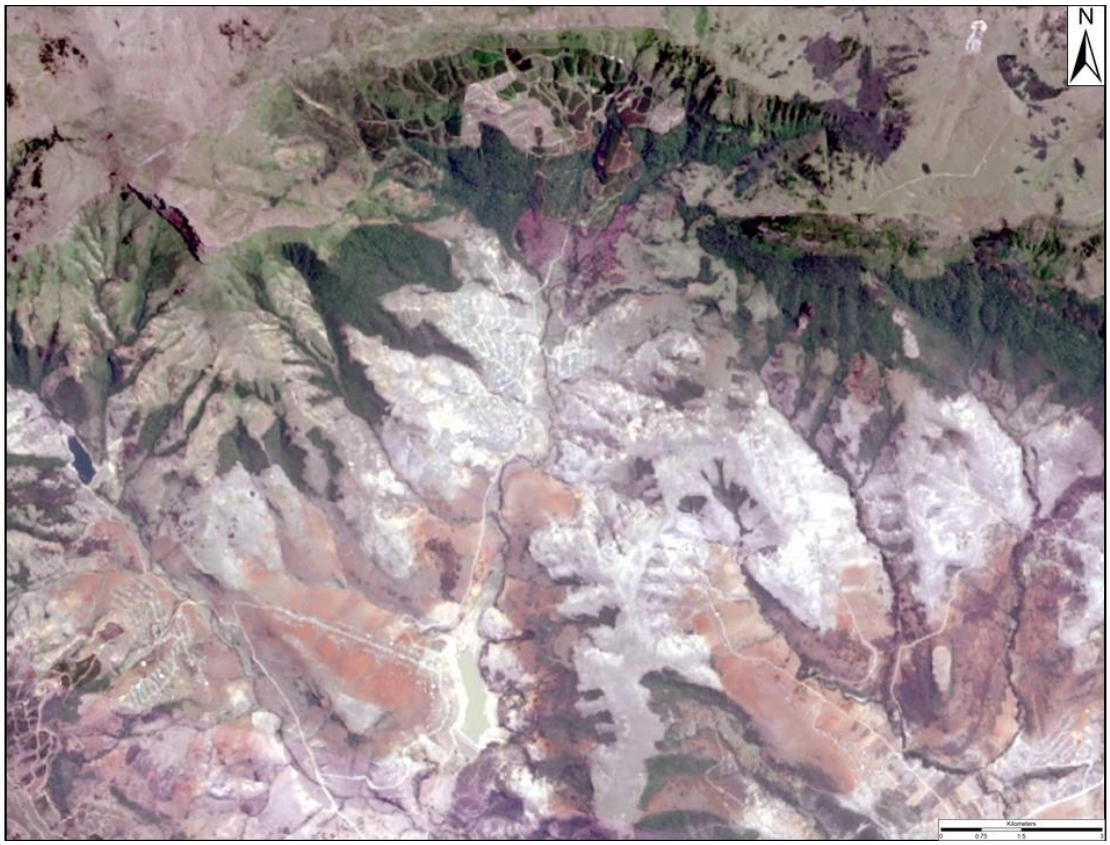

Figure 6.16: Natural colour rendering of Cata (Landsat)

6.3 Summary

This chapter presented the datasets that were created through mapping and carrying out an environmental study of the area. The data presented highlights how severe erosion had become prior to the implementation of Betterment Planning and how the redistribution of land impacted both the occupants of Cata and the environment that they occupy.

The following chapter discusses the data that has been presented in chapters four, five and six, draws a comparison between Cata and Willowvale, and reflects on the topics discussed in chapter two where appropriate.

Chapter Seven – Analysis and discussion

7.1 Introduction

In this chapter I discuss the data presented in the previous chapters. This includes a consideration of the data collected through the mapping of different phases of Cata (pre-Betterment, Betterment and post-Betterment) combined with the anthropological and archival data presented in chapters four, five and six where relevant. This data is also considered in relation to the topics discussed in the literature review. This chapter gives an overall examination of Betterment Planning and the evolution of Cata, and discusses some of the steps that have been taken to mitigate the detrimental impact of Betterment Planning.

7.2 Cata settlement patterns

7.2.1 Pre-Betterment

As shown in the data presented in the preceding chapters, settlement patterns in Cata evolved during three separate phases of occupation. The maps produced in chapter four show how the pre-Betterment occupation was scattered across large spaces across the mid and upper slopes, with small family-based units clustered together, as was common in many settlements in the Transkei and Ciskei in the pre-Betterment period (see Figure 4.8 and Figure 7.1; see Appendix A and I for larger versions of these images). Few limitations were placed on land allotment for residential purposes, allowing for less restricted expansion and greater manipulation of space. This allowed individual farmers to manage their yields as needed, and for the community as a whole to respond to social, political, and environmental changes, as was discussed in the comparisons made between Cata and Willowvale: Willowvale had space that allowed for the expansion of gardens when needed, as opposed to Cata that had the opposite experience (see Andrew & Fox 2004; de Wet 1985).

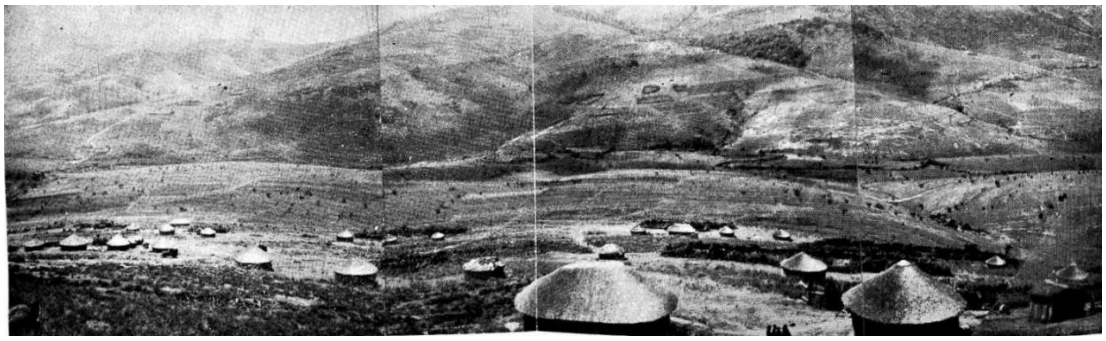

Figure 7.1: Panoramic photograph of Cata pre-Betterment taken by R. Lindsay-Robb (Mills & Wilson 1952)

In order to explain the impact of the implementation of Betterment, I consider the social and political changes that occurred prior to 1961. Cata was not a village in isolation. By 1961, the community was actively participating in the South African economy. While much of their food requirements were met, taxes needed to be paid and extra goods needed to be purchased. The increasing requirement for currency resulted in many of the village's able-bodied men leaving the area to find work as migrant labourers (de Wet 2009).

As discussed in the literature review, the departure of these men from Eastern Cape villages led to changes in many facets of daily life for the remaining community members. Women adapted their agricultural practices in an attempt to salvage as much production as possible. The location of the gardens in relation to the homesteads allowed women to continue carrying out their day-to-day tasks and still maintain their produce. These adaptations were possible because of the pre-existing social structures. People were motivated to help one another and share resources (de Wet 1985, 1995; Wilson *et al.* 1952). The large amounts of available land and the location of homesteads – clearly visible in the pre-Betterment maps – made these changes in agricultural production possible, and allowed the remaining population to produce enough food to sustain themselves, as indicated by the yield calculations in chapter four.

7.2.2 During Betterment

The second period covers the implementation of Betterment Planning. Settlement patterns shifted to a grid-like layout. Houses and residential land were situated in close proximity to neighbouring homes, and the space allotted to each family unit was reduced to a fraction of the original amount. Being able to locate the homestead in an area close to resources like water, wood, and grazing land, was no longer within the inhabitants' control. Despite the reduction in available land, a mirroring of the layout between the old and new sites is clearly visible in the chapter five maps. People relocated gardens and kraals close to the homesteads, using space and remaking associations in a way that made sense to them, in spite of space limitations and the new denser village setting.

The availability of land can play a key role in how adaptable individual households and the community can be, as was outlined in the comparison between Willowvale and Cata in chapter two. The changes brought about by Betterment created limitations as to how much adaptation could occur, as resources and space were limited. Family units were no longer guaranteed property adjacent to one another, meaning that the sharing of resources that occurred in pre-Betterment settlements was encumbered if not made entirely unfeasible. The land available for gardens was a fraction of the area previously available, and the fertility of the allotted land was also lower than that of most gardens prior to the Betterment Planning.

From the 2009 aerial imagery (see Figure 5.2 and Appendix F), it is evident that when the situation allowed, neighbours would drop fences to try to maximise their garden space. This usually occurred when family members had managed to secure adjoining plots (see de Wet 1985:186). Homes were built on the edges of the properties, allowing as much space for gardens as possible. The separation of kin was problematic, as the sharing of resources and the formation of work parties – a primary means of accomplishing agricultural tasks

prior to Betterment Planning (as discussed in chapter two) – became more difficult and, in many cases, impractical.

7.2.3 Post-Betterment

The third phase, post-Betterment, sees the addition of outlying homesteads, proximal to the post-Betterment village boundary (see Figure 7.2; Also see Appendix I). These outliers were once again more scattered across the landscape, leaving larger gaps between neighbouring homesteads. Gardens have increased in size, compared to the average size resulting from the implementation of Betterment Planning, and the settlement pattern more closely resembles pre-Betterment sites. These outliers also reverted to focusing on access to amenities, such as water and wood, making it easier and less time-consuming to carry out daily tasks.

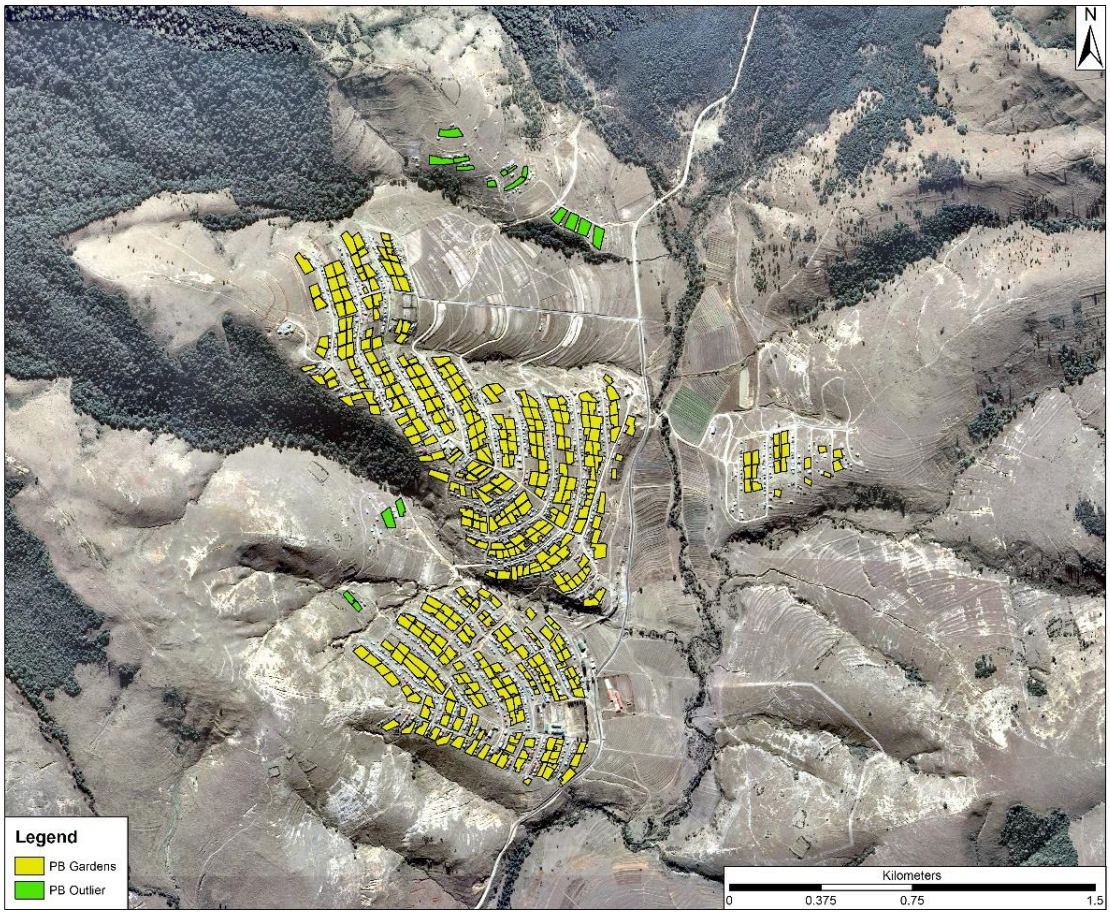

Figure 7.2: Aerial imagery illustrating mapped locations of post-Betterment gardens indicating outliers (QGIS)

Field and grazing land also underwent changes since the 1960s. During Betterment Planning, fields were allocated to a drastically reduced area, located at the bottom of the valley, rather than on the slopes they once covered. This resulted in an increased number of landless occupants, as there was insufficient land for everyone to farm (de Wet 1987, 1989). Prior to Betterment, fields were scattered across the landscape, making access to agricultural land viable for a larger portion of the population. As seen in the data in chapter five, the shift in the location of the fields resulted in reduced production and made accessibility for regular maintenance less practical (see de Wet 2011, 2012).

Grazing land was also shifted to areas of reduced vegetation cover and increased slope angle, as seen in the data presented in chapter five (see Figure

5.3). The environmental impact of this reallocation is significant. The consequences can be seen today in the large denuded patches and erosion in these deserted areas, visible in the imagery presented in chapter six (see Figures 6.4 and 6.5). Additionally, the loss of easily accessible, well covered grazing land and space to keep cattle resulted in many families reducing stock to more sustainable figures. As outlined in chapter five, this was an issue, as the number of milk-producing cattle was already insufficient to meet homestead needs (see de Wet 1985).

7.3 Yields

A range of estimated yields was calculated for the village of Cata before and after the implementation of Betterment Planning. This was done by identifying all visible gardens, calculating their surface areas, and creating a range of potential yields for known cereal crops that were produced. These figures were compared to the estimated figures put forward by de Wet (1985:157, 1995a) for maize and sorghum production. Estimates for possible field production were also calculated.

The yield data sets derived from area calculations and real-world production ranges provide a range of potential yields for crops in the area. Anthropological figures tend to be an underestimation of the actual yield produced and there was indeed quite a difference in kilogram yields between the anthropological figures and those calculated for this thesis. Despite these differences, the pattern in the two datasets is similar, with both showing a significant decrease in yields over time. This pattern suggests that the decrease in yields is linked to the overall amount of land being farmed, as well as the amount of space available for garden and fields.

This disparity in the reported and actual figures has been noted in multiple studies (see de Wet 1985; McAllister 1989:354; Westaway 1993). There are several reasons for this disparity. Some produce would sometimes be

consumed before the harvest was weighed, resulting in a lower total yield being recorded for that period than was actually harvested. Another explanation is that figures were often based on people's memories and estimations, when production figures weren't formally recorded and weighed.

The historical anthropological figures for pre-Betterment gardens all fell within the calculated yield ranges. The post-Betterment calculations were based on the identification and surface-area calculations of 418 visible gardens on the east and west sections of the valley within the Cata village boundary, as defined by the maps produced by de Wet (1985,1995a). The comparative areas for pre-Betterment and post-Betterment gardens are represented in Figure 7.3.

The graphs below indicate the significant changes in garden surface area, which resulted from the implementation of Betterment Planning. This resulted in a knock-on effect, which impacted the potential yields for both sorghum and maize. The mean area for post-Betterment gardens was 49% of the pre-Betterment mean. This is reflected in the significant yield differences across the entire range of results (see Figures 7.4 and 7.5; Also see Appendix H).

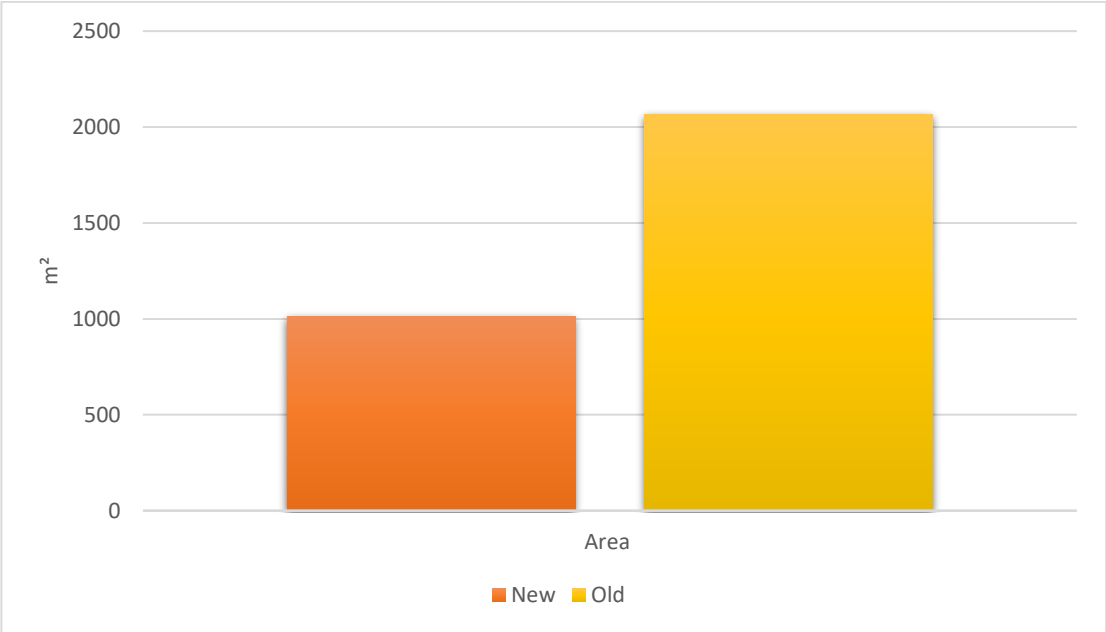

Figure 7.3: Chart depicting comparative mean areas for pre- and post-Betterment gardens in Cata

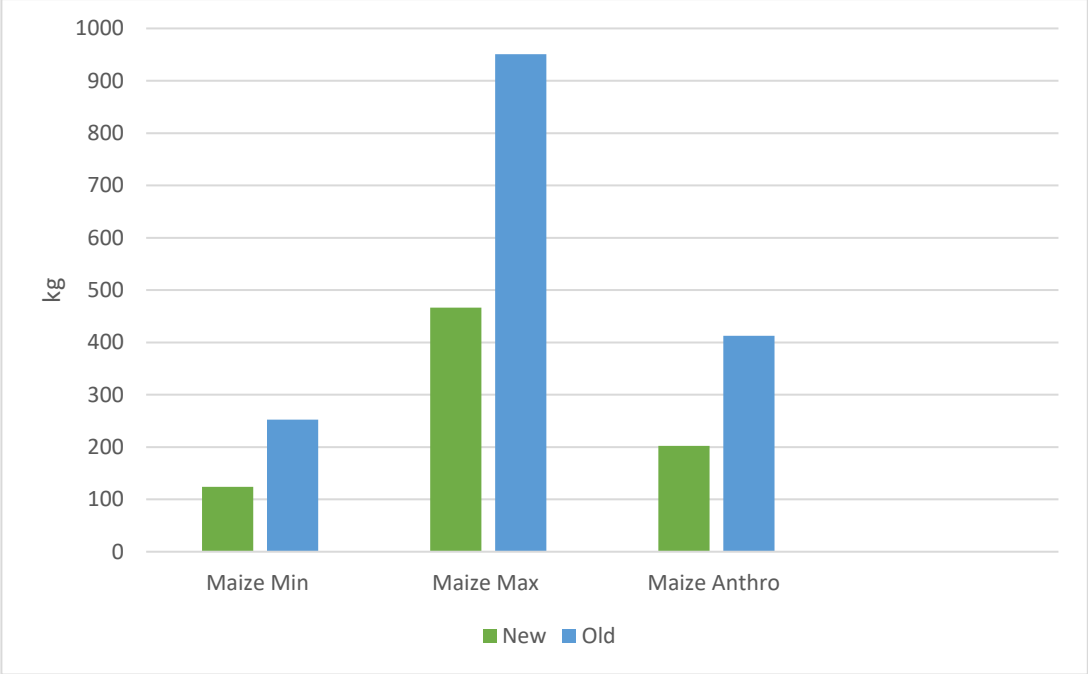

Figure 7.4: Chart depicting comparative maximum, minimum, and anthropologically based yield figures for maize production pre- and post-Betterment

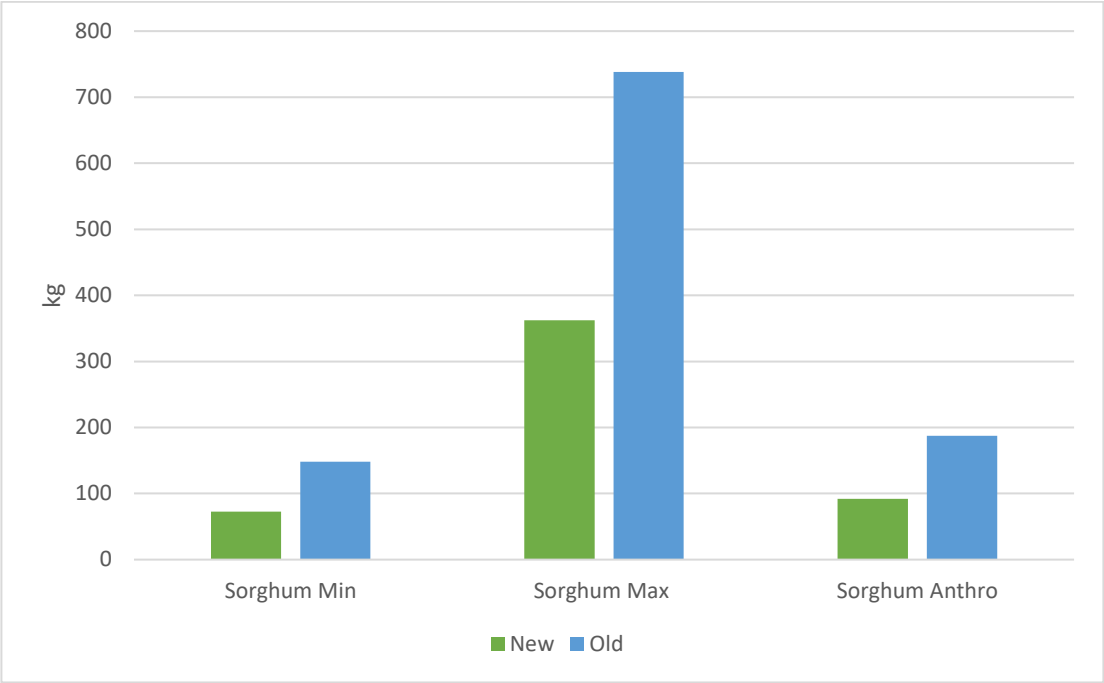

Figure 7.5: Chart depicting comparative maximum, minimum, and anthropologically based yield figures for sorghum production pre- and post-Betterment

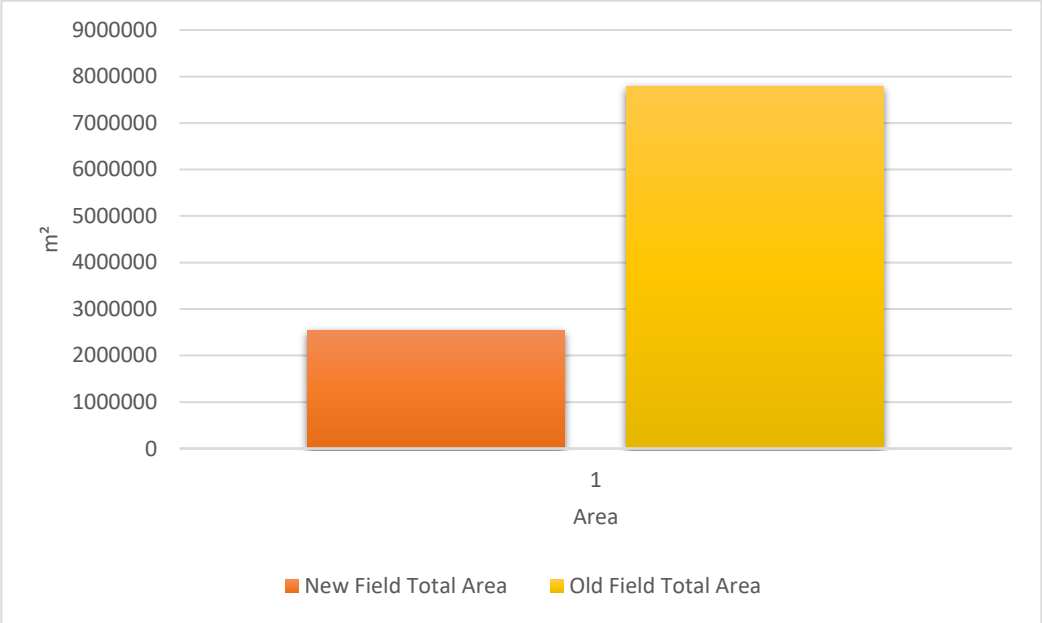

Figure 7.6: Chart depicting comparative mean areas for pre- and post-Betterment fields in Cata

The pre-Betterment yield calculations indicate that even when using the lower estimation, a sufficient quantity of food could be produced from the gardens to provide for most, if not all, of a homestead's requirements. This produce

combined with field production would have significantly reduced the income required to cover a homestead's basic nutritional needs.

The yield calculations indicate a significant decrease in food-production capacity between pre-Betterment and Betterment gardens (these figures are presented in Appendix D and G) as well as potential field production (see Figure 7.6:). Land allocated to field production decreased by 67%, and fields were often not conveniently located. Only 24 families received irrigated fields that were conveniently located, resulting in many of the fields being fallowed. The reduced size of arable land had a knock-on effect: the average potential yield of the measured gardens during Betterment decreased by almost 50%. This significantly impacted the quality of life and feasibility of surviving in Cata. As a result, there was a greater reliance on money earned through employment (mostly by migrant labourers) in order to purchase food to meet basic needs. Any increase in the unemployment rate of the village as time progressed only compounded these issues.

7.4 Impact of Betterment

The reaction to Betterment Planning from the perspective of the Cata community was overwhelmingly negative (de Wet 1985, 1989). The anthropological data collected through studies by de Wet (1985, 1989, 2012), Deliwe (1995), and Westaway (1993, 2012) provides insight into the detrimental effect this policy had on the village. Except for the 24 families that benefitted from the irrigation programme carried out, the residents of Cata were significantly worse off (de Wet 1985, 1989, 2012) after Betterment than before its implementation. Besides the limitations placed on production by the reduced availability of arable land, soil quality in the new allotted residential areas was poor and required significant intervention to improve and maintain. This reduced the ability of village inhabitants to meet their own food requirements, which led to widespread poverty and an increase in migrant labour (de Wet

1995a). This conclusion is supported by the study carried out by de Wet (2009), as discussed in chapter two, that tracked reliance on migrant labour and government funding for survival between 1948 and 2006. This data confirms the reduced ability to rely on agricultural production for income as well as an increased reliance on income from external sources for survival.

After Betterment, the community was left deeply dissatisfied by the implementation of the resettlement process. Issues included insufficient compensation for the loss of homes, the separation of families due to poor pre-planning, and a haphazardly executed plan driven by poorly thought-out policy and a general disregard for the community's wellbeing (de Wet 1985, 1989, 1995a, 2012).

The long-term impact of Betterment Planning was significant, and can be seen in the living conditions that prevail today. It is evident that Betterment Planning was implemented with little consideration given to the people who occupied the area, and displayed a damaging level of ignorance on the part of the government. There is a clear lack of understanding of the friction which resulted from separating families and mixing groups. Competition for the better-situated plots, and attempts by families to obtain neighbouring plots, caused a level of discontent that continued to build after Betterment had been implemented. This eventually led to incidents of violence between different pre-Betterment groups (de Wet 1995a, 2012:400).

A combination of the environmental, social, and political factors at play during this time has resulted in a village that has faced great adversity. Betterment Planning in this village had a predominantly negative impact on this community across all aspects of their lives.

7.5 Environmental factors

The topography of the study area indicates that the environment is sensitive to erosion and prone to poor soil conditions, as discussed in chapter six. The

layout of the pre-Betterment settlement was such that the residential spaces, and by proximity the associated gardens, were located in areas of a lower slope angle, while fields were located on the steeper slopes where terracing was often employed. These land-use functions were also carried out over a large area, as homesteads were scattered around the landscape. Residential areas tended to focus on land with higher moisture content and slightly denser vegetation cover (see Figures 6.10 and 6.11).

Imagery of the pre-Betterment sites shows small amounts of denudement, predominantly in grazing areas, or areas that fell within natural drainage basins with high LS-factors (see Figure 6.9). While overgrazing could have contributed to the erosion, these naturally occurring factors mean that erosion of these spaces was likely to occur, regardless of land use. Due to the resolution of the historical imagery, minor erosion is not clear enough to map. Had the gullies appeared as severely as is clear in later imagery, this would not be the case.

The location of fields below the gardens and cattle byres likely resulted in a natural run-off of animal and organic waste, which provided a source of organic fertiliser. This combined with the probable stabilising effect of the varied root systems of the cultivated vegetation from this area resulted in more nutrient-rich soils. This is supported by the yield figures provided in the anthropological data and the visible worsening of erosion when this land was no longer worked, post-Betterment.

The area chosen for the relocation of residential sites is riddled with environmental difficulties. The slope is steeper, resulting in a greater loss of topsoil due to natural geomorphological processes, which are most prevalent during rainy or windy seasons. The rate of nutrient absorption is also problematic in these areas as the window for absorption is greatly reduced on steeper slopes. Researchers recommend increased fertilisation on sloped agricultural areas to further combat this. This could also have impacted the yield from the newly established gardens and could account from the many

gardens that lie fallow today (see Khan *et al.* 2013; Rockström & de Rouw 1997).

The impact of crowded living also influences the quality of the soil and rate of erosion. A population that had once been spread across the landscape was now condensed into a small section of the valley slope. This creates an unmaintainable stress on the environment that would take massive intervention to correct.

Erosion across the pre-Betterment fields, many of the gardens, and abandoned pathways, has continued to worsen over time (see Figure 7.7). Some areas that showed no erosion now contain large dongas. It is apparent that no real effort has been made to repair the soil cover or save the landscape from disastrous long-term damage. This is alarming given that erosion was used as a justification for carrying out Betterment Planning (see de Wet 1985).

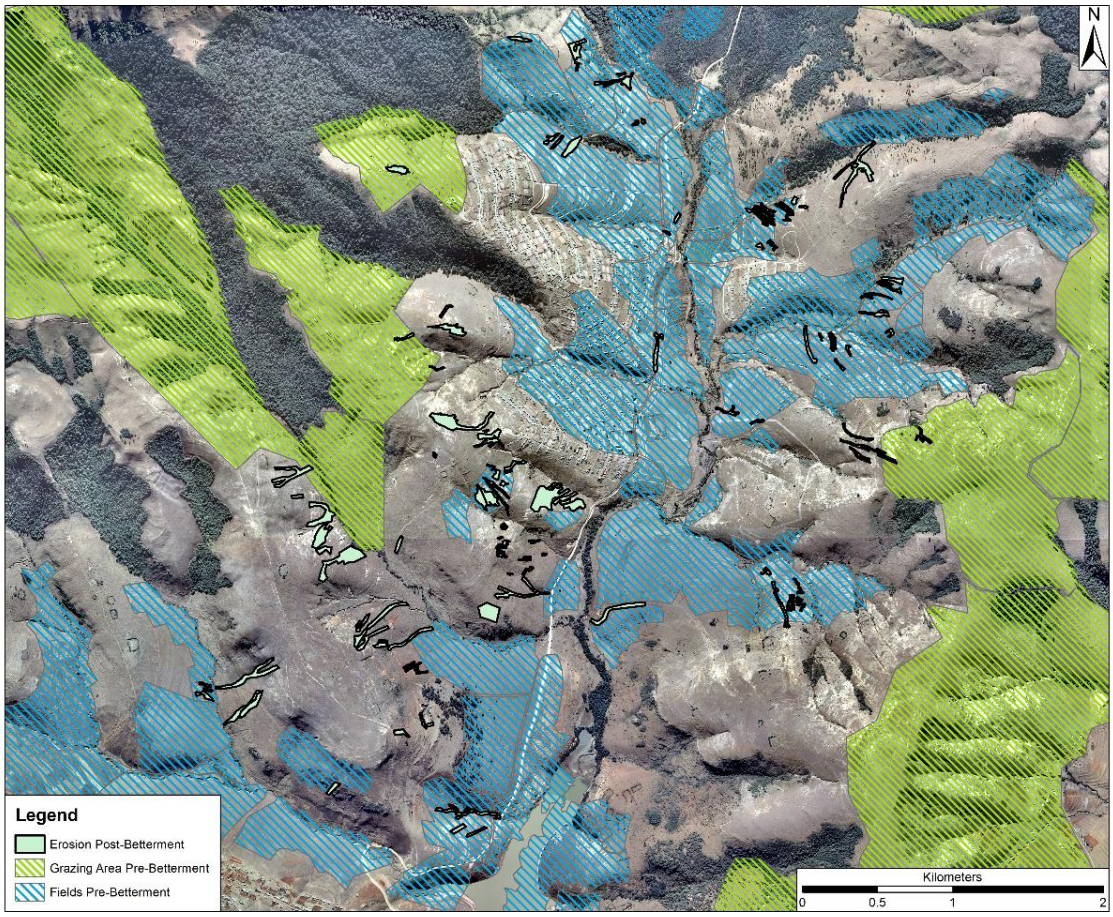

Figure 7.7: Aerial imagery indicating erosion gullies post-Betterment (QGIS)

The data presented in chapter six also indicates that the implementation of Betterment Planning did not achieve its stated goal of preserving surface soils and preventing further erosion. Other than the resulting 'fallowing' of the area, it has for all intents and purpose been neglected. If the true purpose of Betterment Planning was soil preservation, intensive soil fertilisation and rehabilitation programmes would have been implemented by the government and those overseeing Betterment Planning to manage the active erosion that occurred in the past and appears to be ongoing. What remains today is poor-quality soil with low nutrient content, large-scale erosion, and large areas of denuded land as a result of continued overgrazing and poor general vegetation cover over non-forested land.

The normalised difference vegetation index (NDVI), the normalised moisture index (NMI) and natural colour rendering that were produced for this area all support the premise that the location chosen for resettlement was less sustainable than the pre-Betterment sites. The west valley, where the Betterment settlement was placed, has soils with lower natural moisture, thinner vegetation cover, and poor-quality vegetation. This all impacts multiple facets of daily life in Cata.

Thin vegetation cover and unhealthy vegetation (as indicated in the NDVI and natural colour rendering) provides poor grazing for cattle, reducing the area's carrying capacity. This leads to a decrease in the number of cattle that can be supported by the grazing in the area. Poor vegetation cover also exacerbates erosion, particularly in high-risk areas (as indicated by the LS-factor). The moisture levels on the west valley are significantly lower, which means there is a greater chance of erosion when combined with the slope. It is harder for soils on a slope to absorb water and nutrients due to run-off. This makes for poor soils for agricultural production, particularly if irrigation and fertilisation are not practised to compensate for these issues.

7.6 Cata in the context of broader change to South African farming systems

Evaluating the evolution of Cata within the broader landscape of change in South African farming communities highlights two of the key issues for this thesis: the role of women in farming, and how space and resilience are frequently intrinsically linked. Research in farming communities such as Bokoni (discussed in chapter two), indicate how the role of women influences the design and utilisation of space within a homestead and the broader community. In both Bokoni and Cata, the gardens are established near the homesteads. This choice is deliberate and allows for the numerous household responsibilities placed on women to be carried out with greater ease and

efficiency. In Bokoni, the community had greater control over expansion of agricultural land. This allowed for adaptive farming strategies and the potential to implement fallowing practices to aid in soil conservation. The limitations placed on Cata with respect to the expansion of gardens, was restricted by the land-management practices which could be implemented in the specific area. The people, particularly the women, of Cata displayed a remarkable level of resilience prior to Betterment Planning in the way they adapted agricultural production and banded together to accomplish tasks usually carried out by men. The disruption of their social structures had a significant impact on their ability to adapt to the damage caused by the implementation of Betterment Planning.

The comparison of the villages of Cata and Willowvale in chapter two, highlights how Betterment restricted the community of Cata from adapting to the pressure placed on rural villages by taxes and the need to earn cash to successfully exist in South Africa. Willowvale provides a stark comparison to Cata and provides further insight into, and evidence of, the serious repercussions of Betterment Planning. While Willowvale underwent the same pressures of adapting to political and economic changes as Cata, the Willowvale community successfully resisted Betterment Planning, and is in a better state today agriculturally. The village shows evidence of progress, improved infrastructure, and continued agricultural production that is largely not visible in Cata today, as was confirmed during ground truthing (see Andrew 1992; Andrew & Fox 2004).

Two key factors contributed to how successfully the community of Willowvale was able to adapt to the changes caused by the introduction of migrant labour. The first was the expansion and extended utilisation of gardens, as outlined in the study by Andrew and Fox (2004), discussed in chapter two. The second was the maintenance of the social structures of the village which would have

been damaged by the forced removal or ‘restructuring’ brought about by Betterment Planning (Andrew 1992; Andrew & Fox 2004; Mc Allister 1989).

The lack of disruption of the village’s social structures played a vital role in the resilience of this village. Groups could come together to share resources either in the form of work parties or ploughing companies. The inclination to help one another stemmed from deep-seated relationships through kinship ties and good relations with long-term neighbours. The sharing of oxen for ploughing, and labour for tasks ranging from weeding to thatching, helped compensate for the absence of able-bodied men in the village as a result of migrant labour (Heron 1990; McAllister 1986).

In Cata these social structures were torn apart in many sections of the village and replaced by tension and competition with new neighbours, often political in nature. This, combined with the lack of land to expand, created a stark comparison between these two villages (de Wet 2011, 2012). This provides an indication of what Cata may have looked like today had Betterment Planning been abandoned, as it should have been.

7.7 Discussing Cata in a global context

Many of the case studies explored in chapter two highlight the importance of space and how the ability to expand or reallocate land for agricultural production can be the difference between a successful agricultural community and failure to thrive. From Engaruka to Marakwet, access to land and adaptive land management have allowed communities to overcome a multitude of hardships. The limitations placed on Cata by Betterment Planning resulted in an environment that left little room for successful adaptation. Moore and Davies’ work discussed on Marakwet provide an illustrative comparative. When faced with environmental challenges such as soil erosion, unpredictable rainfall (leading to drought) and crop failures, access to land and the ability to manage their land freely allowed for the community to adapt and survive. In Cata the

option to make these adaptations were severly limited after the implementation of Betterment..

The concept of identity and the ties a community has with physical structures is relevant when considering Cata. The people of Cata have positive associations with the areas of cultural significance and memories which remain of life before Betterment, in their original homesteads. The physical remains of the life that existed before are still within view of the Betterment housing. It is clear when talking to individuals today and reading interviews carried out by anthropologists, as well as by the existence of the Cata museum, that the life the community of Cata was forced to abandon still underlies the identity of the community. The people of Cata could have resented the existence of the remaining features in their landscape that serve as constant reminders of their previous lives, but instead they chose to celebrate them. The community created walks that intentionally pass sections of the old settlement, a toposcope that depicts what the pre-Betterment village looked like, and a beautiful diorama of the village that is exhibited in the museum. This celebration of the physical representation of communities past provides a striking comparative to the Galicians, as outlined in the work of González-Ruibal, where so much effort was made to change and hide the way the past was presented through physical structures. Also relevant to consider here is the comparison between Cata and the constructs put forward by Given, highlighting the intersection between memory, experience and structure. As stated above, the remaining homestead walls, gardens and fields that have slowly decayed over the decades, serve as a constant reminder of a forced change this community had to endure and the consequences that followed.

7.8 Summary

Cata was a village with potential which was hobbled through the implementation of Betterment Planning. In the face of adversity caused by the general political climate and economic inequalities at the time, the resilience of rural communities was already being tested. It is evident when comparing villages that underwent Betterment Planning to those fortunate enough to have successfully resisted it, that the implementation of these policies hampered the community in its ability to practice agricultural production. It resulted in disastrous effects such as overcrowding, the disruption of key social structures, the development of distrust in the traditional hierarchy, and tension among neighbours. All of this combined to create a damaged environment, and a village that was a shadow of what it once was.

While the village would not have been able to completely escape the effects of a changing political and economic landscape, most notably the migrant labour system, the ability to mitigate these effects was undoubtedly hampered by the land restrictions and poor neighbour relations created by Betterment. In addition, the land use changes, motivated by the need to curb erosion, resulted in the exacerbation of erosion and other environmental issues which continue unabated today.

Chapter Eight – Conclusion and recommendations

8.1 Introduction

This chapter summarises the work undertaken and the topics explored in this thesis. The constraints of this thesis are also discussed, and I outline what future research could be undertaken to address further lacunae in our knowledge.

8.2 Summary of the key findings of this research

The mapping reported in this thesis contributes to a deeper understanding of the pre- and post-Betterment spatial layouts of the Cata area, while the inclusion of a wider range of factors contributing to community life in the mapping provides a more holistic view of the Cata community structure. Mapping undertaken after the implementation of Betterment Planning allows for a greater understanding of the impact that these policies had on the community. Previous maps created of this area have been largely indicative and regional in scale. These maps did not focus on the homestead gardens or the spatial distribution of amenities.

The surface area calculations of the comparative gardens allowed for the creation of a complete dataset. This provided a quantitative basis for the pre- and post-Betterment yields which provide realistic ranges that can be used to compare the estimates generated through past research, and thus identify factors contributing to yields. The shift of homesteads back to settlement configurations based on indigenous ideas in spite of the control of the oppressive apartheid government, supports the concepts put forward by theorists regarding the memory and sentiment that individuals place on physical structures.

The environmental data provides quantitative information which indicates why erosion was not a justifiable motivation for the implementation of Betterment

Planning. Instead, the research in this thesis shows that erosion was exacerbated by the rezoning of land usage. The dataset highlighted the long-term erosion of the site and how both the naturally occurring features, and the abandonment of pre-Betterment sites and activities, exacerbated the level of erosion in the area.

The environmental mapping and data produced provides a base for understanding how limiting the changes imposed by Betterment Planning had become on multiple levels. Furthermore, the environmental data indicated the poorer conditions of the site chosen for relocation which impacted the carrying capacity for grazing and potential for agricultural production. The environmental data combined with the yield dataset show how the range of production yields significantly reduced after Betterment even in ideal environmental circumstances. This established how the reduced land area significantly contributed towards a failure to thrive.

This thesis utilised a variety of datasets to produce a summarised, holistic understanding of the impact that Betterment Planning had on the Cata community. Case studies such as these should serve as a warning for future land reform programmes. Policies can have dramatic and unforeseen impacts on the lives of the affected communities and can jeopardise their ability to successfully participate in the broader economy of South Africa. Any attempts made to move communities should be based on an in-depth understanding of environmental factors, gender relations, cultural practices, and existing social structures, and how these factors inform the way communities interact with space.

8.3 Recommendations for future research and interventions

1. Future research on the area would benefit from archaeological investigations of the material changes associated with the spatial changes that occurred between the pre- and post-Betterment homesteads reported on in this thesis.

This would deepen insight into people's responses to Betterment, as well as increased reliance on migrant wages. This would create a micro-scale evidence base which could be a useful addition to the maps and broader dataset created during the research for this thesis.

2. Future research would also benefit from additional interviews focused on understanding more specific aspects of pre- and post-Betterment life in Cata. This should, however, only be done if there is sufficient funding available to provide psychological debriefing, given the traumatic nature of the content discussed.

3. An in-depth analysis of the soil chemistry of the area could provide a valuable dataset. This would help to understand the type of nutrient changes that have taken place over time.

4. In terms of practical interventions, there is a definite need for intervention to mitigate further erosion in the area. This would need to be funded by government grants or perhaps an Non-Governmental Organisation.

5. There is also a need to address a deterioration of soil conditions. There is currently little to no government support available for small-scale rural agriculture in the area – or for that matter, in South Africa as a whole. A reassessment of land-management practices may allow for improved garden yields and as a result, an improvement in the overall condition of the village.

6. There is also a requirement for improved infrastructure in the area. Basic necessities such as potable running water in each home, indoor plumbing, and well-maintained access roads, could all improve the day-to-day lives of the community residing in Cata. The costs to correct these issues would need to be covered by either government grants or an Non-Governmental Organisation.

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Appendix A – Larger images from Chapters One to Three

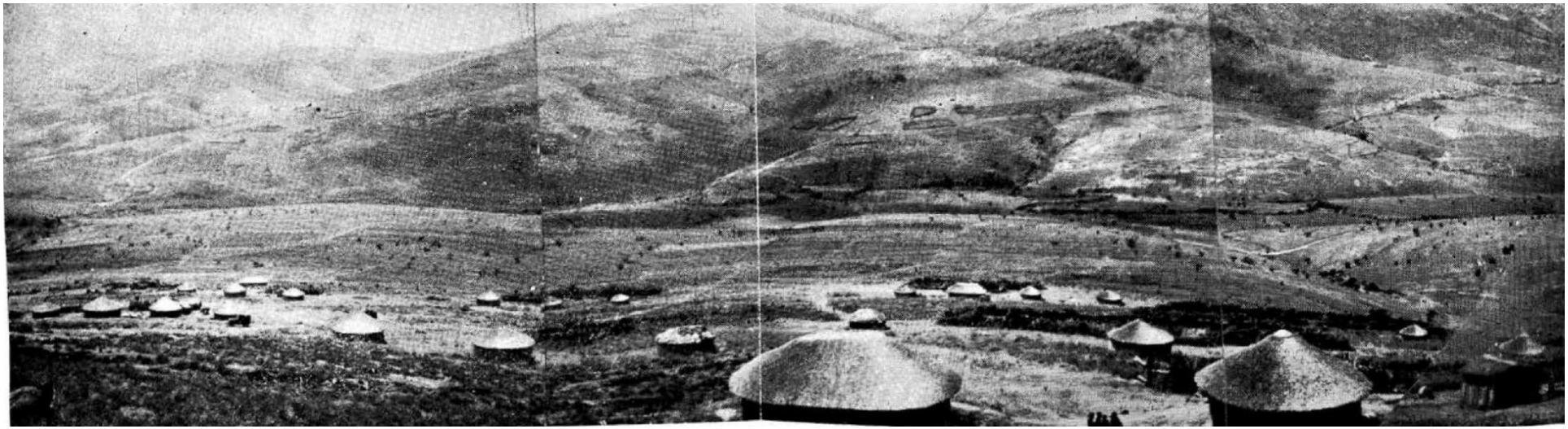

Figure A.1: Enlarged panoramic photograph of Cata pre-Betterment taken by R. Lindsay-Robb (Mills & Wilson 1951)

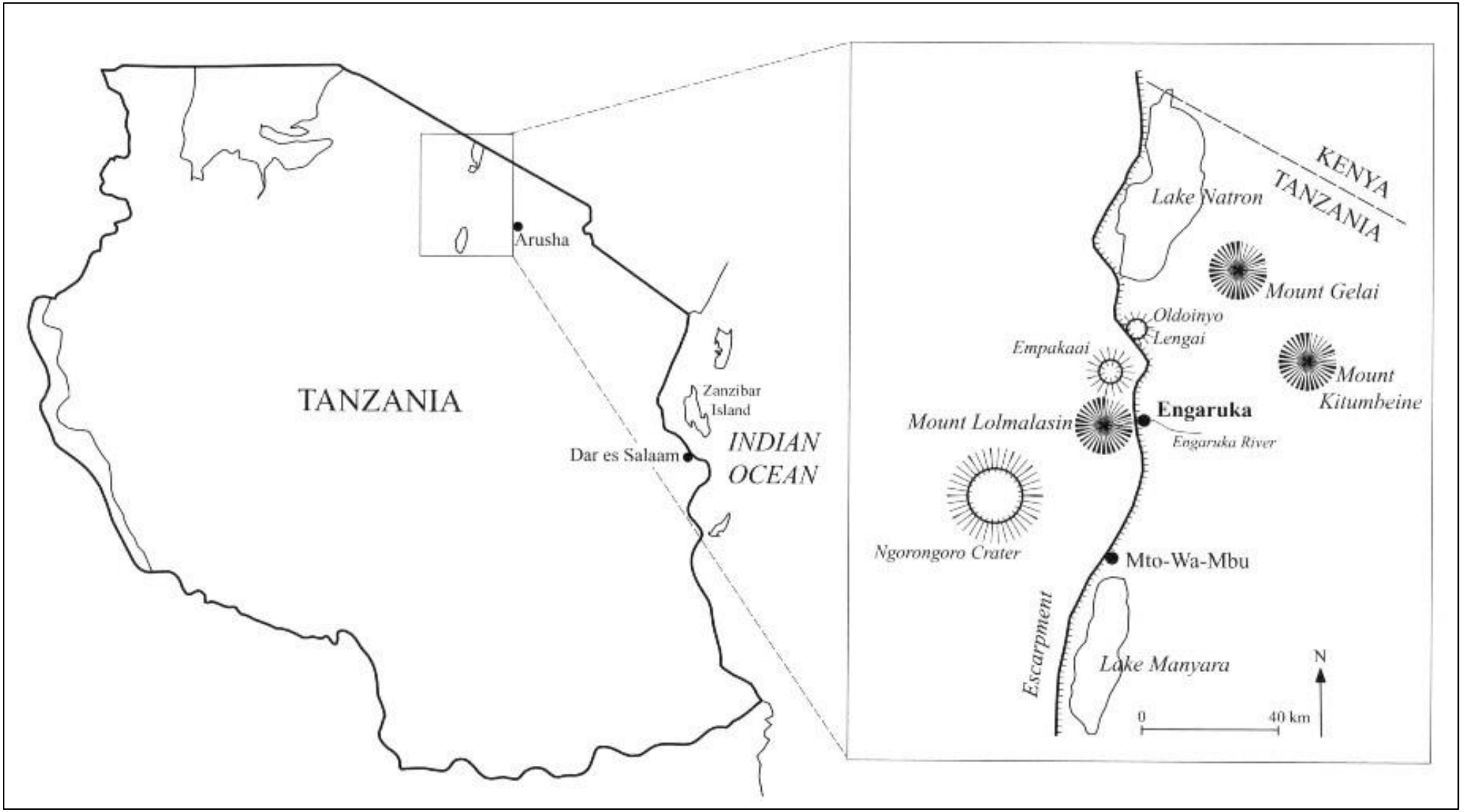

Figure A.2: Map of Tanzania and Engaruka area (Westerberg et al. 2010)

b

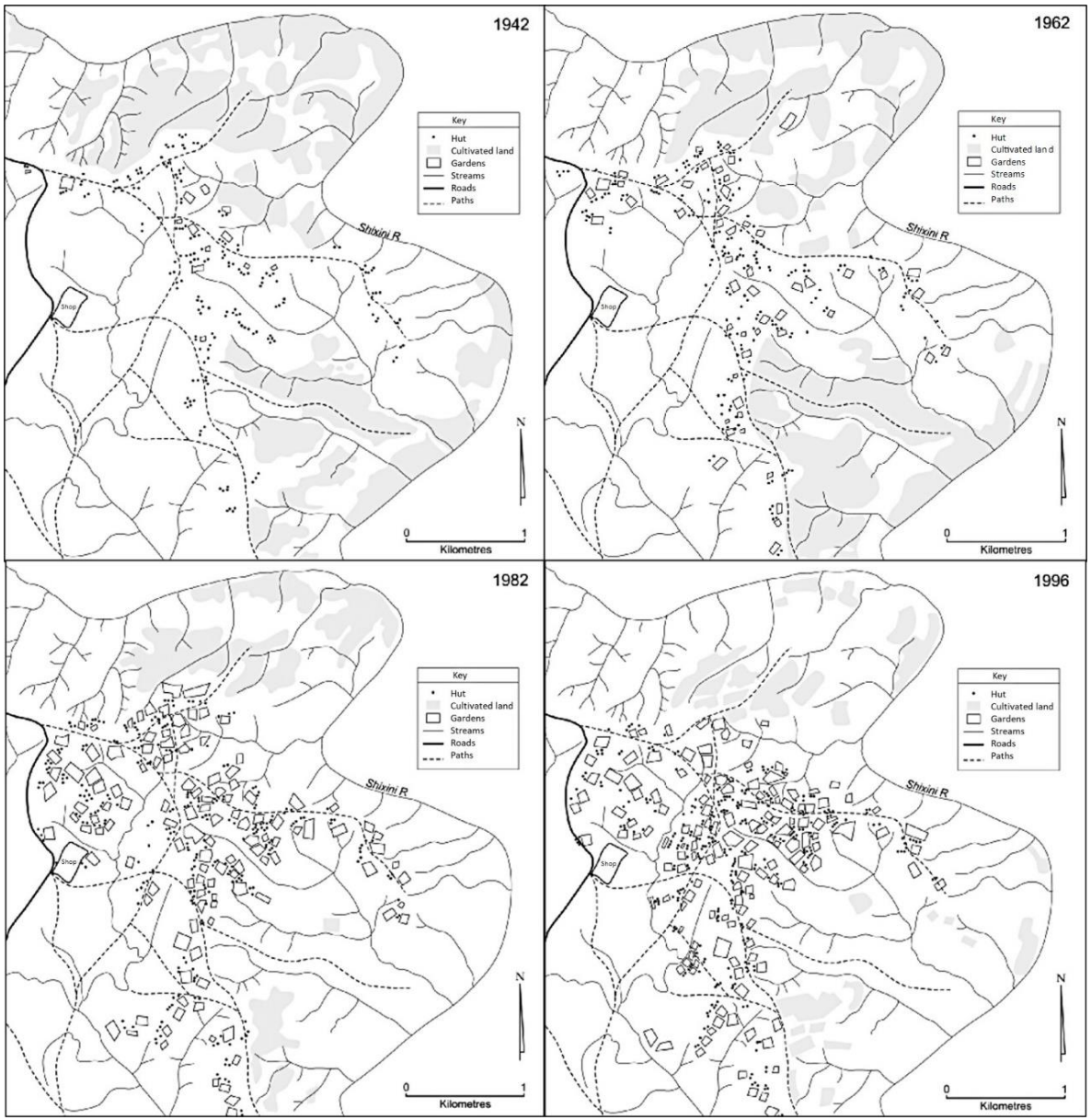

Figure A.3: Mapped changes in Willowvale from 1942 to 1996 providing four snapshots which indicate the organic expansion of settlements and associated gardens.(From Andrew and Fox 2004)

C

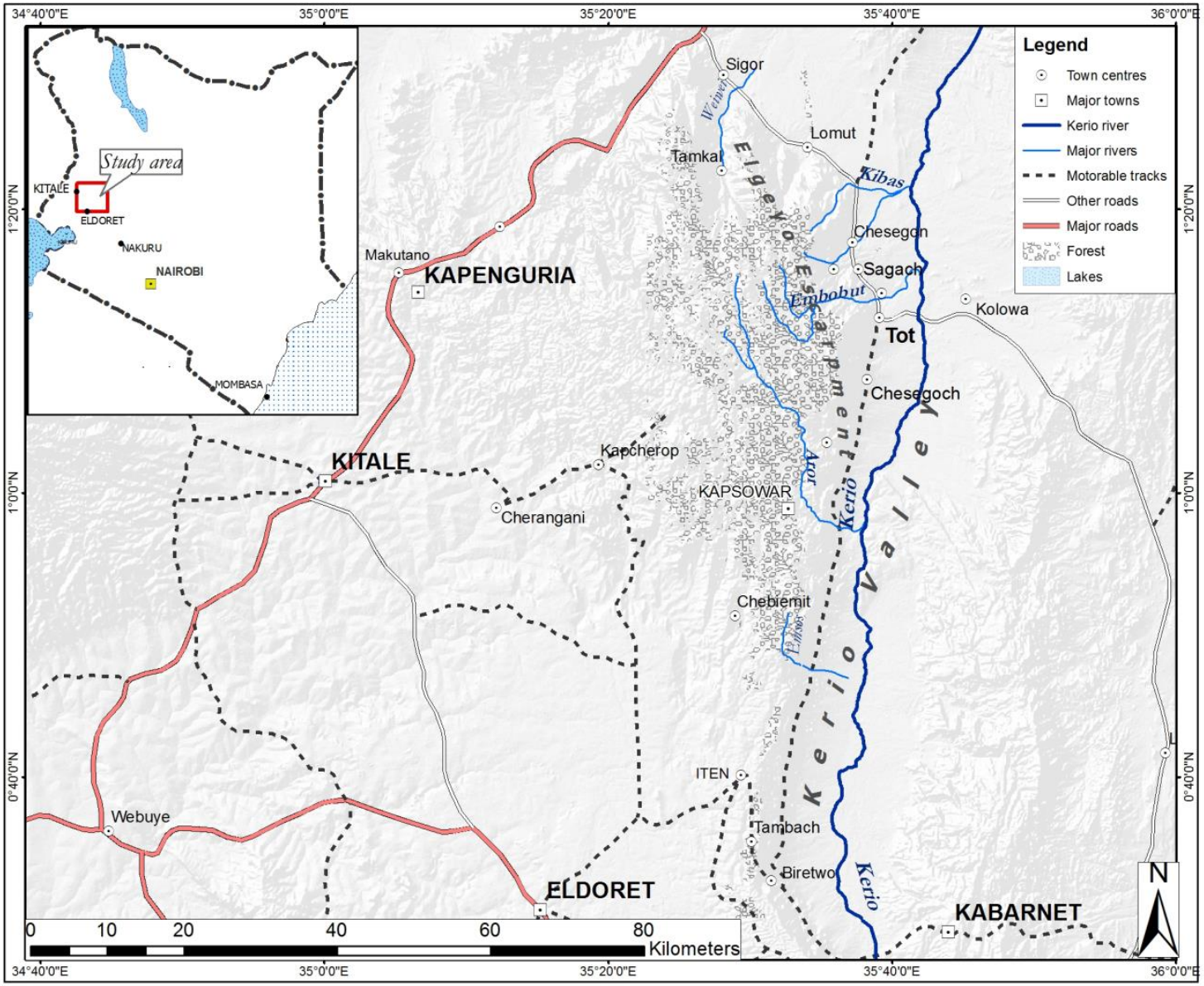

Figure A.4: Map indicating the location of Marakwet and the Kerio Valley (http://maraketheritage.co./landscape-and-maps)

d

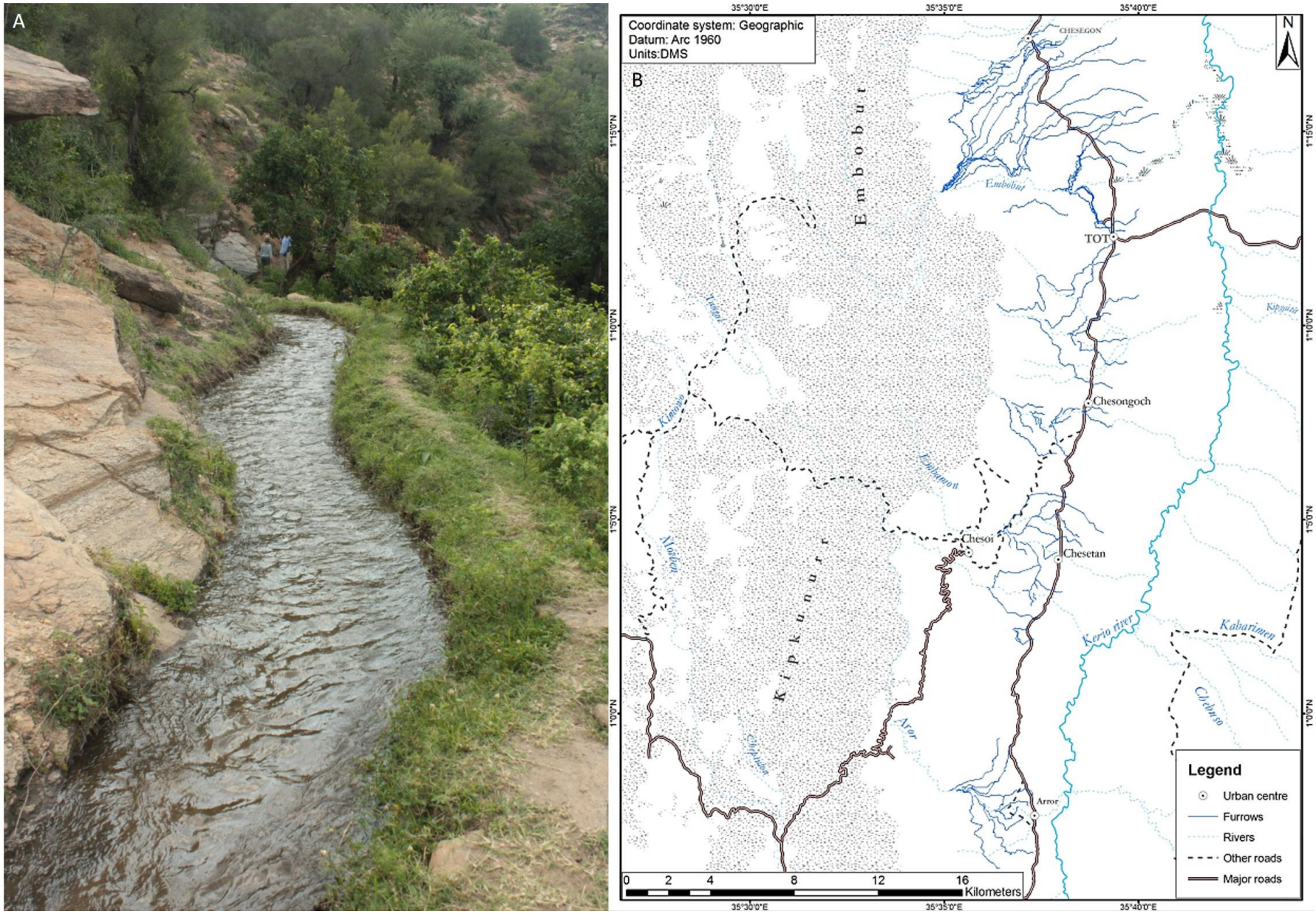

Figure A.5: Map and image of irrigation furrows in Marakwet ((http://marakwetheritage.com/agriculture/)

e

Appendix B – Pre-Betterment maps

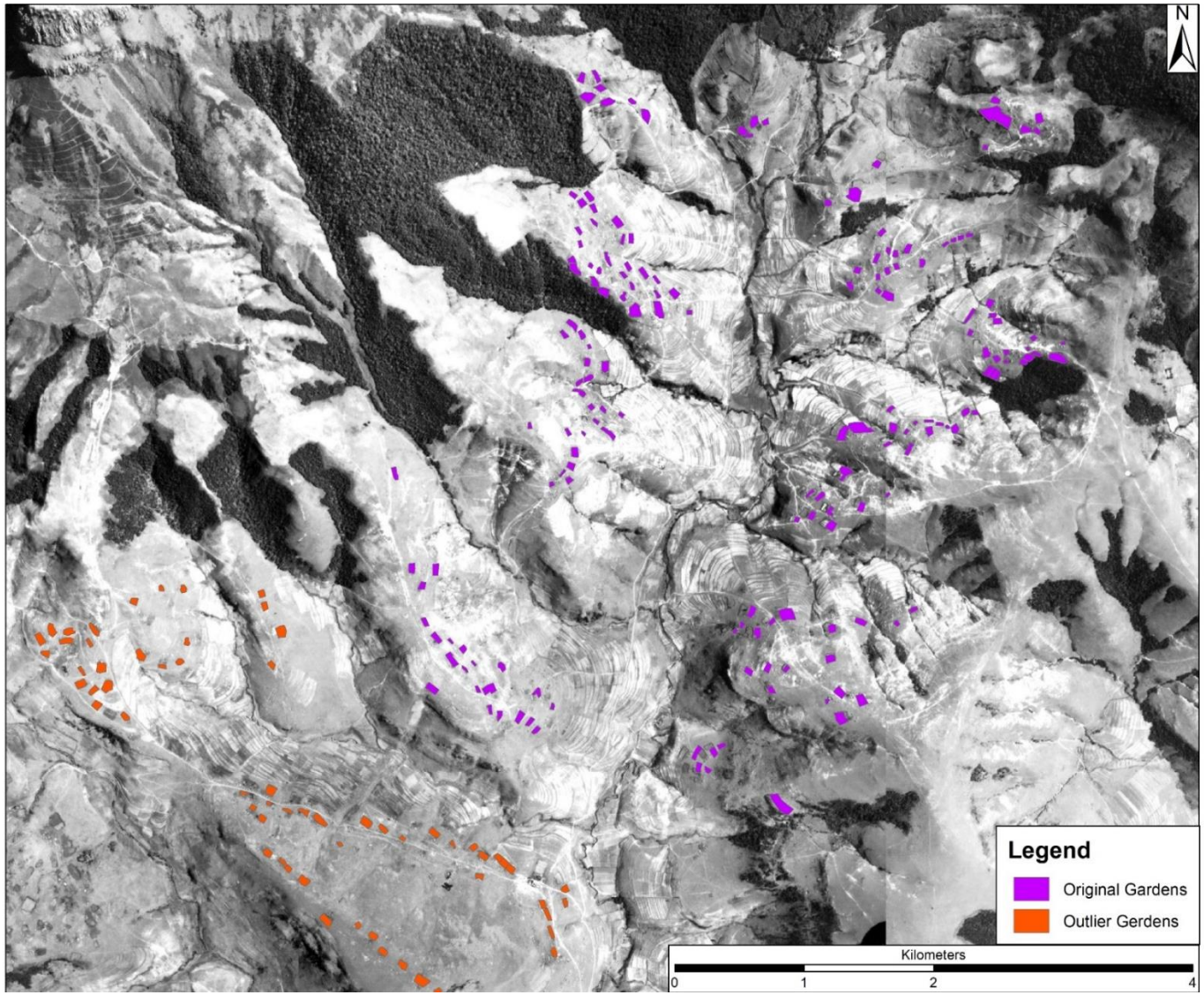

Figure B.1: Enlarged historical aerial imagery from the NGI illustrating the location of visible gardens (QGIS)

f

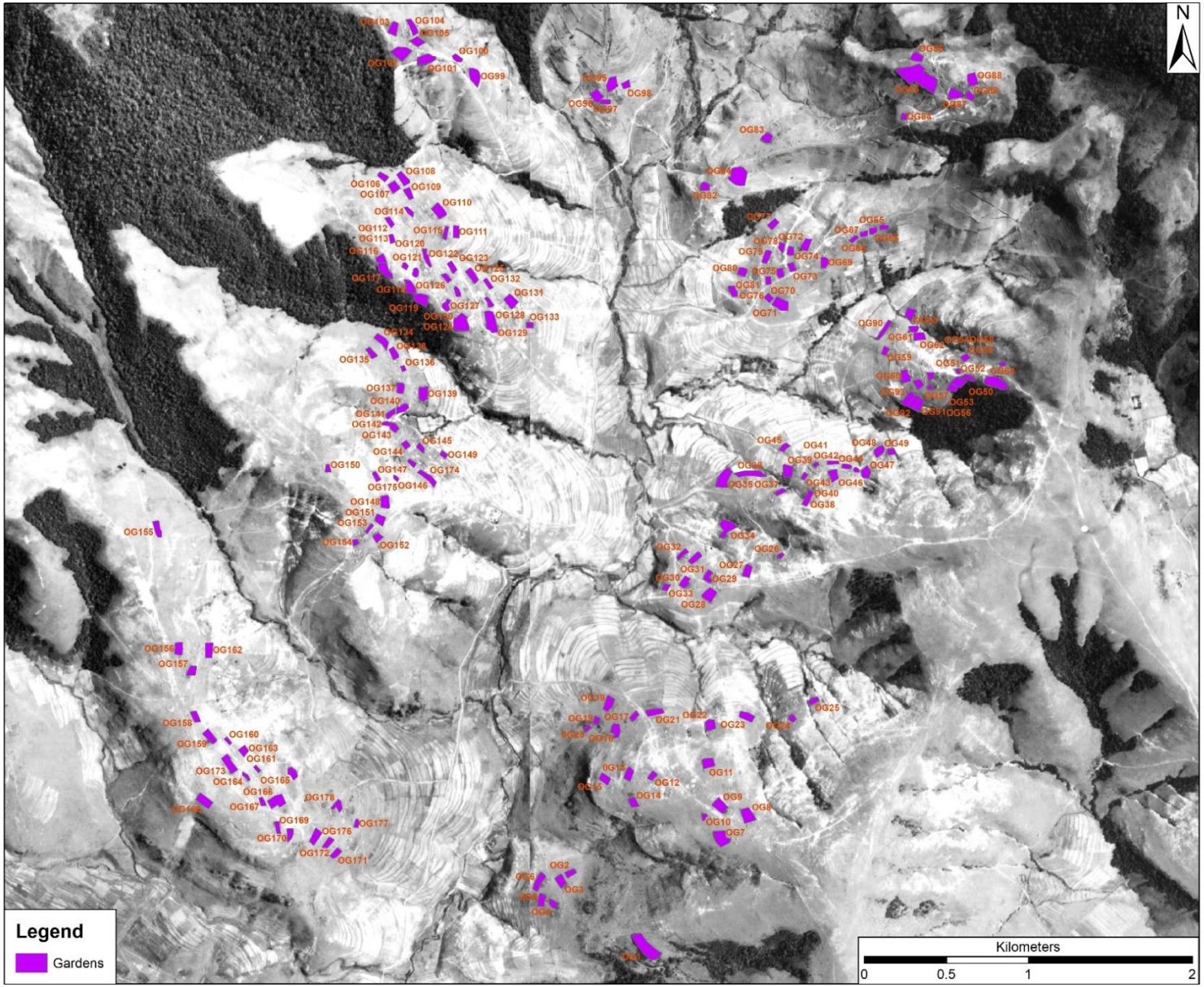

Figure B.2: Historical aerial imagery from the NGI illustrating the location of visible gardens with the labels (QGIS)

g

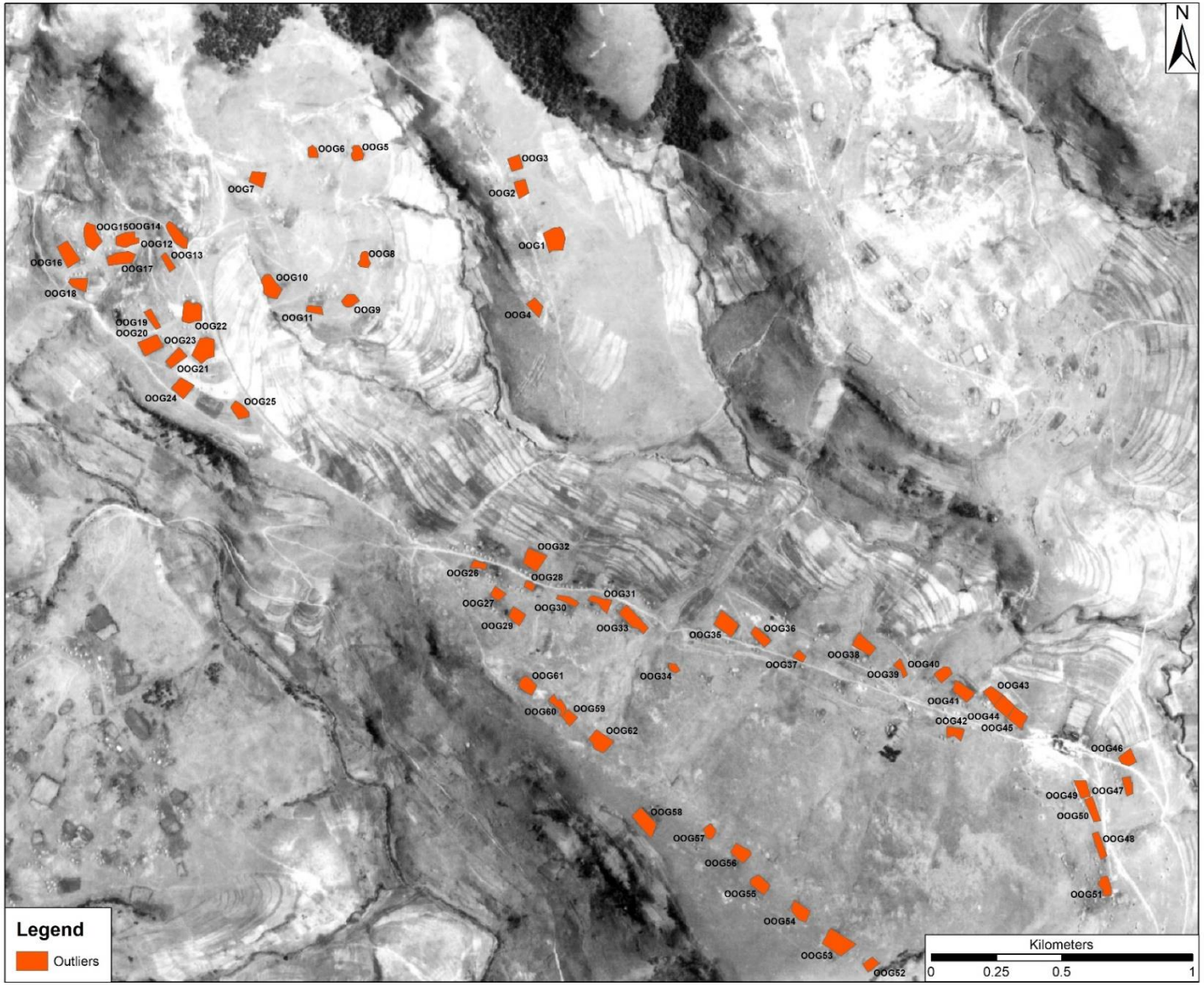

Figure B.3: Historical aerial imagery from the NGI illustrating the location of visible outlier gardens with labels (QGIS)

h

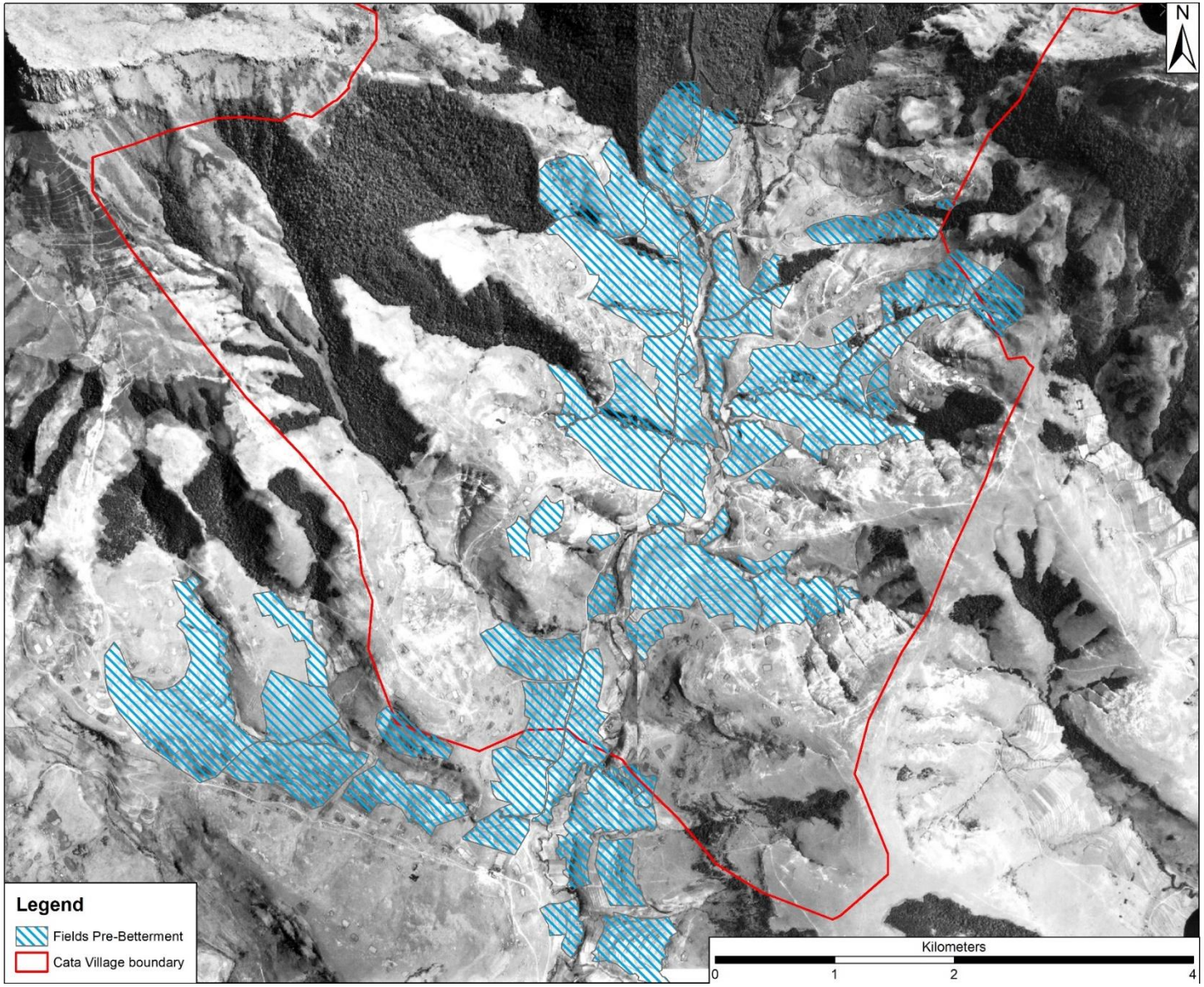

Figure B.4: Enlarged historical aerial imagery from the NGI illustrating the location of approximate location of fields (QGIS)

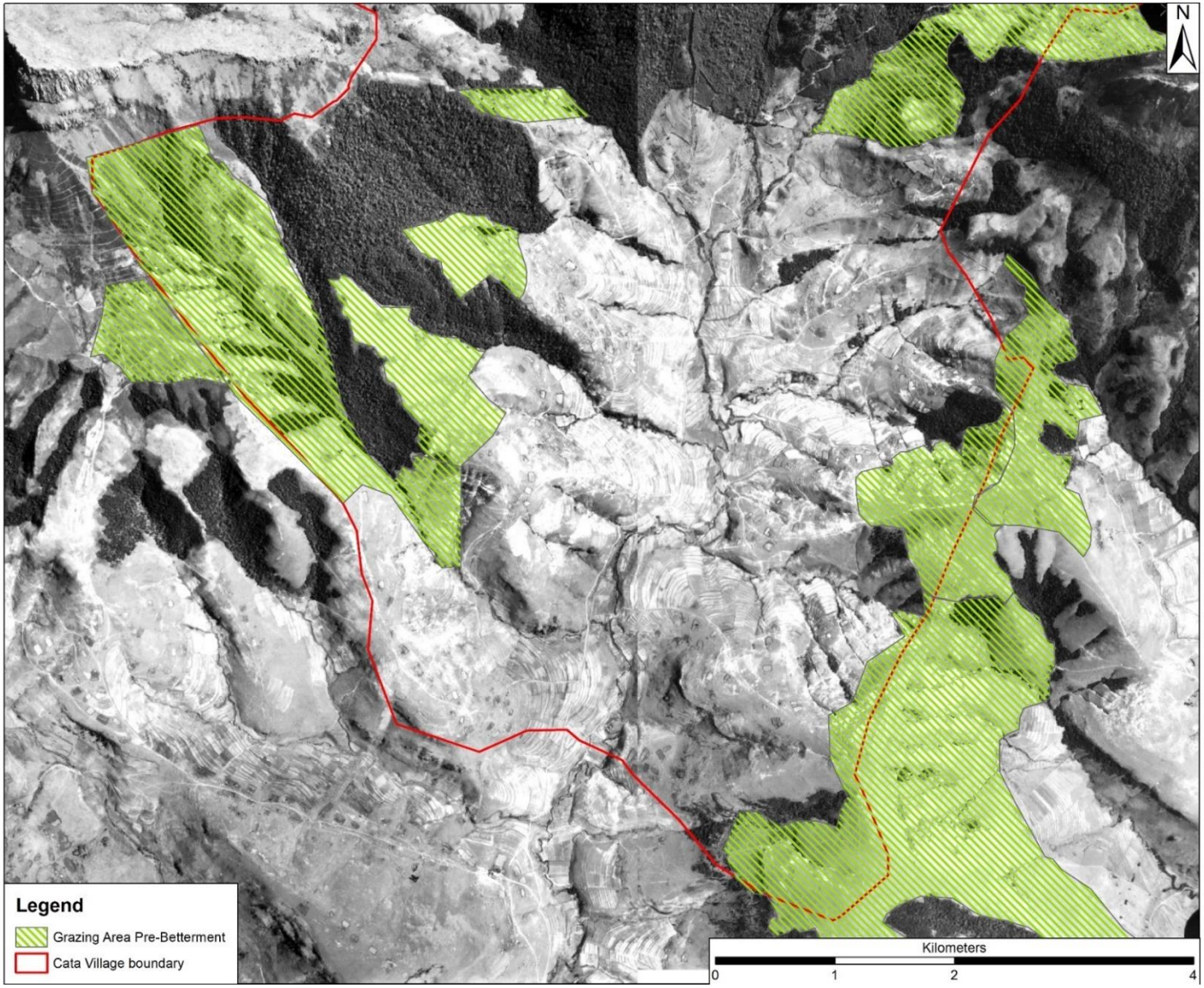

Figure B.5: Enlarged historical aerial imagery from the NGI illustrating the location of approximate location of grazing land (QGIS) (place marker)

j

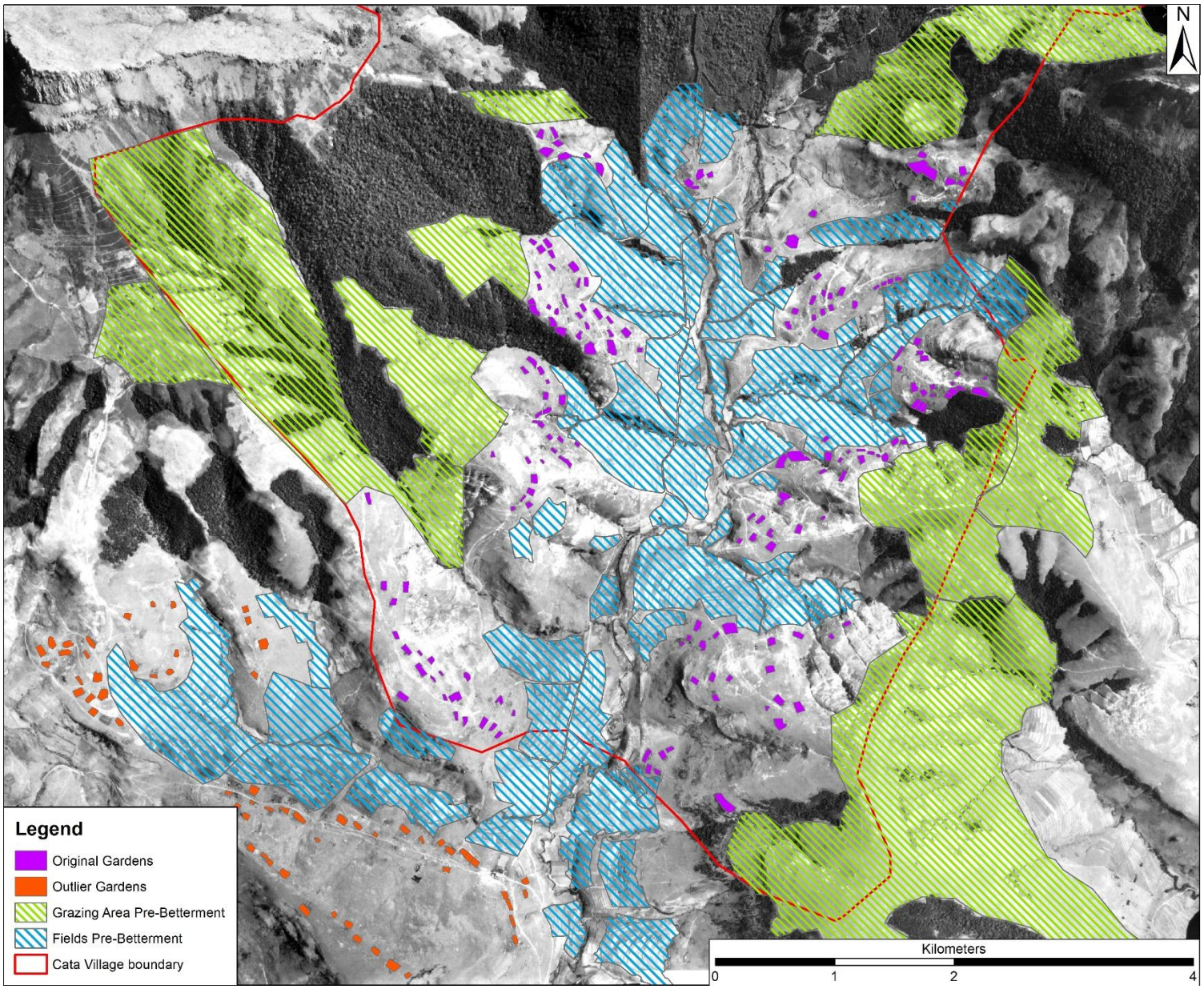

Figure B.6: Enlarged historical aerial imagery from the NGI displaying land allocations in Cata (QGIS)

k



Figure B.7: Enlarged satellite image of Cata depicting slope (elevation exaggeration of 2) (Google Earth)

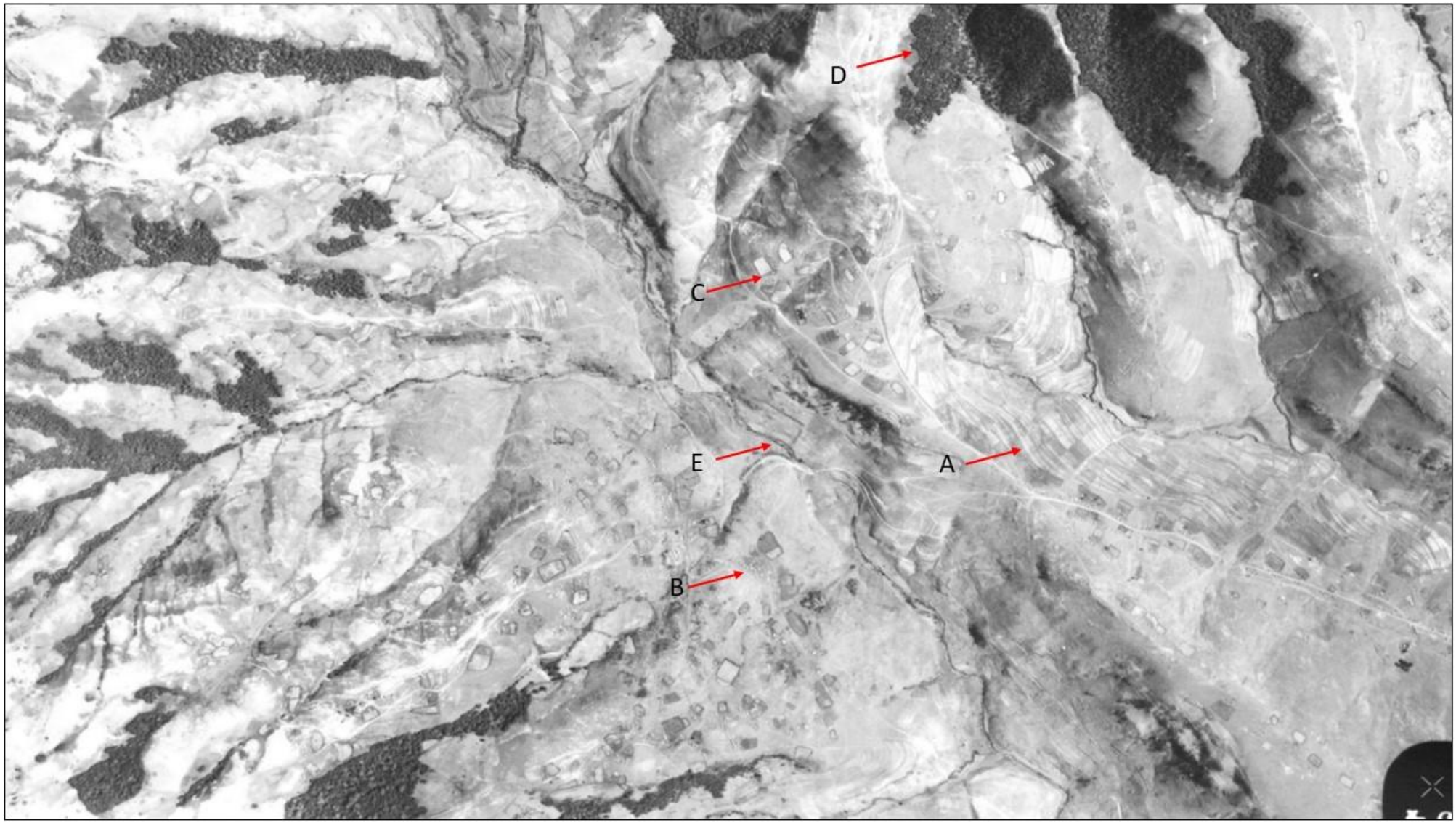

Figure B.8: Enlarged historical aerial imagery from the NGI displaying land different features in Cata- A- An example of visible fields, B- An example of homesteads, C- An example of a garden, D- an example of a forested area, E- Cata River

m

Appendix C – Unedited imagery

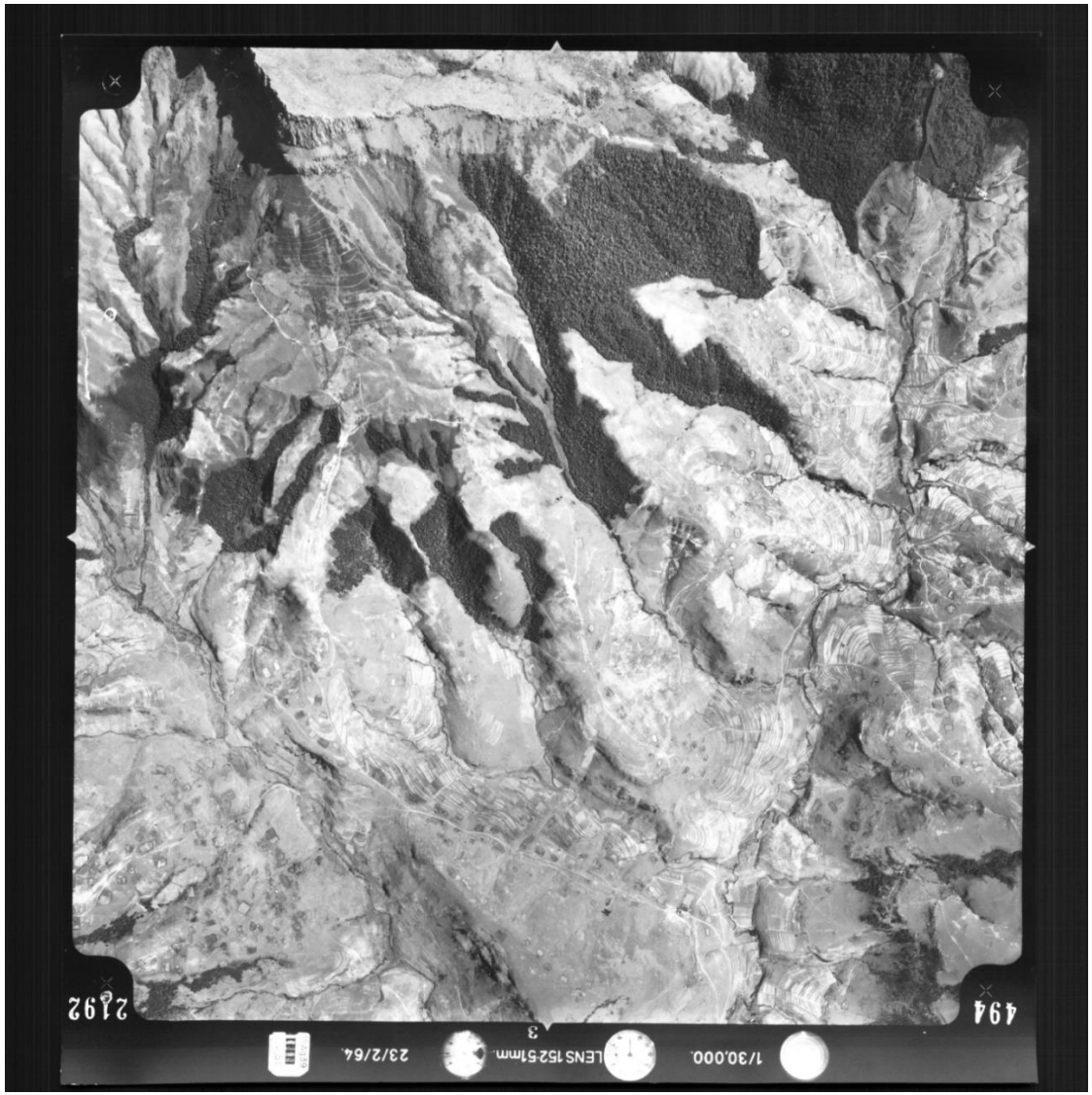

Figure C.1: Historical Aerial photograph of Cata (NGI)

n

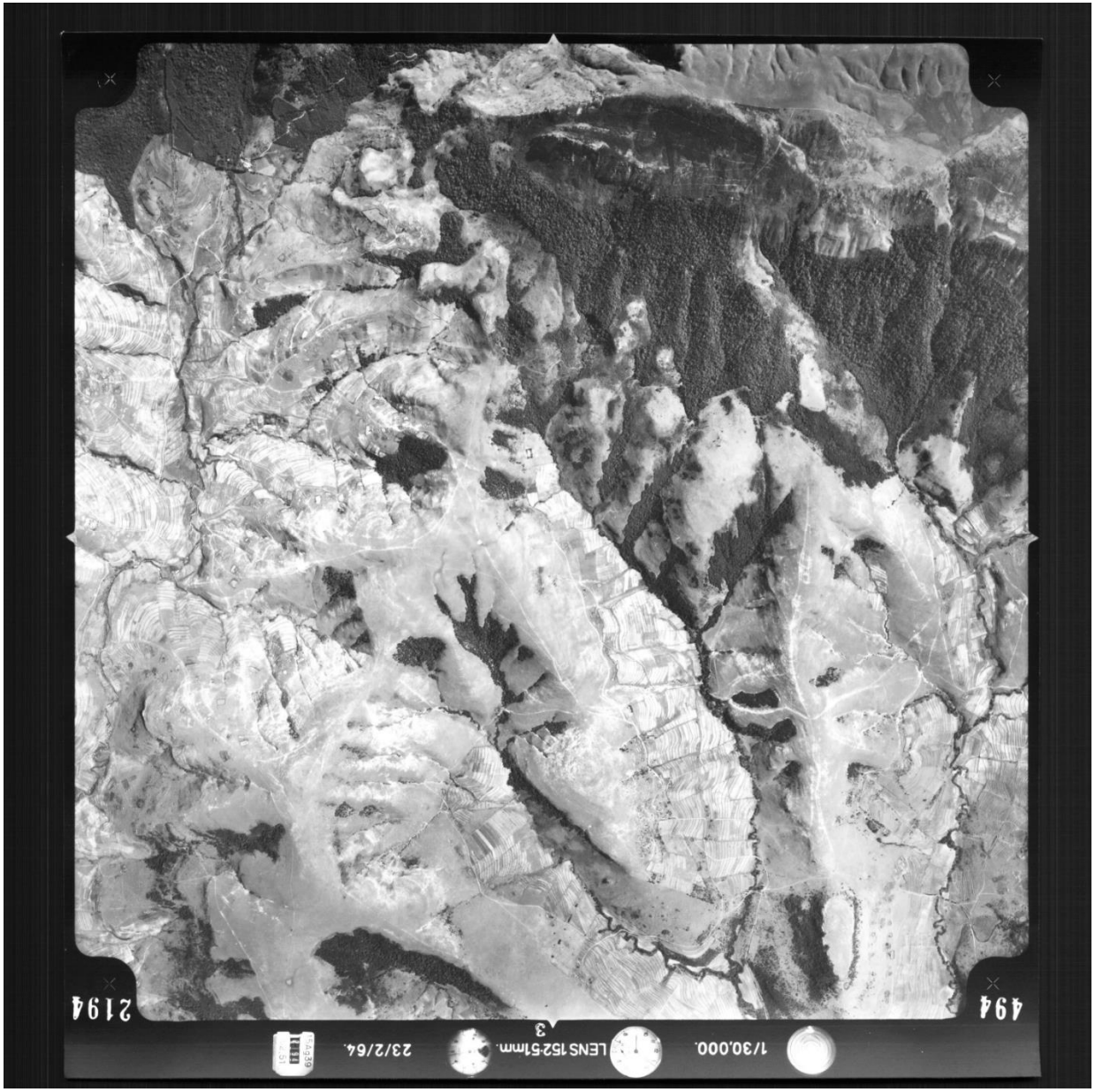

Figure C.2: Historical Aerial photograph of Cata (NGI)

o

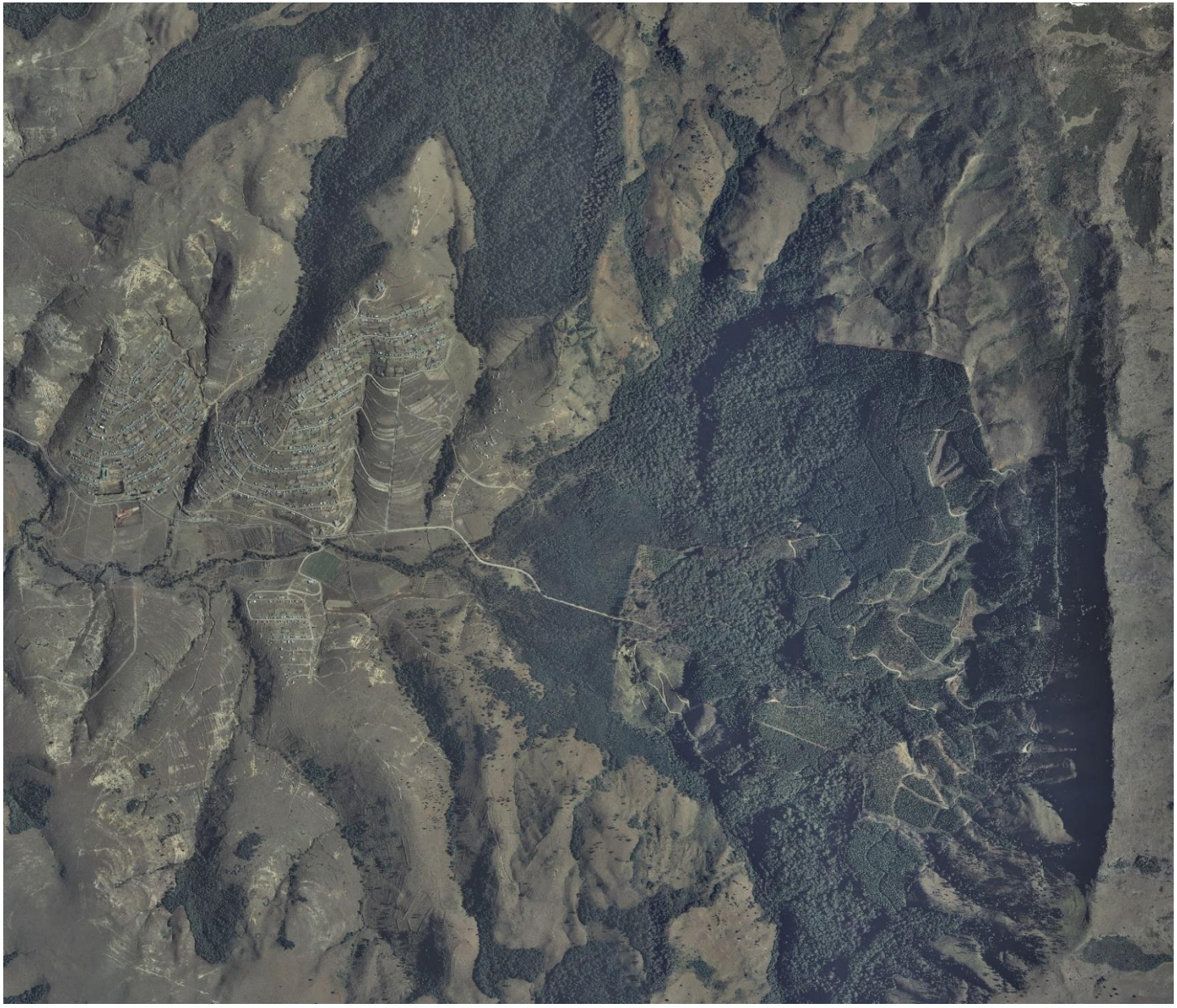

Figure C.3: Aerial Image of Cata (NGI)

p

Appendix D – Table of yields for maize/sorghum, and areas calculated for pre-Betterment gardens

Table D.1: Yield and area calculations for 178 pre-Betterment gardens in Cata anthropological figures derived from de Wet 1985.

Name	Area (m²)	Maize Min (kg)	Maize Max (kg)	Maize Anthro (kg)	Sorghum Min (kg)	Sorghum Max (kg)	Sorghum Anthro(kg)
OG1	8 872	1 082.94	4 081.15	1 770.68	637.02	3 168.36	804.87
OG2	1 499	182.97	689.54	299.17	107.63	535.32	135.99
OG3	2 198	268.29	1 011.09	438.68	157.82	784.95	199.4
OG4	1 328	162.1	610.88	265.04	95.35	474.25	120.48
OG5	2 090	255.11	961.41	417.12	150.06	746.38	189.6
OG6	2 832	345.68	1 302.73	565.21	203.34	1 011.36	256.92
OG7	4 640	566.37	2 134.41	926.06	333.16	1 657.03	420.94
OG8	3 973	484.96	1 827.59	792.94	285.27	1 418.83	360.43
OG9	3 357	409.77	1 544.23	669.99	241.04	1 198.85	304.55
OG10	738	90.08	339.48	147.29	52.99	263.55	66.95
OG11	2 716	331.52	1 249.37	542.06	195.01	969.94	246.4
OG12	1 290	157.46	593.4	257.46	92.62	460.68	117.03
OG13	2 249	274.52	1 034.55	448.86	161.48	803.16	204.03
OG14	1 776	216.78	816.97	354.46	127.52	634.24	161.12
OG15	2 073	253.04	953.59	413.73	148.84	740.31	188.06
OG16	2 489	303.81	1 144.95	496.76	178.71	888.87	225.8
OG17	1 333	162.71	613.18	266.04	95.71	476.04	120.93
OG18	2 703	329.94	1 243.39	539.47	194.08	965.29	245.22
OG19	1 019	124.38	468.74	203.37	73.17	363.9	92.44
OG20	724	88.37	333.04	144.5	51.98	258.55	65.68
OG21	2 568	313.46	1 181.29	512.52	184.38	917.08	232.97
OG22	2 442	298.08	1 123.33	487.38	175.34	872.08	221.54
OG23	2 618	319.56	1 204.29	522.5	187.98	934.94	237.5
OG24	998	121.82	459.08	199.18	71.66	356.4	90.54
OG25	1 353	165.15	622.38	270.03	97.15	483.18	122.74
OG26	660	80.56	303.6	131.72	47.39	235.7	59.88
OG27	2 265	276.47	1 041.91	452.05	162.63	808.87	205.48

q

Name	Area (m²)	Maize Min (kg)	Maize Max (kg)	Maize Anthro (kg)	Sorghum Min (kg)	Sorghum Max (kg)	Sorghum Anthro(kg)
OG28	3 272	399.39	1 505.13	653.03	234.93	1 168.49	296.84
OG29	1 805	220.32	830.31	360.24	129.6	644.6	163.75
OG30	2 003	244.49	921.39	399.76	143.82	715.31	181.71
OG31	2 039	248.89	937.95	406.95	146.4	728.17	184.98
OG32	1 318	160.88	606.28	263.05	94.63	470.68	119.57
OG33	1 005	122.67	462.3	200.58	72.16	358.9	91.17
OG34	4 364	532.68	2 007.45	870.97	313.34	1 558.47	395.9
OG35	4 925	601.16	2 265.51	982.94	353.62	1 758.81	446.8
OG36	3 764	459.45	1 731.45	751.22	270.26	1 344.2	341.47
OG37	1 187	144.89	546.02	236.9	85.23	423.9	107.68
OG38	2 169	264.75	997.75	432.89	155.74	774.59	196.77
OG39	2 752	335.92	1 265.93	549.25	197.6	982.79	249.66
OG40	789	96.31	362.94	157.47	56.65	281.77	71.58
OG41	504	61.52	231.84	100.59	36.19	179.99	45.72
OG42	986	120.35	453.56	196.79	70.8	352.12	89.45
OG43	2 170	264.88	998.21	433.09	155.81	774.95	196.86
OG44	1 010	123.28	464.6	201.58	72.52	360.69	91.63
OG45	1 290	157.46	593.4	257.46	92.62	460.68	117.03
OG46	575	70.19	264.5	114.76	41.29	205.34	52.16
OG47	2 240	273.42	1 030.41	447.06	160.83	799.95	203.21
OG48	2 014	245.83	926.45	401.96	144.61	719.24	182.71
OG49	1 187	144.89	546.02	236.9	85.23	423.9	107.68
OG50	5 229	638.27	2 405.36	1 043.61	375.45	1 867.38	474.37
OG51	1 426	174.06	655.96	284.6	102.39	509.25	129.37
OG52	2 554	311.75	1 174.85	509.73	183.38	912.08	231.7
OG53	1 522	185.78	700.12	303.76	109.28	543.54	138.08
OG54	1 035	126.34	476.1	206.57	74.31	369.62	93.9
OG55	1 114	135.98	512.44	222.33	79.99	397.83	101.06
OG56	604	73.73	277.84	120.55	43.37	215.7	54.79
OG57	1 606	196.03	738.76	320.53	115.31	573.53	145.7
OG58	471	57.49	216.66	94	33.82	168.2	42.73

r

Name	Area (m²)	Maize Min (kg)	Maize Max (kg)	Maize Anthro (kg)	Sorghum Min (kg)	Sorghum Max (kg)	Sorghum Anthro(kg)
OG59	1 167	142.45	536.82	232.91	83.79	416.76	105.87
OG60	2 574	314.19	1 184.05	513.72	184.82	919.22	233.51
OG61	1 341	163.69	616.86	267.64	96.29	478.9	121.66
OG62	2 094	255.6	963.25	417.92	150.35	747.81	189.97
OG63	2 176	265.61	1 000.97	434.29	156.24	777.09	197.41
OG64	541	66.04	248.86	107.97	38.84	193.2	49.08
OG65	1 051	128.29	483.46	209.76	75.46	375.33	95.35
OG66	1 161	141.72	534.06	231.71	83.36	414.62	105.33
OG67	930	113.52	427.8	185.61	66.77	332.12	84.37
OG68	863	105.34	396.98	172.24	61.96	308.19	78.29
OG69	1 773	216.42	815.59	353.86	127.3	633.17	160.85
OG70	1 223	149.28	562.58	244.09	87.81	436.76	110.95
OG71	3 928	479.46	1 806.89	783.95	282.03	1 402.76	356.35
OG72	2 248	274.4	1 034.09	448.66	161.41	802.8	203.94
OG73	1 301	158.8	598.46	259.65	93.41	464.61	118.03
OG74	1 331	162.47	612.26	265.64	95.57	475.33	120.75
OG75	1 471	179.55	676.66	293.58	105.62	525.32	133.45
OG76	1 084	132.32	498.64	216.35	77.83	387.12	98.34
OG77	1 725	210.56	793.51	344.28	123.86	616.03	156.49
OG78	1 169	142.69	537.74	233.31	83.94	417.47	106.05
OG79	1 968	240.22	905.29	392.78	141.3	702.81	178.54
OG80	1 740	212.39	800.41	347.27	124.93	621.39	157.85
OG81	1 790	218.49	823.41	357.25	128.52	639.24	162.39
OG82	1 600	195.3	736	319.33	114.88	571.39	145.15
OG83	1 959	239.12	901.15	390.98	140.66	699.6	177.72
OG84	851	103.88	391.46	169.84	61.1	303.91	77.2
OG85	15 135	1 847.42	6 962.15	3 020.66	1 086.71	5 405	1 373.05
OG86	2 205	269.15	1 014.31	440.08	158.32	787.45	200.04
OG87	2 909	355.08	1 338.15	580.58	208.87	1 038.86	263.9
OG88	2 919	356.3	1 342.75	582.58	209.59	1 042.43	264.81
OG89	1 344	164.05	618.24	268.24	96.5	479.97	121.93

s

Name	Area (m²)	Maize Min (kg)	Maize Max (kg)	Maize Anthro (kg)	Sorghum Min (kg)	Sorghum Max (kg)	Sorghum Anthro(kg)
OG90	2 128	259.75	978.89	424.71	152.79	759.95	193.05
OG91	1 937	236.44	891.03	386.59	139.08	691.74	175.72
OG92	2 170	264.88	998.21	433.09	155.81	774.95	196.86
OG93	2 483	303.08	1 142.19	495.56	178.28	886.73	225.26
OG94	6 776	827.1	3 116.98	1 352.36	486.52	2 419.84	614.72
OG95	3 249	396.58	1 494.55	648.44	233.28	1 160.28	294.75
OG96	2 700	329.57	1 242.01	538.87	193.86	964.22	244.94
OG97	1 134	138.42	521.64	226.32	81.42	404.97	102.88
OG98	1 421	173.45	653.66	283.6	102.03	507.47	128.91
OG99	3 793	462.98	1 744.79	757.01	272.34	1 354.55	344.1
OG100	1 361	166.13	626.06	271.63	97.72	486.04	123.47
OG101	3 491	426.12	1 605.87	696.74	250.66	1 246.7	316.7
OG102	4 544	554.65	2 090.25	906.9	326.26	1 622.75	412.23
OG103	2 426	296.12	1 115.97	484.18	174.19	866.37	220.09
OG104	2 265	276.47	1 041.91	452.05	162.63	808.87	205.48
OG105	2 132	260.24	980.73	425.51	153.08	761.38	193.42
OG106	1 515	184.93	696.9	302.37	108.78	541.04	137.44
OG107	2 284	278.79	1 050.65	455.84	163.99	815.66	207.2
OG108	2 501	305.28	1 150.47	499.15	179.57	893.15	226.89
OG109	1 772	216.3	815.13	353.66	127.23	632.81	160.76
OG110	3 374	411.84	1 552.05	673.39	242.26	1 204.92	306.09
OG111	1 881	229.6	865.27	375.41	135.06	671.74	170.64
OG112	1 311	160.02	603.06	261.65	94.13	468.18	118.93
OG113	1 042	127.19	479.32	207.96	74.82	372.12	94.53
OG114	1 163	141.96	534.98	232.11	83.5	415.33	105.51
OG115	1 269	154.9	583.74	253.27	91.12	453.18	115.12
OG116	1 683	205.43	774.19	335.89	120.84	601.03	152.68
OG117	3 496	426.73	1 608.17	697.74	251.02	1 248.49	317.16
OG118	2 649	323.34	1 218.55	528.69	190.2	946.01	240.32
OG119	3 525	430.27	1 621.51	703.52	253.1	1 258.84	319.79
OG120	816	99.6	375.36	162.86	58.59	291.41	74.03

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Name	Area (m²)	Maize Min (kg)	Maize Max (kg)	Maize Anthro (kg)	Sorghum Min (kg)	Sorghum Max (kg)	Sorghum Anthro(kg)
OG121	1 162	141.84	534.52	231.91	83.43	414.97	105.42
OG122	1 949	237.9	896.55	388.98	139.94	696.02	176.81
OG123	1 585	193.47	729.1	316.34	113.8	566.03	143.79
OG124	1 134	138.42	521.64	226.32	81.42	404.97	102.88
OG125	2 481	302.84	1 141.27	495.16	178.14	886.01	225.08
OG126	1 210	147.7	556.6	241.49	86.88	432.11	109.77
OG127	1 624	198.23	747.04	324.12	116.6	579.96	147.33
OG128	5 199	634.61	2 391.56	1 037.62	373.29	1 856.66	471.65
OG129	1 204	146.96	553.84	240.3	86.45	429.97	109.23
OG130	5 419	661.46	2 492.76	1 081.53	389.09	1 935.23	491.61
OG131	2 946	359.6	1 355.17	587.97	211.53	1 052.07	267.26
OG132	1 244	151.85	572.24	248.28	89.32	444.26	112.86
OG133	988	120.6	454.48	197.19	70.94	352.83	89.63
OG134	2 696	329.08	1 240.17	538.07	193.58	962.79	244.58
OG135	1 618	197.5	744.28	322.92	116.17	577.82	146.78
OG136	612	74.7	281.52	122.14	43.94	218.56	55.52
OG137	1 834	223.86	843.65	366.03	131.68	654.96	166.38
OG138	1 888	230.45	868.49	376.81	135.56	674.24	171.28
OG139	3 022	368.87	1 390.13	603.13	216.98	1 079.21	274.16
OG140	2 016	246.08	927.37	402.36	144.75	719.95	182.89
OG141	1 338	163.32	615.48	267.04	96.07	477.83	121.38
OG142	730	89.11	335.8	145.69	52.41	260.7	66.23
OG143	1 435	175.16	660.1	286.4	103.03	512.47	130.18
OG144	1 166	142.33	536.36	232.71	83.72	416.4	105.78
OG145	1 137	138.79	523.02	226.92	81.64	406.04	103.15
OG146	976	119.13	448.96	194.79	70.08	348.55	88.54
OG147	1 136	138.66	522.56	226.72	81.57	405.69	103.06
OG148	2 708	330.55	1 245.69	540.47	194.44	967.08	245.67
OG149	857	104.61	394.22	171.04	61.53	306.05	77.75
OG150	892	108.88	410.32	178.03	64.05	318.55	80.92
OG151	2 081	254.01	957.27	415.33	149.42	743.16	188.79

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Name	Area (m²)	Maize Min (kg)	Maize Max (kg)	Maize Anthro (kg)	Sorghum Min (kg)	Sorghum Max (kg)	Sorghum Anthro(kg)
OG152	1 438	175.53	661.48	287	103.25	513.54	130.46
OG153	829	101.19	381.34	165.45	59.52	296.05	75.21
OG154	852	104	391.92	170.04	61.17	304.27	77.29
OG155	2 352	287.09	1 081.93	469.41	168.88	839.94	213.37
OG156	2 467	301.13	1 134.83	492.37	177.13	881.01	223.81
OG157	1 910	233.14	878.61	381.2	137.14	682.1	173.28
OG158	1 781	217.39	819.27	355.45	127.88	636.03	161.57
OG159	2 565	313.09	1 179.91	511.93	184.17	916.01	232.7
OG160	696	84.96	320.16	138.91	49.97	248.55	63.14
OG161	1 665	203.23	765.9	332.3	119.55	594.6	151.05
OG162	2 837	346.29	1 305.03	566.21	203.7	1 013.15	257.37
OG163	640	78.12	294.4	127.73	45.95	228.56	58.06
OG164	821	100.21	377.66	163.86	58.95	293.19	74.48
OG165	2 032	248.03	934.73	405.55	145.9	725.67	184.34
OG166	4 146	506.07	1 907.17	827.46	297.69	1 480.62	376.13
OG167	984	120.11	452.64	196.39	70.65	351.41	89.27
OG168	3 379	412.45	1 554.35	674.38	242.62	1 206.71	306.54
OG169	1 319	161	606.74	263.25	94.71	471.04	119.66
OG170	1 724	210.44	793.05	344.08	123.78	615.67	156.4
OG171	1 619	197.62	744.74	323.12	116.25	578.18	146.88
OG172	1 636	199.7	752.56	326.51	117.47	584.25	148.42
OG173	3 613	441.01	1 661.99	721.09	259.42	1 290.27	327.77
OG174	2 707	330.42	1 245.23	540.27	194.37	966.72	245.58
OG175	534	65.18	245.64	106.58	38.34	190.7	48.44
OG176	2 839	346.54	1 305.95	566.61	203.84	1 013.86	257.55
OG177	780	95.21	358.8	155.67	56	278.55	70.76
OG178	1 852	226.06	851.93	369.62	132.98	661.38	168.01
Total	367 898	44 906.73	169 234.18	73 425.45	26 415.44	131 383.37	33 375.71
Average	2 066.84	252.29	950.75	412.5	148.4	738.11	187.5

Appendix E – Expanded pre-Betterment graphs

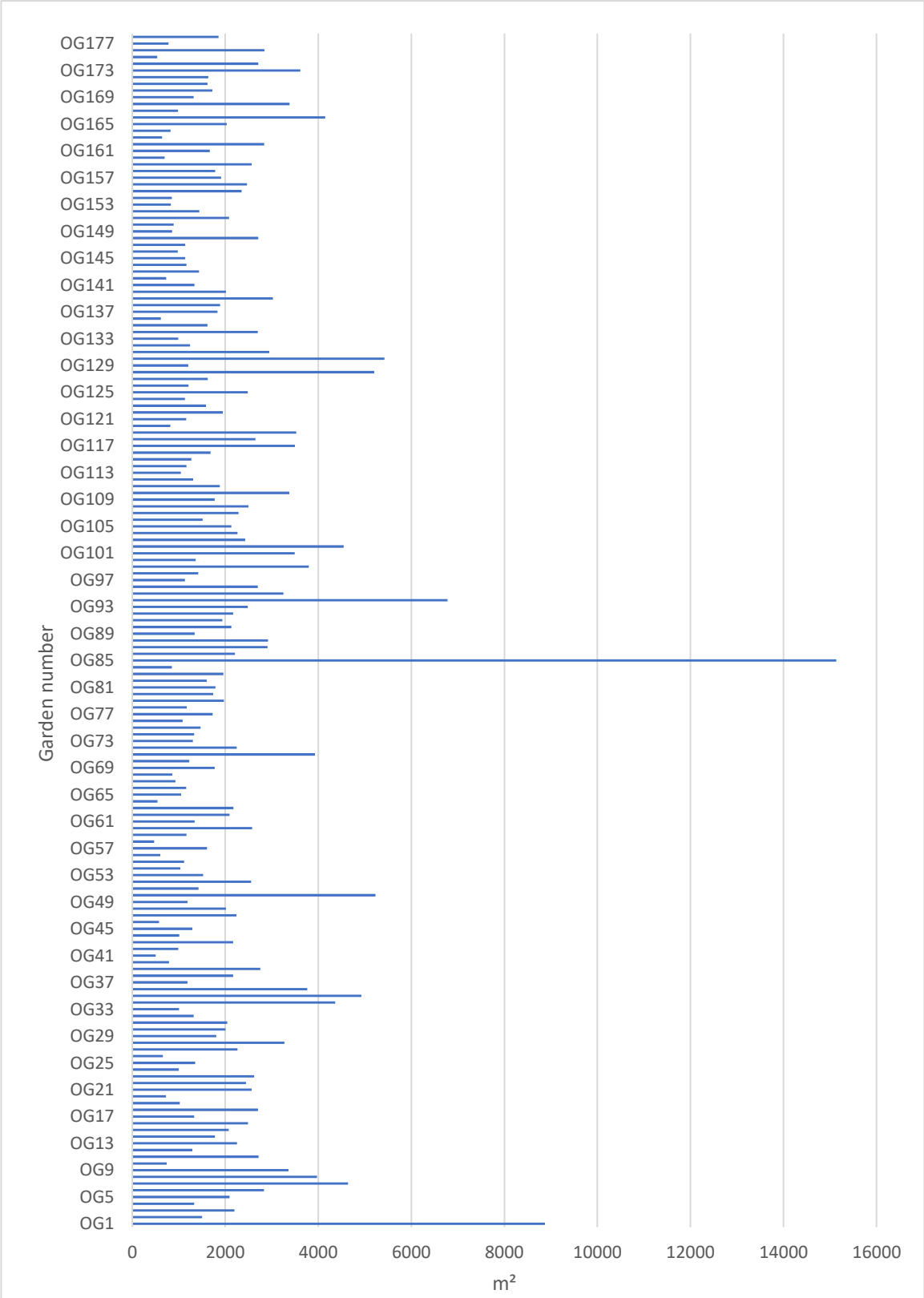

Figure E.1: Expanded graph depicting the surface area's calculated for the visible gardens in Cata

w

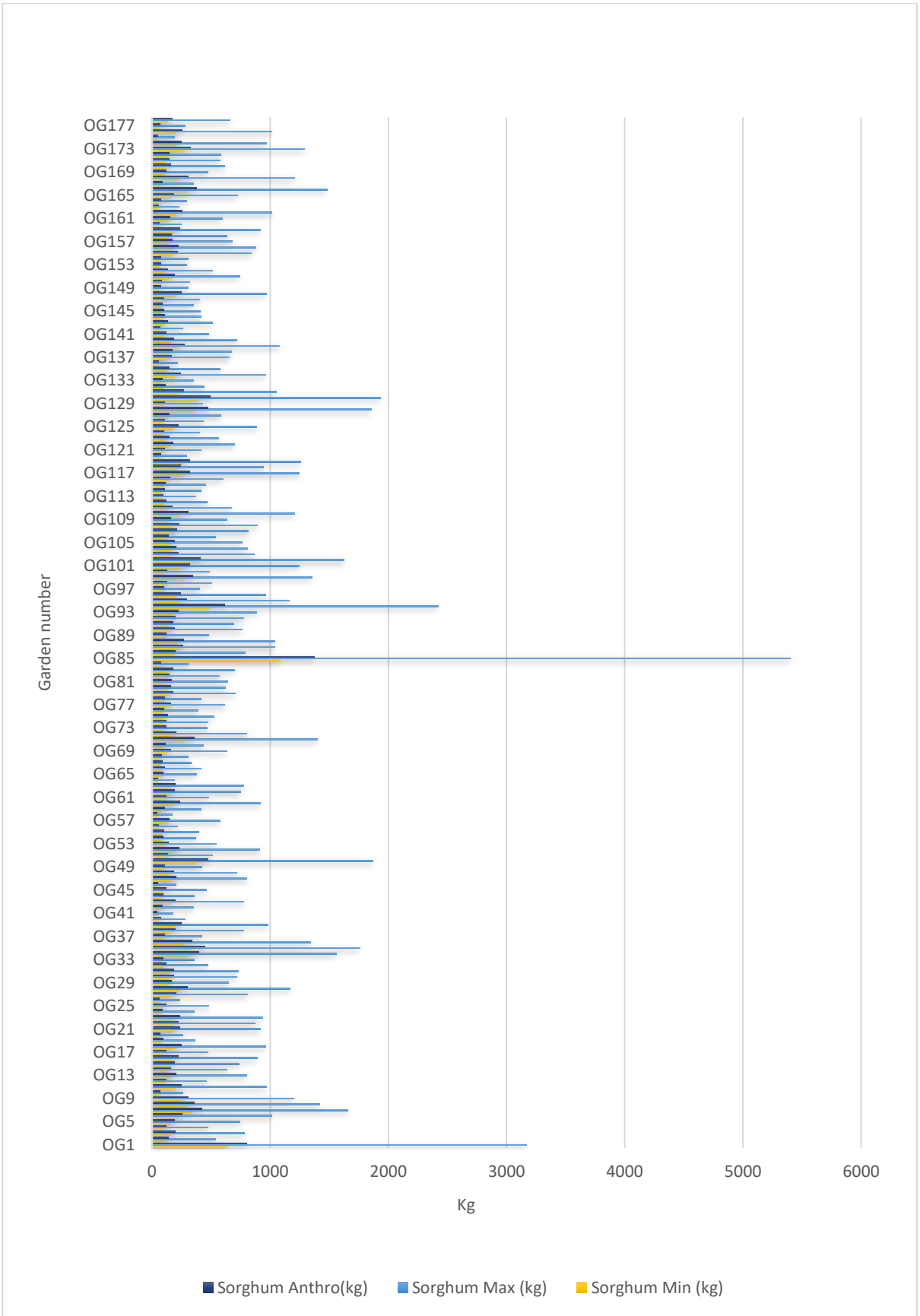

Figure E.2: Expanded chart depicting comparative maximum, minimum and anthropologically based (de Wet 1985) yield figures for sorghum production

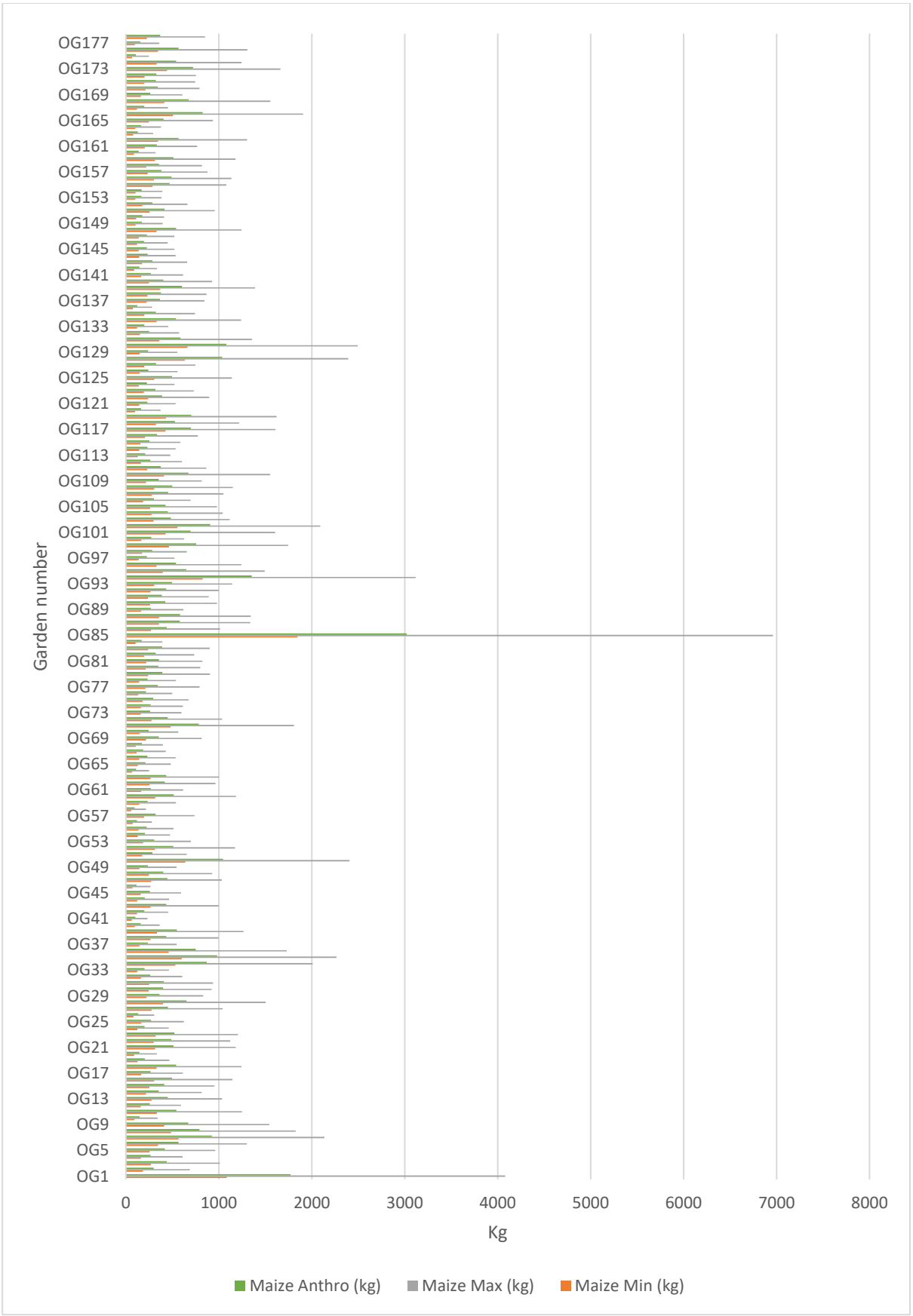

Figure E.3: Expanded chart depicting comparative maximum, minimum and anthropologically based (de Wet 1985) yield figures for maize production

y

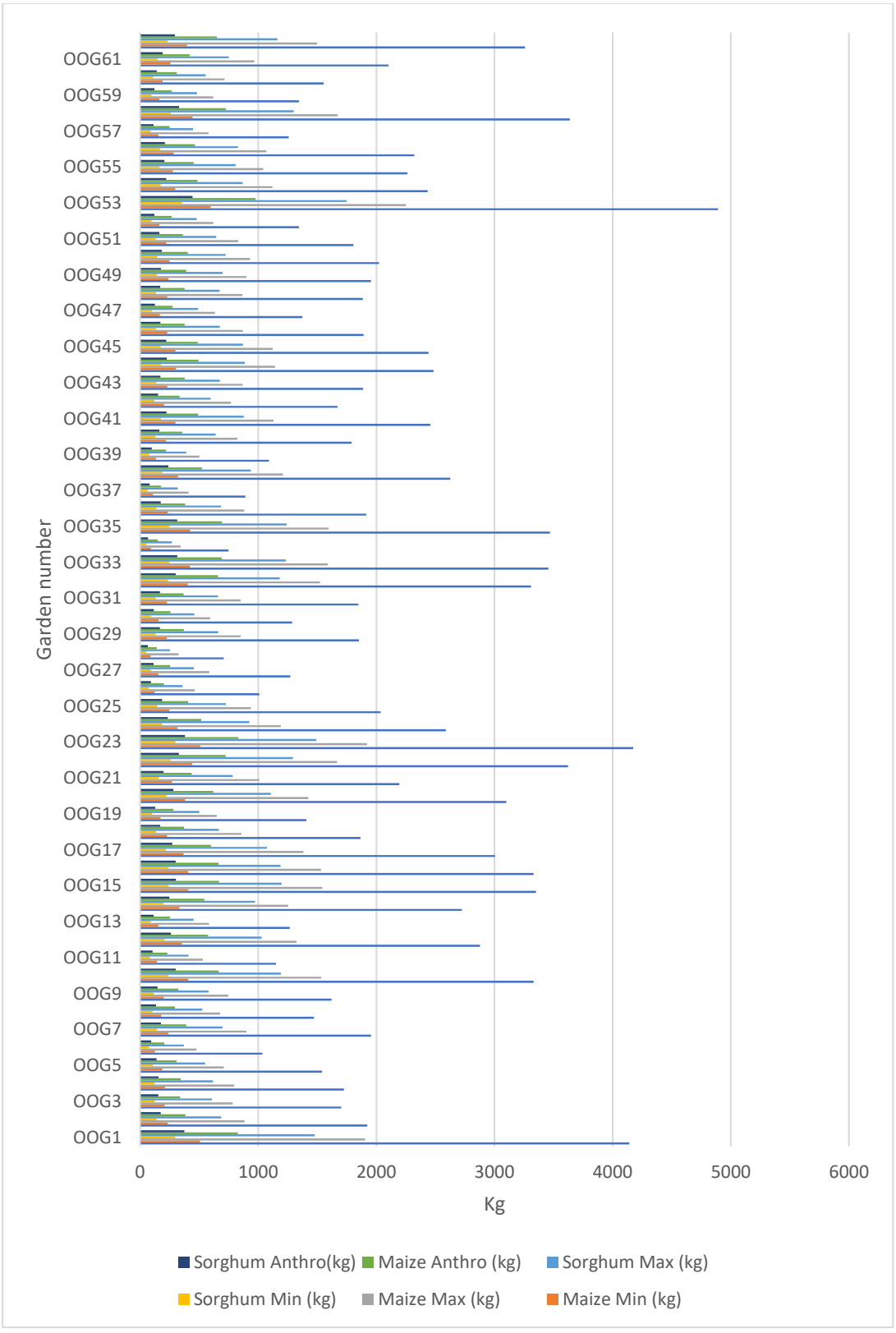

Figure E.4: Enlarged chart depicting comparative maximum, minimum and anthropologically based (de Wet 1985) yield figures for Outlying gardens for both sorghum and maize

z

Appendix F – Figures from and relevant to Chapter Five

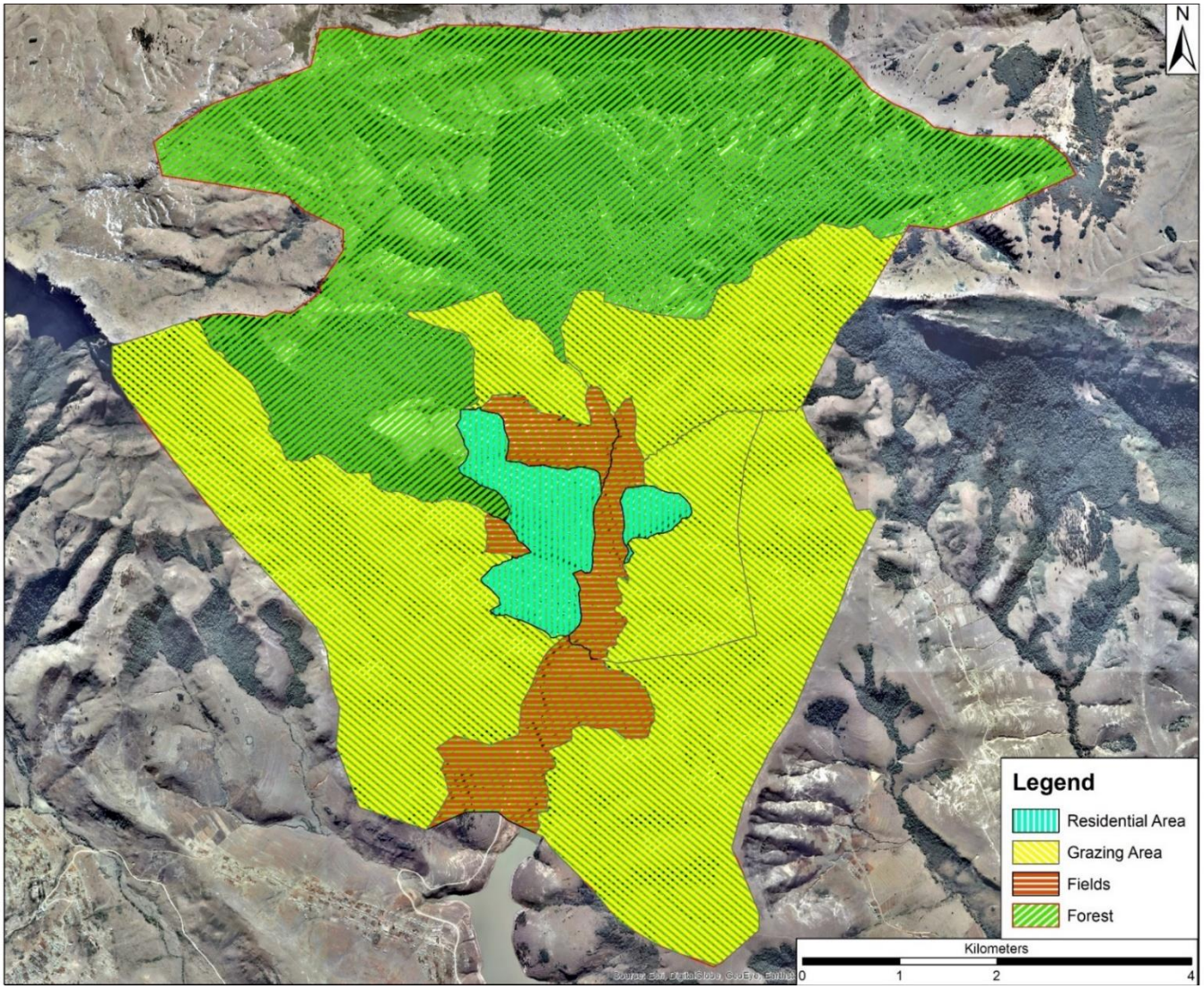

Figure F.1: Enlarged map of Cata showing division of land use after Betterment Planning on aerial imagery (interpreted from de Wet 1985) (ArcGIS)

aa

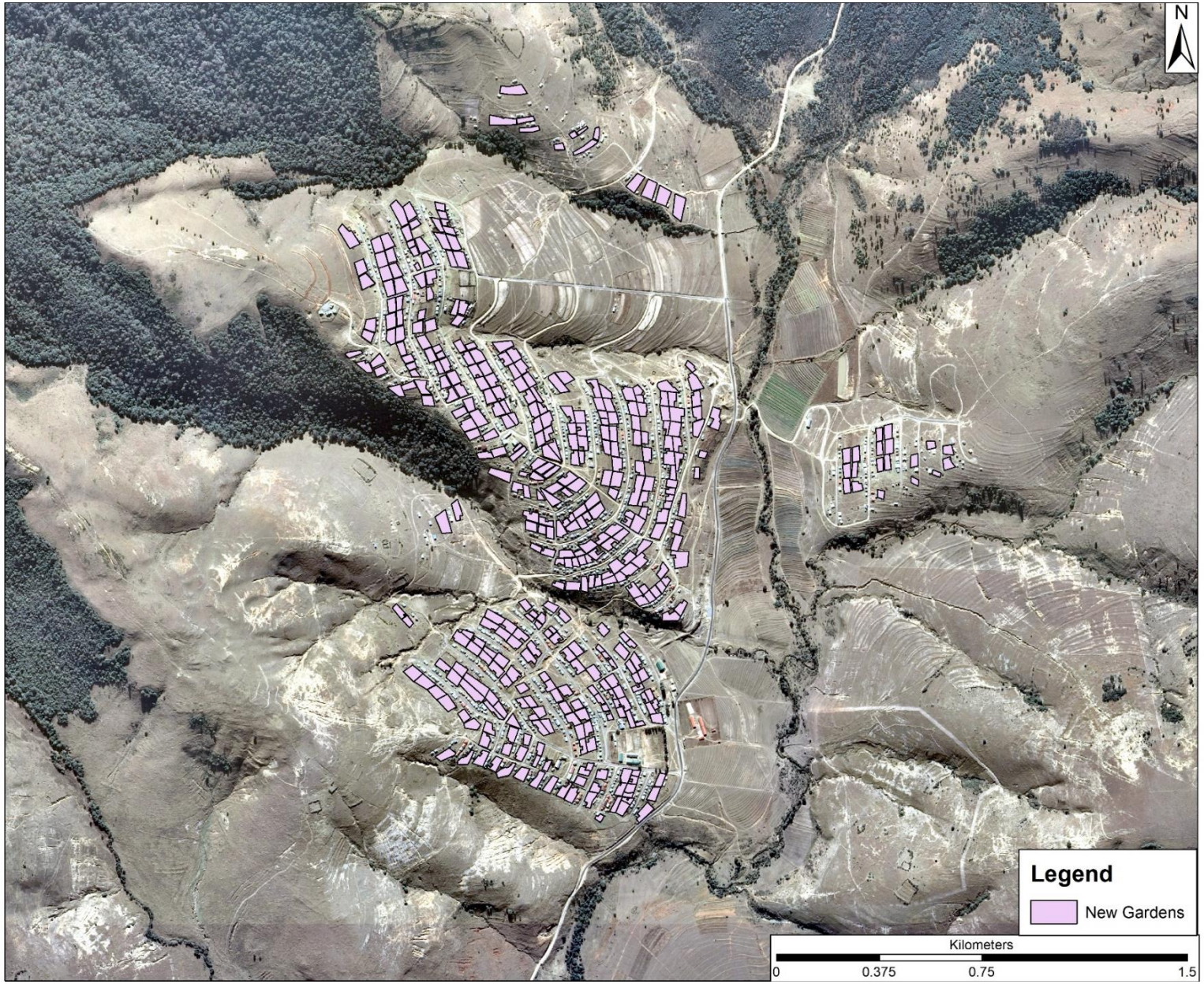

Figure F.2: Enlarged aerial imagery illustrating mapped locations of gardens (QGIS)

bb

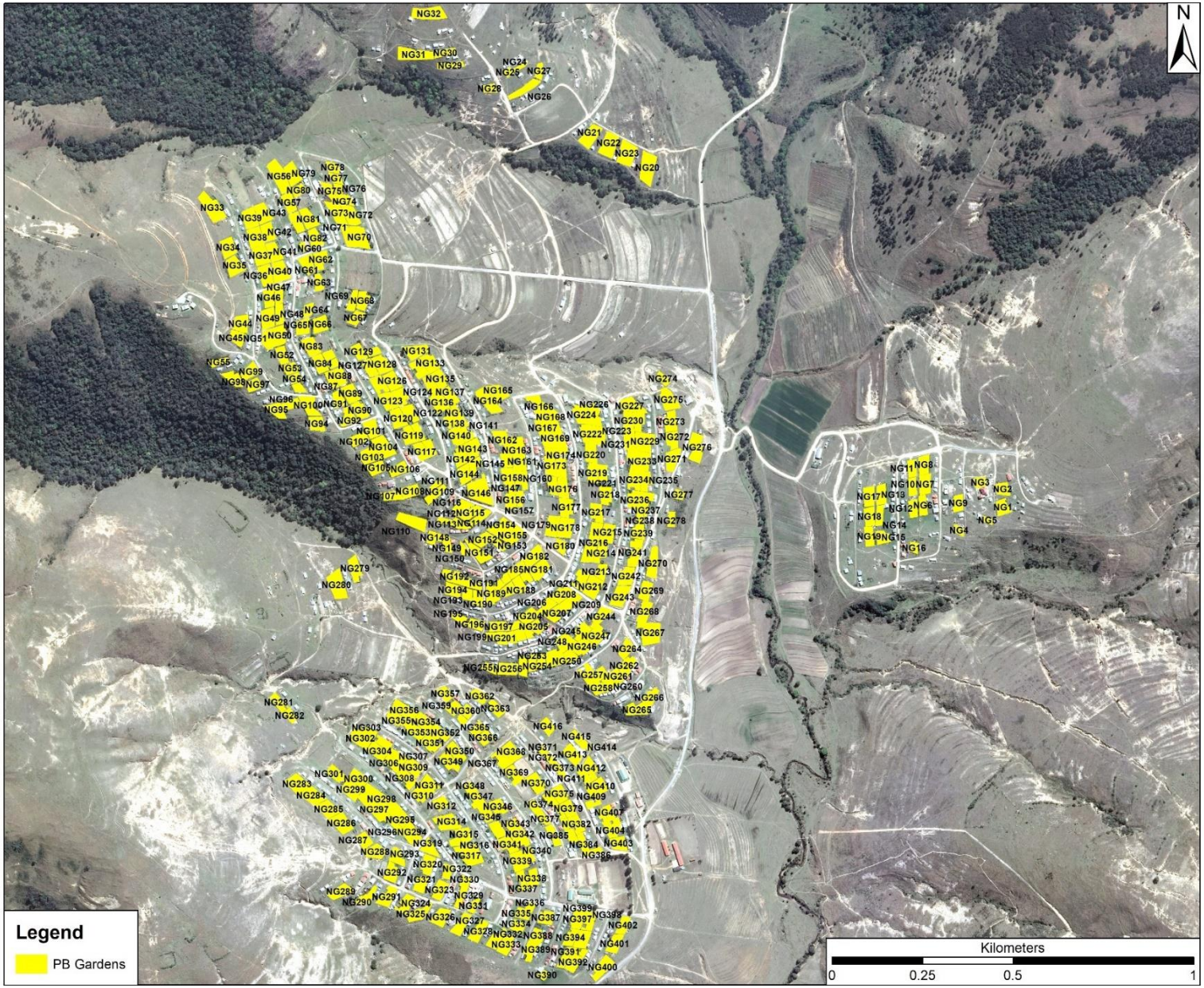

Figure F.3.: Aerial imagery illustrating mapped locations of gardens with labels (QGIS)

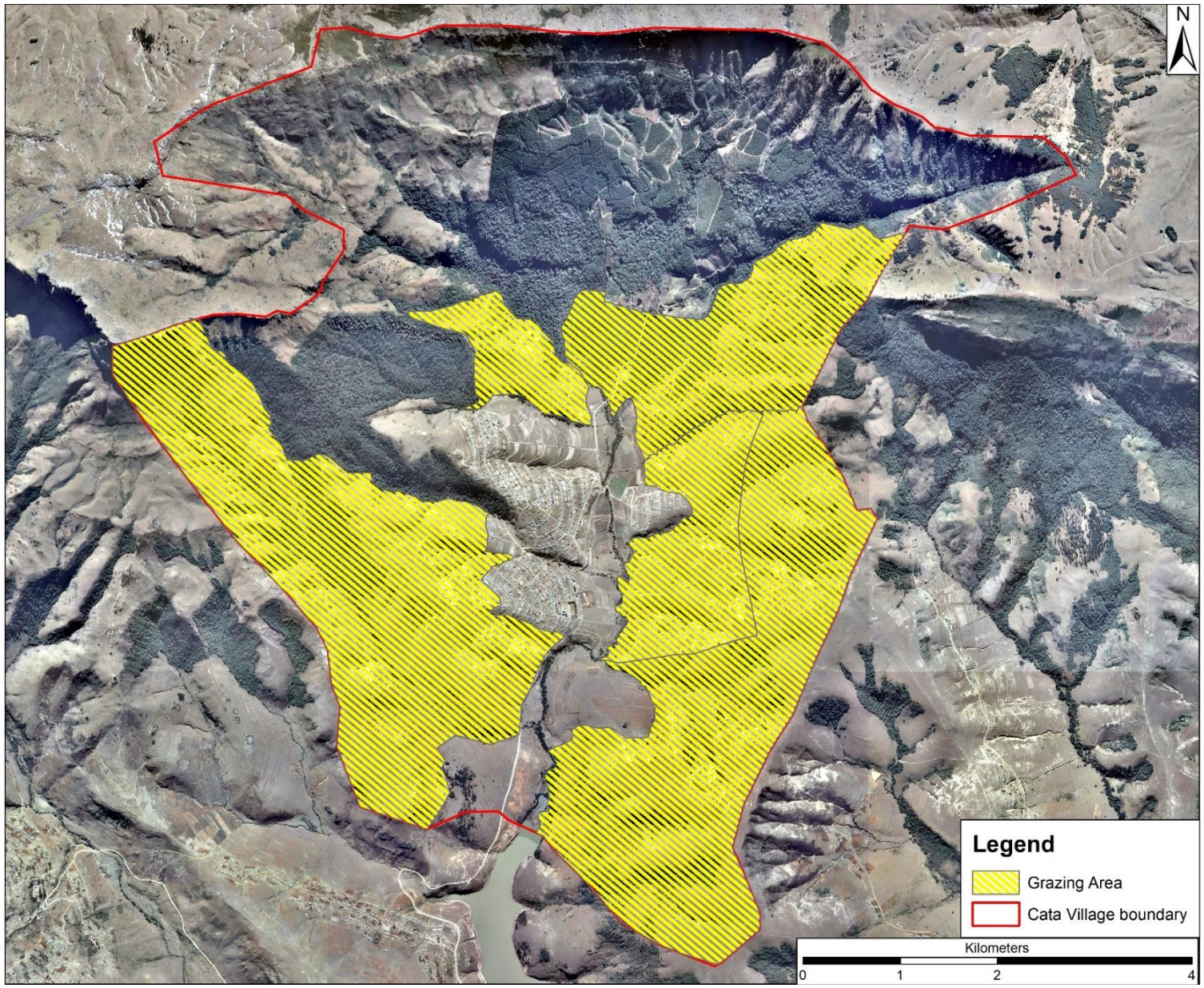

Figure F.4: Enlarged aerial imagery illustrating mapped locations of grazing areas (QGIS)

dd

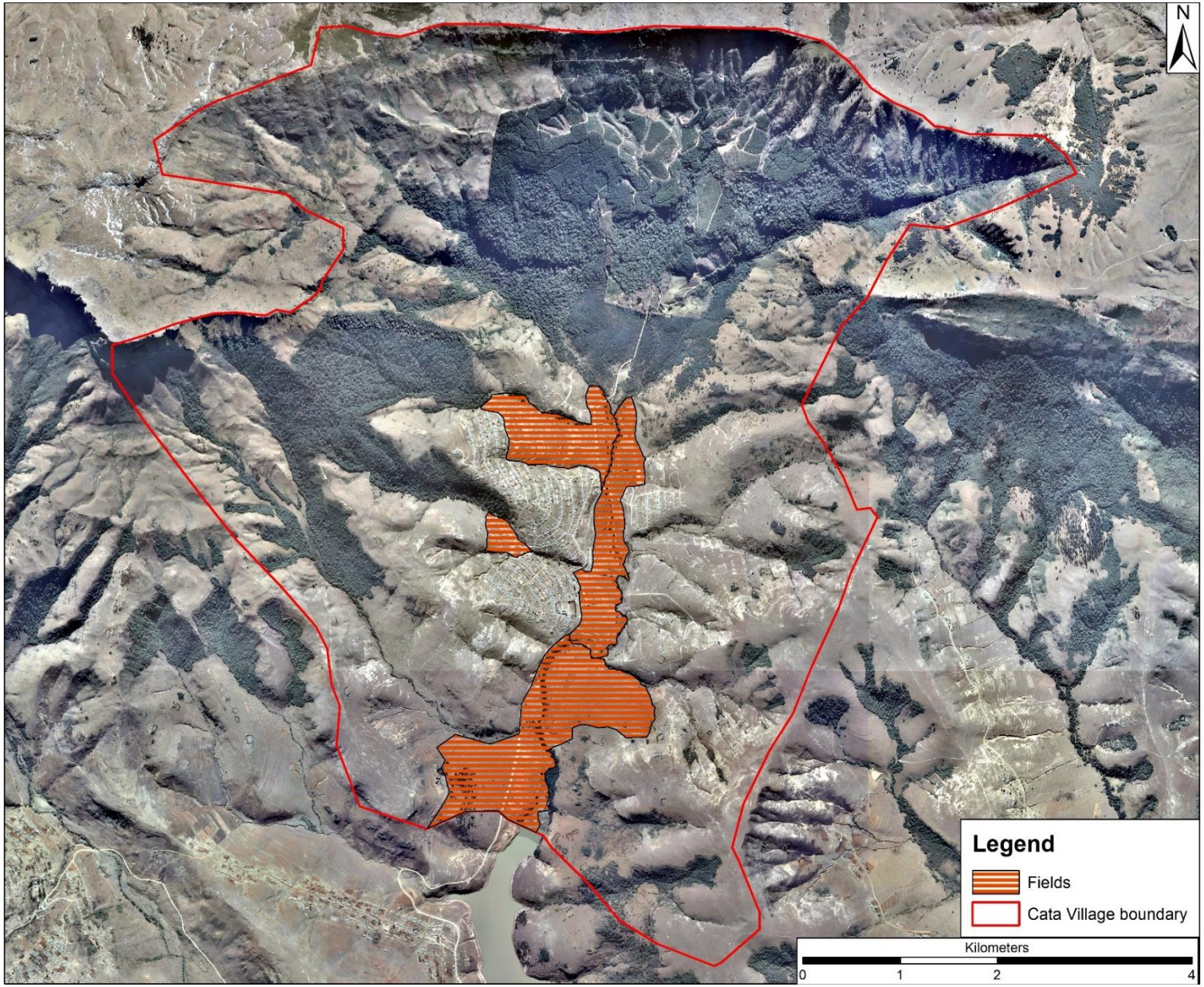

Figure F.5: Enlarged aerial imagery illustrating mapped locations of fields (QGIS)

ee

Appendix G – Table of yields for maize and sorghum, and calculated post-Betterment gardens

Table G.1: Yield and area calculations for 418 post-Betterment gardens in Cata anthropological figures derived from de Wet 1985.

Name	Area (m²)	Maize Min (kg)	Maize Max (kg)	Maize Anthro (kg)	Sorghum Min (kg)	Sorghum Max (kg)	Sorghum Anthro(kg)
NG1	1 003	122.43	461.39	72.02	358.19	200.18	90.99
NG2	866	105.70	398.36	62.18	309.27	172.84	78.56
NG3	628	76.65	288.88	45.09	224.27	125.34	56.97
NG4	465	56.76	213.90	33.39	166.06	92.81	42.18
NG5	361	44.06	166.06	25.92	128.92	72.05	32.75
NG6	876	106.93	402.96	62.90	312.84	174.83	79.47
NG7	1 216	148.43	559.37	87.31	434.26	242.69	110.32
NG8	1 078	131.58	495.89	77.40	384.97	215.15	97.80
NG9	871	106.32	400.66	62.54	311.05	173.84	79.02
NG10	799	97.53	367.54	57.37	285.34	159.47	72.49
NG11	802	97.89	368.92	57.58	286.41	160.06	72.76
NG12	809	98.75	372.14	58.09	288.91	161.46	73.39
NG13	1 054	128.65	484.85	75.68	376.40	210.36	95.62
NG14	785	95.82	361.10	56.36	280.34	156.67	71.22
NG15	914	111.56	420.44	65.63	326.41	182.42	82.92
NG16	513	62.62	235.98	36.83	183.20	102.39	46.54
NG17	1 125	137.32	517.51	80.78	401.76	224.53	102.06
NG18	1 033	126.09	475.19	74.17	368.90	206.17	93.71
NG19	963	117.54	442.98	69.14	343.91	192.20	87.36
NG20	2 229	272.07	1 025.35	160.04	796.02	444.87	202.21
NG21	1 984	242.17	912.65	142.45	708.52	395.97	179.99
NG22	1 640	200.18	754.41	117.75	585.68	327.31	148.78
NG23	1 873	228.62	861.59	134.48	668.88	373.82	169.92
NG24	363	44.31	166.98	26.06	129.63	72.45	32.93
NG25	329	40.16	151.34	23.62	117.49	65.66	29.85
NG26	576	70.31	264.96	41.36	205.70	114.96	52.25
NG27	1 195	145.86	549.71	85.80	426.76	238.50	108.41
NG28	587	71.65	270.02	42.15	209.63	117.15	53.25

ff

Name	Area (m²)	Maize Min (kg)	Maize Max (kg)	Maize Anthro (kg)	Sorghum Min (kg)	Sorghum Max (kg)	Sorghum Anthro(kg)
NG29	878	107.17	403.88	63.04	313.55	175.23	79.65
NG30	836	102.04	384.56	60.03	298.55	166.85	75.84
NG31	1 996	243.63	918.17	143.31	712.81	398.36	181.08
NG32	2 019	246.44	928.75	144.97	721.02	402.95	183.16
NG33	2 289	279.40	1 052.95	164.35	817.45	456.84	207.66
NG34	1 355	165.39	623.31	97.29	483.90	270.43	122.93
NG35	1 425	173.94	655.51	102.32	508.89	284.40	129.28
NG36	1 368	166.98	629.29	98.22	488.54	273.03	124.10
NG37	1 460	178.21	671.61	104.83	521.39	291.39	132.45
NG38	1 469	179.31	675.75	105.48	524.61	293.18	133.27
NG39	1 422	173.57	654.13	102.10	507.82	283.80	129.00
NG40	1 584	193.34	728.65	113.73	565.68	316.14	143.70
NG41	1 238	151.11	569.49	88.89	442.11	247.08	112.31
NG42	1 168	142.57	537.29	83.86	417.11	233.11	105.96
NG43	1 387	169.30	638.03	99.59	495.32	276.82	125.83
NG44	1 222	149.16	562.13	87.74	436.40	243.89	110.86
NG45	989	120.72	454.94	71.01	353.19	197.39	89.72
NG46	1 072	130.85	493.13	76.97	382.83	213.95	97.25
NG47	831	101.43	382.26	59.67	296.77	165.85	75.39
NG48	908	110.83	417.68	65.20	324.26	181.22	82.37
NG49	1 367	166.86	628.83	98.15	488.18	272.83	124.01
NG50	1 206	147.21	554.77	86.59	430.69	240.69	109.41
NG51	1 243	151.72	571.79	89.25	443.90	248.08	112.76
NG52	908	110.83	417.68	65.20	324.26	181.22	82.37
NG53	758	92.52	348.68	54.43	270.70	151.28	68.77
NG54	592	72.26	272.32	42.51	211.41	118.15	53.71
NG55	714	87.15	328.44	51.27	254.98	142.50	64.77
NG56	2 219	270.85	1 020.75	159.33	792.45	442.87	201.31
NG57	1 125	137.32	517.51	80.78	401.76	224.53	102.06
NG58	477	58.22	219.42	34.25	170.35	95.20	43.27
NG59	578	70.55	265.88	41.50	206.41	115.36	52.44

gg

Name	Area (m²)	Maize Min (kg)	Maize Max (kg)	Maize Anthro (kg)	Sorghum Min (kg)	Sorghum Max (kg)	Sorghum Anthro(kg)
NG60	288	35.15	132.48	20.68	102.85	57.48	26.13
NG61	1 185	144.64	545.11	85.08	423.19	236.50	107.50
NG62	1 186	144.76	545.57	85.16	423.54	236.70	107.59
NG63	751	91.67	345.46	53.92	268.20	149.89	68.13
NG64	633	77.26	291.18	45.45	226.06	126.33	57.43
NG65	1 098	134.02	505.09	78.84	392.12	219.14	99.61
NG66	1 205	147.08	554.31	86.52	430.33	240.50	109.32
NG67	853	104.12	392.38	61.25	304.62	170.24	77.38
NG68	1 040	126.94	478.41	74.67	371.40	207.56	94.35
NG69	833	101.68	383.18	59.81	297.48	166.25	75.57
NG70	1 672	204.09	769.13	120.05	597.10	333.70	151.68
NG71	1 053	128.53	484.39	75.61	376.05	210.16	95.53
NG72	1 395	170.28	641.71	100.16	498.18	278.42	126.55
NG73	1 486	181.38	683.57	106.70	530.68	296.58	134.81
NG74	730	89.10	335.80	52.41	260.70	145.69	66.23
NG75	848	103.51	390.08	60.89	302.84	169.24	76.93
NG76	405	49.43	186.30	29.08	144.63	80.83	36.74
NG77	597	72.87	274.62	42.87	213.20	119.15	54.16
NG78	644	78.61	296.24	46.24	229.98	128.53	58.42
NG79	1 435	175.16	660.11	103.03	512.47	286.40	130.18
NG80	683	83.37	314.18	49.04	243.91	136.31	61.96
NG81	1 318	160.88	606.29	94.63	470.68	263.05	119.57
NG82	1 097	133.90	504.63	78.77	391.76	218.94	99.52
NG83	1 264	154.29	581.45	90.76	451.40	252.27	114.67
NG84	1 092	133.29	502.33	78.41	389.97	217.94	99.07
NG85	529	64.57	243.34	37.98	188.92	105.58	47.99
NG86	465	56.76	213.90	33.39	166.06	92.81	42.18
NG87	765	93.38	351.90	54.93	273.20	152.68	69.40
NG88	985	120.23	453.10	70.72	351.76	196.59	89.36
NG89	1 273	155.38	585.59	91.40	454.61	254.07	115.49
NG90	1 082	132.07	497.73	77.69	386.40	215.95	98.16

hh

Name	Area (m²)	Maize Min (kg)	Maize Max (kg)	Maize Anthro (kg)	Sorghum Min (kg)	Sorghum Max (kg)	Sorghum Anthro(kg)
NG91	963	117.54	442.98	69.14	343.91	192.20	87.36
NG92	1 066	130.12	490.37	76.54	380.69	212.75	96.71
NG93	523	63.84	240.58	37.55	186.77	104.38	47.45
NG94	1 120	136.71	515.21	80.42	399.97	223.53	101.61
NG95	1 126	137.44	517.97	80.85	402.12	224.73	102.15
NG96	862	105.22	396.52	61.89	307.84	172.04	78.20
NG97	890	108.63	409.40	63.90	317.84	177.63	80.74
NG98	1 080	131.83	496.81	77.55	385.69	215.55	97.98
NG99	1 088	132.80	500.49	78.12	388.55	217.14	98.70
NG100	1 367	166.86	628.83	98.15	488.18	272.83	124.01
NG101	1 160	141.59	533.61	83.29	414.26	231.51	105.24
NG102	1 010	123.28	464.61	72.52	360.69	201.58	91.63
NG103	1 451	177.11	667.47	104.18	518.18	289.59	131.63
NG104	1 770	216.05	814.21	127.09	632.10	353.26	160.57
NG105	1 097	133.90	504.63	78.77	391.76	218.94	99.52
NG106	1 068	130.36	491.29	76.68	381.40	213.15	96.89
NG107	923	112.66	424.58	66.27	329.62	184.21	83.73
NG108	1 108	135.24	509.69	79.56	395.69	221.14	100.52
NG109	974	118.89	448.04	69.93	347.83	194.39	88.36
NG110	354	43.21	162.84	25.42	126.42	70.65	32.11
NG111	1 733	211.53	797.19	124.43	618.89	345.87	157.22
NG112	396	48.34	182.16	28.43	141.42	79.03	35.93
NG113	739	90.20	339.94	53.06	263.91	147.49	67.04
NG114	837	102.17	385.02	60.10	298.91	167.05	75.93
NG115	1 036	126.46	476.57	74.39	369.98	206.77	93.99
NG116	1 012	123.53	465.53	72.66	361.40	201.98	91.81
NG117	1 092	133.29	502.33	78.41	389.97	217.94	99.07
NG118	676	82.51	310.96	48.54	241.41	134.92	61.33
NG119	1 190	145.25	547.41	85.44	424.97	237.50	107.96
NG120	698	85.20	321.08	50.12	249.27	139.31	63.32
NG121	1 313	160.27	603.99	94.27	468.90	262.05	119.12

Name	Area (m²)	Maize Min (kg)	Maize Max (kg)	Maize Anthro (kg)	Sorghum Min (kg)	Sorghum Max (kg)	Sorghum Anthro(kg)
NG122	1 170	142.81	538.21	84.01	417.83	233.51	106.14
NG123	1 262	154.04	580.53	90.61	450.68	251.87	114.49
NG124	1 114	135.98	512.45	79.99	397.83	222.33	101.06
NG125	1 144	139.64	526.25	82.14	408.54	228.32	103.78
NG126	1 265	154.41	581.91	90.83	451.76	252.47	114.76
NG127	983	119.99	452.18	70.58	351.05	196.19	89.18
NG128	1 335	162.95	614.11	95.85	476.75	266.44	121.11
NG129	899	109.73	413.54	64.55	321.05	179.42	81.56
NG130	550	67.13	253.00	39.49	196.42	109.77	49.90
NG131	1 469	179.31	675.75	105.48	524.61	293.18	133.27
NG132	1 114	135.98	512.45	79.99	397.83	222.33	101.06
NG133	1 239	151.23	569.95	88.96	442.47	247.28	112.40
NG134	1 017	124.14	467.83	73.02	363.19	202.97	92.26
NG135	1 185	144.64	545.11	85.08	423.19	236.50	107.50
NG136	1 401	171.01	644.47	100.59	500.32	279.61	127.10
NG137	1 056	128.90	485.77	75.82	377.12	210.76	95.80
NG138	1 035	126.33	476.11	74.31	369.62	206.57	93.90
NG139	763	93.13	350.98	54.78	272.48	152.28	69.22
NG140	1 195	145.86	549.71	85.80	426.76	238.50	108.41
NG141	669	81.66	307.74	48.03	238.91	133.52	60.69
NG142	1 206	147.21	554.77	86.59	430.69	240.69	109.41
NG143	1 382	168.69	635.73	99.23	493.54	275.82	125.38
NG144	1 118	136.46	514.29	80.27	399.26	223.13	101.42
NG145	923	112.66	424.58	66.27	329.62	184.21	83.73
NG146	1 581	192.98	727.27	113.52	564.61	315.54	143.43
NG147	988	120.60	454.48	70.94	352.83	197.19	89.63
NG148	870	106.19	400.20	62.47	310.69	173.64	78.93
NG149	754	92.03	346.84	54.14	269.27	150.48	68.40
NG150	470	57.37	216.20	33.75	167.85	93.80	42.64
NG151	1 328	162.10	610.89	95.35	474.25	265.04	120.48
NG152	1 137	138.78	523.03	81.64	406.04	226.92	103.15

Name	Area (m²)	Maize Min (kg)	Maize Max (kg)	Maize Anthro (kg)	Sorghum Min (kg)	Sorghum Max (kg)	Sorghum Anthro(kg)
NG153	549	67.01	252.54	39.42	196.06	109.57	49.81
NG154	1 429	174.43	657.35	102.60	510.32	285.20	129.64
NG155	1 497	182.73	688.63	107.49	534.61	298.77	135.81
NG156	1 050	128.16	483.01	75.39	374.97	209.56	95.26
NG157	621	75.80	285.66	44.59	221.77	123.94	56.34
NG158	1 273	155.38	585.59	91.40	454.61	254.07	115.49
NG159	1 148	140.13	528.09	82.43	409.97	229.12	104.15
NG160	821	100.21	377.66	58.95	293.19	163.86	74.48
NG161	1 112	135.73	511.53	79.84	397.12	221.93	100.88
NG162	1 259	153.67	579.15	90.40	449.61	251.27	114.22
NG163	1 253	152.94	576.39	89.97	447.47	250.07	113.67
NG164	1 741	212.51	800.87	125.01	621.74	347.47	157.94
NG165	1 365	166.61	627.91	98.01	487.47	272.43	123.83
NG166	1 310	159.90	602.61	94.06	467.83	261.45	118.84
NG167	1 139	139.03	523.95	81.78	406.76	227.32	103.33
NG168	1 056	128.90	485.77	75.82	377.12	210.76	95.80
NG169	1 101	134.39	506.47	79.05	393.19	219.74	99.88
NG170	641	78.24	294.86	46.02	228.91	127.93	58.15
NG171	1 063	129.75	488.99	76.32	379.62	212.15	96.44
NG172	460	56.15	211.60	33.03	164.27	91.81	41.73
NG173	1 096	133.78	504.17	78.69	391.40	218.74	99.43
NG174	1 094	133.53	503.25	78.55	390.69	218.34	99.25
NG175	959	117.06	441.14	68.86	342.48	191.40	87.00
NG176	1 079	131.70	496.35	77.47	385.33	215.35	97.89
NG177	1 270	155.02	584.21	91.19	453.54	253.47	115.21
NG178	1 554	189.68	714.85	111.58	554.96	310.15	140.98
NG179	1 355	165.39	623.31	97.29	483.90	270.43	122.93
NG180	791	96.55	363.86	56.79	282.48	157.87	71.76
NG181	1 427	174.18	656.43	102.46	509.61	284.80	129.46
NG182	1 458	177.96	670.69	104.69	520.68	290.99	132.27
NG183	523	63.84	240.58	37.55	186.77	104.38	47.45

kk

Name	Area (m²)	Maize Min (kg)	Maize Max (kg)	Maize Anthro (kg)	Sorghum Min (kg)	Sorghum Max (kg)	Sorghum Anthro(kg)
NG184	846	103.26	389.16	60.74	302.12	168.85	76.75
NG185	1 023	124.87	470.59	73.45	365.33	204.17	92.81
NG186	388	47.36	178.48	27.86	138.56	77.44	35.20
NG187	413	50.41	189.98	29.65	147.49	82.43	37.47
NG188	961	117.30	442.06	69.00	343.19	191.80	87.18
NG189	1 194	145.74	549.25	85.73	426.40	238.30	108.32
NG190	813	99.24	373.98	58.37	290.34	162.26	73.76
NG191	866	105.70	398.36	62.18	309.27	172.84	78.56
NG192	1 202	146.72	552.93	86.30	429.26	239.90	109.05
NG193	1 005	122.67	462.31	72.16	358.90	200.58	91.17
NG194	628	76.65	288.88	45.09	224.27	125.34	56.97
NG195	597	72.87	274.62	42.87	213.20	119.15	54.16
NG196	886	108.15	407.56	63.62	316.41	176.83	80.38
NG197	1 027	125.36	472.43	73.74	366.76	204.97	93.17
NG198	493	60.18	226.78	35.40	176.06	98.39	44.72
NG199	512	62.50	235.52	36.76	182.84	102.19	46.45
NG200	676	82.51	310.96	48.54	241.41	134.92	61.33
NG201	550	67.13	253.00	39.49	196.42	109.77	49.90
NG202	622	75.92	286.12	44.66	222.13	124.14	56.43
NG203	441	53.83	202.86	31.66	157.49	88.02	40.01
NG204	1 282	156.48	589.73	92.05	457.83	255.86	116.30
NG205	831	101.43	382.26	59.67	296.77	165.85	75.39
NG206	934	114.00	429.64	67.06	333.55	186.41	84.73
NG207	1 137	138.78	523.03	81.64	406.04	226.92	103.15
NG208	1 269	154.90	583.75	91.12	453.18	253.27	115.12
NG209	1 082	132.07	497.73	77.69	386.40	215.95	98.16
NG210	601	73.36	276.46	43.15	214.63	119.95	54.52
NG211	555	67.74	255.30	39.85	198.20	110.77	50.35
NG212	1 651	201.52	759.47	118.54	589.60	329.51	149.78
NG213	793	96.79	364.78	56.94	283.20	158.27	71.94
NG214	1 009	123.16	464.15	72.45	360.33	201.38	91.54

Name	Area (m²)	Maize Min (kg)	Maize Max (kg)	Maize Anthro (kg)	Sorghum Min (kg)	Sorghum Max (kg)	Sorghum Anthro(kg)
NG215	1 358	165.76	624.69	97.51	484.97	271.03	123.20
NG216	2 442	298.07	1 123.33	175.34	872.08	487.38	221.54
NG217	1 144	139.64	526.25	82.14	408.54	228.32	103.78
NG218	1 145	139.76	526.71	82.21	408.90	228.52	103.87
NG219	1 094	133.53	503.25	78.55	390.69	218.34	99.25
NG220	799	97.53	367.54	57.37	285.34	159.47	72.49
NG221	1 173	143.18	539.59	84.22	418.90	234.11	106.41
NG222	1 241	151.48	570.87	89.11	443.18	247.68	112.58
NG223	1 104	134.76	507.85	79.27	394.26	220.34	100.15
NG224	1 439	175.65	661.95	103.32	513.89	287.20	130.55
NG225	529	64.57	243.34	37.98	188.92	105.58	47.99
NG226	665	81.17	305.90	47.75	237.48	132.72	60.33
NG227	1 469	179.31	675.75	105.48	524.61	293.18	133.27
NG228	998	121.82	459.08	71.66	356.40	199.18	90.54
NG229	1 805	220.32	830.31	129.60	644.60	360.24	163.75
NG230	1 191	145.37	547.87	85.51	425.33	237.70	108.05
NG231	1 046	127.68	481.17	75.10	373.55	208.76	94.89
NG232	657	80.19	302.22	47.17	234.63	131.12	59.60
NG233	1 563	190.78	718.99	112.22	558.18	311.95	141.80
NG234	1 171	142.93	538.67	84.08	418.19	233.71	106.23
NG235	1 083	132.19	498.19	77.76	386.76	216.15	98.25
NG236	1 357	165.64	624.23	97.43	484.61	270.83	123.11
NG237	975	119.01	448.50	70.01	348.19	194.59	88.45
NG238	818	99.85	376.28	58.73	292.12	163.26	74.21
NG239	766	93.50	352.36	55.00	273.55	152.88	69.49
NG240	431	52.61	198.26	30.95	153.92	86.02	39.10
NG241	547	66.77	251.62	39.28	195.34	109.17	49.62
NG242	1 338	163.32	615.49	96.07	477.83	267.04	121.38
NG243	1 576	192.37	724.97	113.16	562.82	314.54	142.97
NG244	1 206	147.21	554.77	86.59	430.69	240.69	109.41
NG245	1 001	122.18	460.47	71.87	357.48	199.78	90.81

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Name	Area (m²)	Maize Min (kg)	Maize Max (kg)	Maize Anthro (kg)	Sorghum Min (kg)	Sorghum Max (kg)	Sorghum Anthro(kg)
NG246	1 367	166.86	628.83	98.15	488.18	272.83	124.01
NG247	1 340	163.56	616.41	96.21	478.54	267.44	121.56
NG248	1 346	164.29	619.17	96.64	480.68	268.64	122.11
NG249	786	95.94	361.56	56.44	280.70	156.87	71.31
NG250	833	101.68	383.18	59.81	297.48	166.25	75.57
NG251	615	75.07	282.90	44.16	219.63	122.74	55.79
NG252	700	85.44	322.00	50.26	249.98	139.71	63.50
NG253	721	88.01	331.66	51.77	257.48	143.90	65.41
NG254	896	109.37	412.16	64.33	319.98	178.82	81.29
NG255	663	80.93	304.98	47.60	236.77	132.32	60.15
NG256	1 248	152.33	574.09	89.61	445.68	249.08	113.22
NG257	1 326	161.85	609.97	95.21	473.54	264.64	120.29
NG258	943	115.10	433.78	67.71	336.76	188.20	85.55
NG259	549	67.01	252.54	39.42	196.06	109.57	49.81
NG260	750	91.55	345.00	53.85	267.84	149.69	68.04
NG261	796	97.16	366.16	57.15	284.27	158.87	72.21
NG262	733	89.47	337.18	52.63	261.77	146.29	66.50
NG263	544	66.40	250.24	39.06	194.27	108.57	49.35
NG264	985	120.23	453.10	70.72	351.76	196.59	89.36
NG265	1 342	163.81	617.33	96.36	479.25	267.84	121.75
NG266	1 037	126.58	477.03	74.46	370.33	206.97	94.08
NG267	2 260	275.86	1 039.61	162.27	807.09	451.05	205.03
NG268	1 196	145.98	550.17	85.87	427.11	238.70	108.50
NG269	1 107	135.12	509.23	79.48	395.33	220.94	100.43
NG270	1 449	176.87	666.55	104.04	517.47	289.19	131.45
NG271	1 342	163.81	617.33	96.36	479.25	267.84	121.75
NG272	1 039	126.82	477.95	74.60	371.05	207.36	94.26
NG273	1 224	149.40	563.05	87.88	437.11	244.29	111.04
NG274	597	72.87	274.62	42.87	213.20	119.15	54.16
NG275	1 606	196.03	738.77	115.31	573.53	320.53	145.70
NG276	1 736	211.90	798.57	124.65	619.96	346.47	157.49

nn

Name	Area (m²)	Maize Min (kg)	Maize Max (kg)	Maize Anthro (kg)	Sorghum Min (kg)	Sorghum Max (kg)	Sorghum Anthro(kg)
NG277	509	62.13	234.14	36.55	181.77	101.59	46.18
NG278	582	71.04	267.72	41.79	207.84	116.16	52.80
NG279	1 259	153.67	579.15	90.40	449.61	251.27	114.22
NG280	2 151	262.55	989.47	154.44	768.16	429.30	195.14
NG281	932	113.76	428.72	66.92	332.83	186.01	84.55
NG282	668	81.54	307.28	47.96	238.56	133.32	60.60
NG283	1 578	192.61	725.89	113.30	563.53	314.94	143.16
NG284	1 574	192.12	724.05	113.01	562.11	314.14	142.79
NG285	1 364	166.49	627.45	97.94	487.11	272.23	123.74
NG286	1 624	198.23	747.05	116.60	579.96	324.12	147.33
NG287	925	112.91	425.50	66.42	330.34	184.61	83.92
NG288	1 243	151.72	571.79	89.25	443.90	248.08	112.76
NG289	1 267	154.65	582.83	90.97	452.47	252.87	114.94
NG290	1 029	125.60	473.35	73.88	367.48	205.37	93.35
NG291	1 322	161.36	608.13	94.92	472.11	263.85	119.93
NG292	1 157	141.22	532.23	83.07	413.19	230.92	104.96
NG293	1 038	126.70	477.49	74.53	370.69	207.17	94.17
NG294	1 103	134.63	507.39	79.20	393.90	220.14	100.06
NG295	1 189	145.13	546.95	85.37	424.61	237.30	107.87
NG296	992	121.08	456.32	71.23	354.26	197.98	89.99
NG297	2 185	266.70	1 005.11	156.89	780.31	436.08	198.22
NG298	2 272	277.32	1 045.13	163.13	811.37	453.45	206.12
NG299	1 476	180.16	678.97	105.98	527.11	294.58	133.90
NG300	1 196	145.98	550.17	85.87	427.11	238.70	108.50
NG301	1 081	131.95	497.27	77.62	386.05	215.75	98.07
NG302	1 524	186.02	701.05	109.42	544.25	304.16	138.26
NG303	614	74.95	282.44	44.09	219.27	122.54	55.70
NG304	1 246	152.09	573.17	89.46	444.97	248.68	113.04
NG305	762	93.01	350.52	54.71	272.12	152.08	69.13
NG306	993	121.21	456.78	71.30	354.62	198.18	90.08
NG307	747	91.18	343.62	53.64	266.77	149.09	67.77

Name	Area (m²)	Maize Min (kg)	Maize Max (kg)	Maize Anthro (kg)	Sorghum Min (kg)	Sorghum Max (kg)	Sorghum Anthro(kg)
NG308	1 262	154.04	580.53	90.61	450.68	251.87	114.49
NG309	1 284	156.73	590.65	92.19	458.54	256.26	116.48
NG310	935	114.13	430.10	67.13	333.91	186.61	84.82
NG311	1 284	156.73	590.65	92.19	458.54	256.26	116.48
NG312	862	105.22	396.52	61.89	307.84	172.04	78.20
NG313	778	94.96	357.88	55.86	277.84	155.27	70.58
NG314	939	114.62	431.94	67.42	335.33	187.41	85.19
NG315	1 037	126.58	477.03	74.46	370.33	206.97	94.08
NG316	1 065	129.99	489.91	76.47	380.33	212.55	96.62
NG317	1 163	141.96	534.99	83.50	415.33	232.11	105.51
NG318	490	59.81	225.40	35.18	174.99	97.79	44.45
NG319	999	121.94	459.54	71.73	356.76	199.38	90.63
NG320	1 184	144.52	544.65	85.01	422.83	236.30	107.41
NG321	987	120.47	454.02	70.87	352.48	196.99	89.54
NG322	706	86.18	324.76	50.69	252.13	140.90	64.05
NG323	1 187	144.89	546.03	85.23	423.90	236.90	107.68
NG324	1 103	134.63	507.39	79.20	393.90	220.14	100.06
NG325	1 289	157.34	592.95	92.55	460.33	257.26	116.94
NG326	1 296	158.19	596.17	93.05	462.83	258.66	117.57
NG327	1 203	146.84	553.39	86.38	429.61	240.10	109.14
NG328	1 272	155.26	585.13	91.33	454.26	253.87	115.40
NG329	515	62.86	236.90	36.98	183.92	102.78	46.72
NG330	755	92.16	347.30	54.21	269.62	150.68	68.49
NG331	569	69.45	261.74	40.85	203.20	113.56	51.62
NG332	1 083	132.19	498.19	77.76	386.76	216.15	98.25
NG333	1 273	155.38	585.59	91.40	454.61	254.07	115.49
NG334	817	99.72	375.82	58.66	291.77	163.06	74.12
NG335	707	86.30	325.22	50.76	252.48	141.10	64.14
NG336	446	54.44	205.16	32.02	159.28	89.01	40.46
NG337	831	101.43	382.26	59.67	296.77	165.85	75.39
NG338	1 094	133.53	503.25	78.55	390.69	218.34	99.25

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Name	Area (m²)	Maize Min (kg)	Maize Max (kg)	Maize Anthro (kg)	Sorghum Min (kg)	Sorghum Max (kg)	Sorghum Anthro(kg)
NG339	1 152	140.61	529.93	82.71	411.40	229.92	104.51
NG340	989	120.72	454.94	71.01	353.19	197.39	89.72
NG341	1 193	145.62	548.79	85.66	426.04	238.10	108.23
NG342	1 150	140.37	529.01	82.57	410.69	229.52	104.33
NG343	1 008	123.04	463.69	72.38	359.98	201.18	91.45
NG344	840	102.53	386.40	60.31	299.98	167.65	76.20
NG345	1 016	124.01	467.37	72.95	362.83	202.77	92.17
NG346	1 059	129.26	487.15	76.04	378.19	211.36	96.07
NG347	868	105.95	399.28	62.32	309.98	173.24	78.74
NG348	654	79.83	300.84	46.96	233.56	130.53	59.33
NG349	1 239	151.23	569.95	88.96	442.47	247.28	112.40
NG350	1 090	133.05	501.41	78.26	389.26	217.54	98.88
NG351	1 197	146.11	550.63	85.95	427.47	238.90	108.59
NG352	1 124	137.20	517.05	80.70	401.40	224.33	101.97
NG353	1 157	141.22	532.23	83.07	413.19	230.92	104.96
NG354	1 192	145.50	548.33	85.59	425.69	237.90	108.14
NG355	1 297	158.31	596.63	93.13	463.18	258.86	117.66
NG356	1 567	191.27	720.83	112.51	559.61	312.74	142.16
NG357	816	99.60	375.36	58.59	291.41	162.86	74.03
NG358	392	47.85	180.32	28.15	139.99	78.24	35.56
NG359	413	50.41	189.98	29.65	147.49	82.43	37.47
NG360	633	77.26	291.18	45.45	226.06	126.33	57.43
NG361	372	45.41	171.12	26.71	132.85	74.24	33.75
NG362	934	114.00	429.64	67.06	333.55	186.41	84.73
NG363	868	105.95	399.28	62.32	309.98	173.24	78.74
NG364	338	41.26	155.48	24.27	120.71	67.46	30.66
NG365	452	55.17	207.92	32.45	161.42	90.21	41.01
NG366	845	103.14	388.70	60.67	301.77	168.65	76.66
NG367	1 152	140.61	529.93	82.71	411.40	229.92	104.51
NG368	1 265	154.41	581.91	90.83	451.76	252.47	114.76
NG369	1 159	141.47	533.15	83.22	413.90	231.31	105.14

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Name	Area (m²)	Maize Min (kg)	Maize Max (kg)	Maize Anthro (kg)	Sorghum Min (kg)	Sorghum Max (kg)	Sorghum Anthro(kg)
NG370	1 343	163.93	617.79	96.43	479.61	268.04	121.84
NG371	364	44.43	167.44	26.14	129.99	72.65	33.02
NG372	375	45.77	172.50	26.93	133.92	74.84	34.02
NG373	437	53.34	201.02	31.38	156.06	87.22	39.64
NG374	728	88.86	334.88	52.27	259.98	145.29	66.04
NG375	1 150	140.37	529.01	82.57	410.69	229.52	104.33
NG376	602	73.48	276.92	43.22	214.99	120.15	54.61
NG377	568	69.33	261.28	40.78	202.84	113.36	51.53
NG378	410	50.05	188.60	29.44	146.42	81.83	37.20
NG379	961	117.30	442.06	69.00	343.19	191.80	87.18
NG380	434	52.97	199.64	31.16	154.99	86.62	39.37
NG381	419	51.14	192.74	30.08	149.63	83.62	38.01
NG382	1 015	123.89	466.91	72.88	362.48	202.57	92.08
NG383	369	45.04	169.74	26.49	131.78	73.65	33.48
NG384	908	110.83	417.68	65.20	324.26	181.22	82.37
NG385	700	85.44	322.00	50.26	249.98	139.71	63.50
NG386	366	44.67	168.36	26.28	130.71	73.05	33.20
NG387	986	120.35	453.56	70.80	352.12	196.79	89.45
NG388	787	96.06	362.02	56.51	281.05	157.07	71.40
NG389	1 141	139.27	524.87	81.92	407.47	227.72	103.51
NG390	406	49.56	186.76	29.15	144.99	81.03	36.83
NG391	831	101.43	382.26	59.67	296.77	165.85	75.39
NG392	1 167	142.45	536.83	83.79	416.76	232.91	105.87
NG393	495	60.42	227.70	35.54	176.77	98.79	44.91
NG394	941	114.86	432.86	67.56	336.05	187.81	85.37
NG395	454	55.42	208.84	32.60	162.13	90.61	41.19
NG396	792	96.67	364.32	56.87	282.84	158.07	71.85
NG397	1 204	146.96	553.85	86.45	429.97	240.30	109.23
NG398	540	65.91	248.40	38.77	192.84	107.77	48.99
NG399	458	55.90	210.68	32.88	163.56	91.41	41.55
NG400	1 522	185.78	700.13	109.28	543.54	303.76	138.08

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Name	Area (m²)	Maize Min (kg)	Maize Max (kg)	Maize Anthro (kg)	Sorghum Min (kg)	Sorghum Max (kg)	Sorghum Anthro(kg)
NG401	1 138	138.91	523.49	81.71	406.40	227.12	103.24
NG402	922	112.54	424.12	66.20	329.26	184.01	83.64
NG403	1 072	130.85	493.13	76.97	382.83	213.95	97.25
NG404	697	85.08	320.62	50.05	248.91	139.11	63.23
NG405	478	58.35	219.88	34.32	170.70	95.40	43.36
NG406	511	62.37	235.06	36.69	182.49	101.99	46.36
NG407	703	85.81	323.38	50.48	251.05	140.31	63.78
NG408	546	66.65	251.16	39.20	194.99	108.97	49.53
NG409	637	77.75	293.02	45.74	227.48	127.13	57.79
NG410	887	108.27	408.02	63.69	316.76	177.03	80.47
NG411	800	97.65	368.00	57.44	285.70	159.66	72.58
NG412	1 077	131.46	495.43	77.33	384.62	214.95	97.71
NG413	1 301	158.80	598.47	93.41	464.61	259.65	118.03
NG414	514	62.74	236.44	36.91	183.56	102.58	46.63
NG415	547	66.77	251.62	39.28	195.34	109.17	49.62
NG416	908	110.83	417.68	65.20	324.26	181.22	82.37
NG417	539	65.79	247.94	38.70	192.49	107.57	48.90
Total	422 860	51 614.71	194 517.71	30 361.77	151 011.34	84 394.82	38 361.86
Average	1 014.05	123.78	466.47	72.81	362.14	202.39	91.99

Appendix H – Expanded Post-Betterment graphs

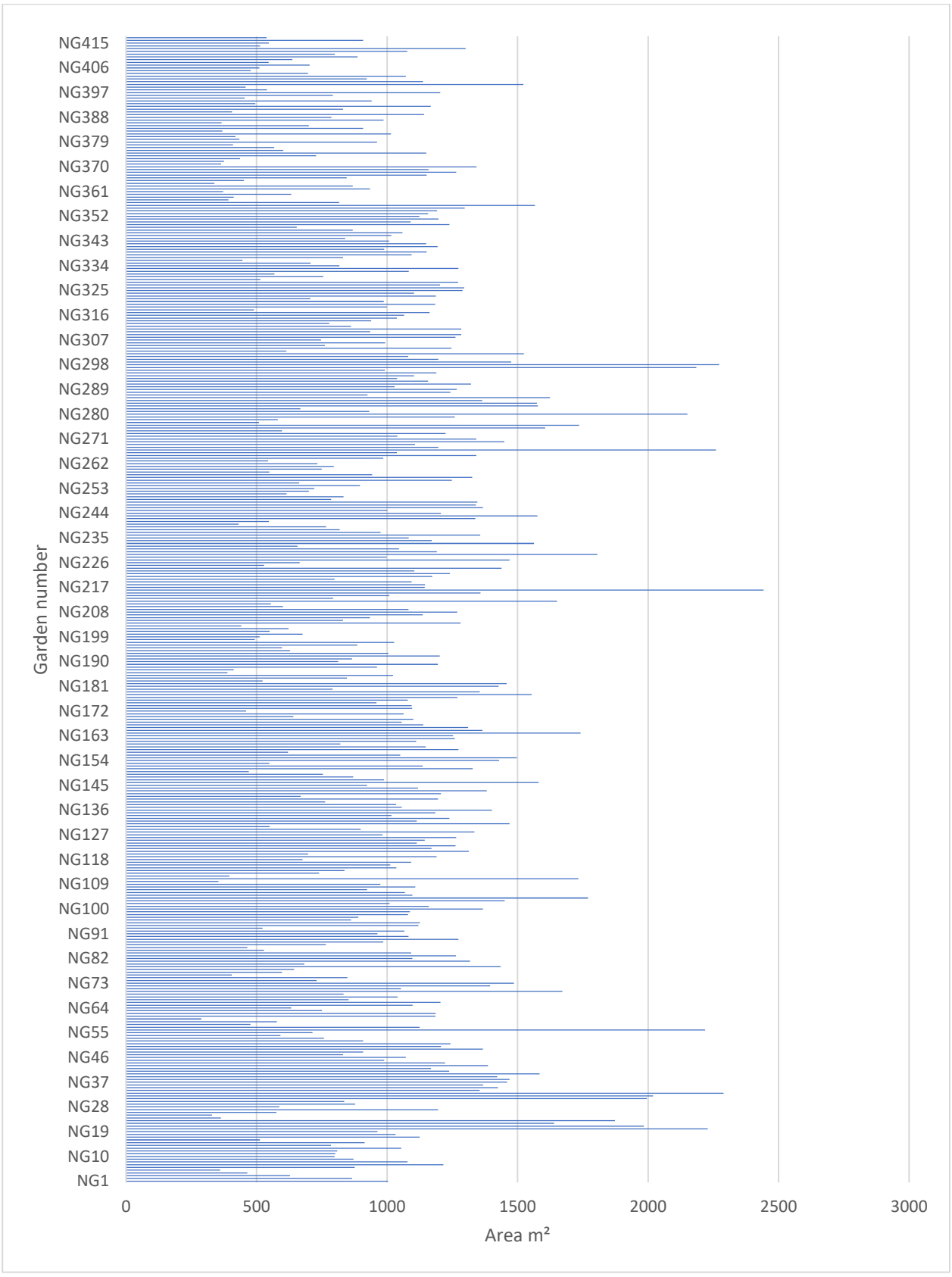

Figure H.1: Enlarged graph depicting the surface area's calculated for the visible gardens in Cata

tt

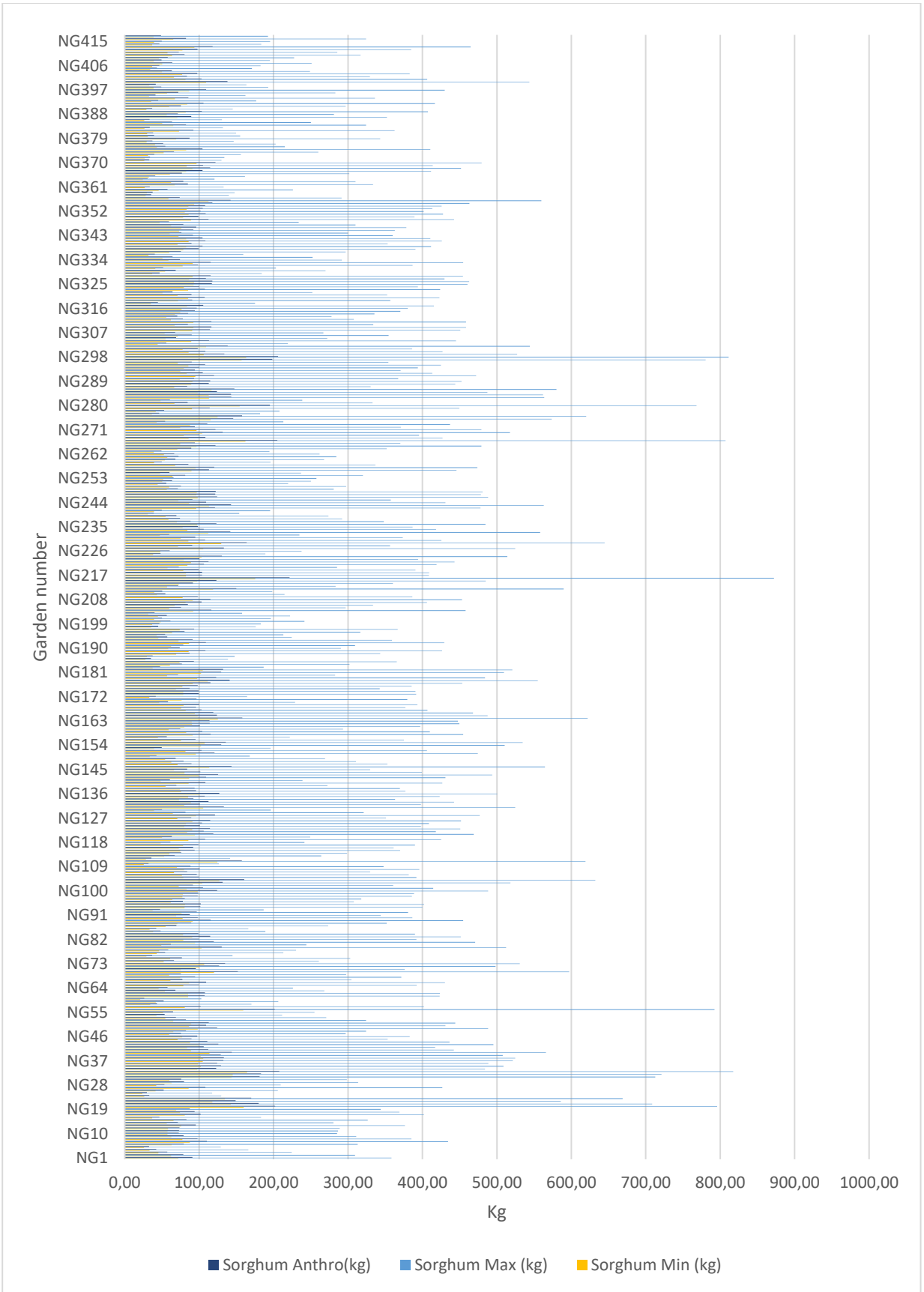

Figure H.2: Enlarged chart depicting comparative maximum, minimum and anthropologically-based (de Wet 1985) yield figures for sorghum production

uu

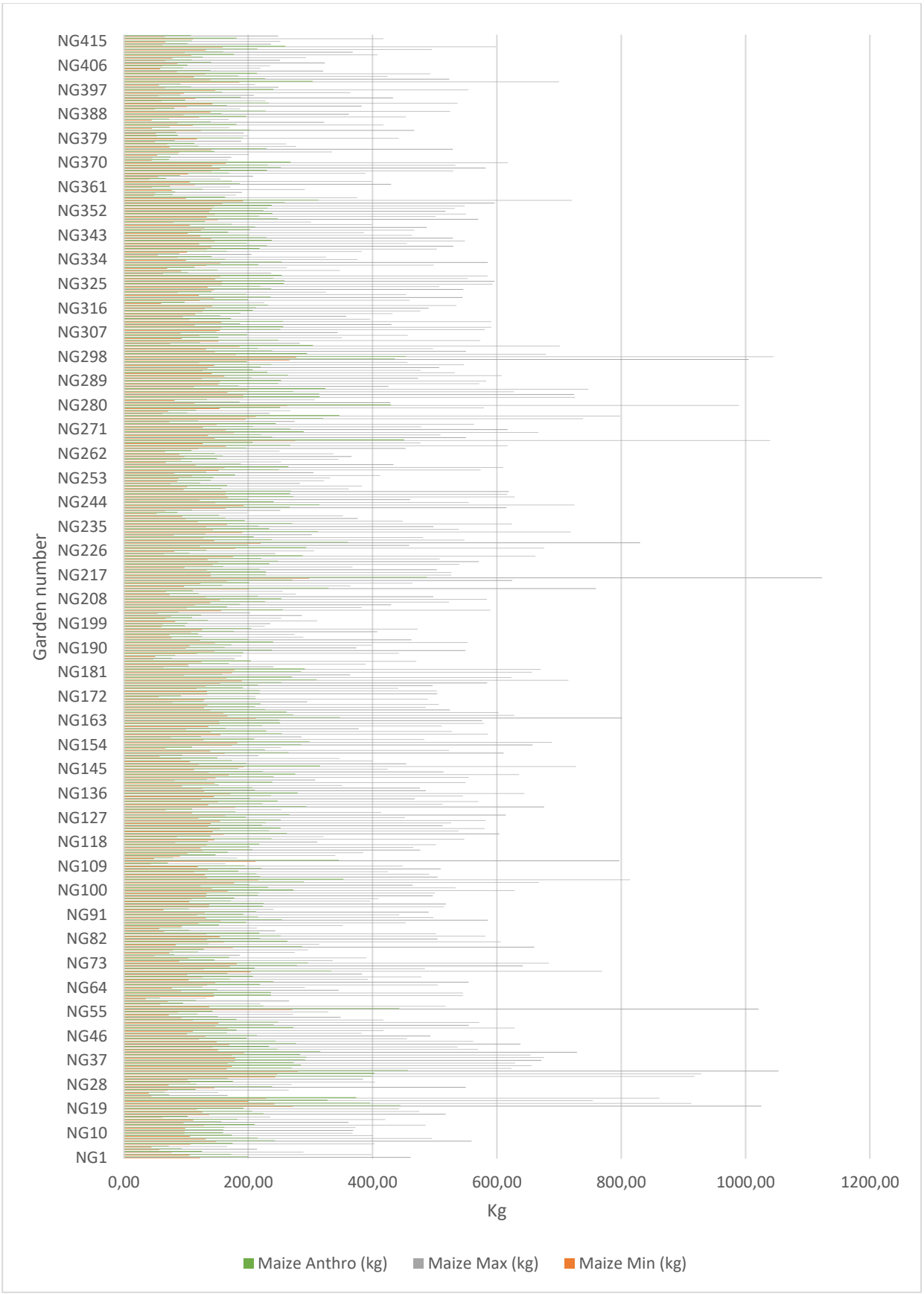

Figure H.3: Enlarged chart depicting comparative maximum, minimum and anthropologically-based (de Wet 1985) yield figures for maize production after Betterment Planning

Appendix I – Image and maps from Chapter Six and Seven

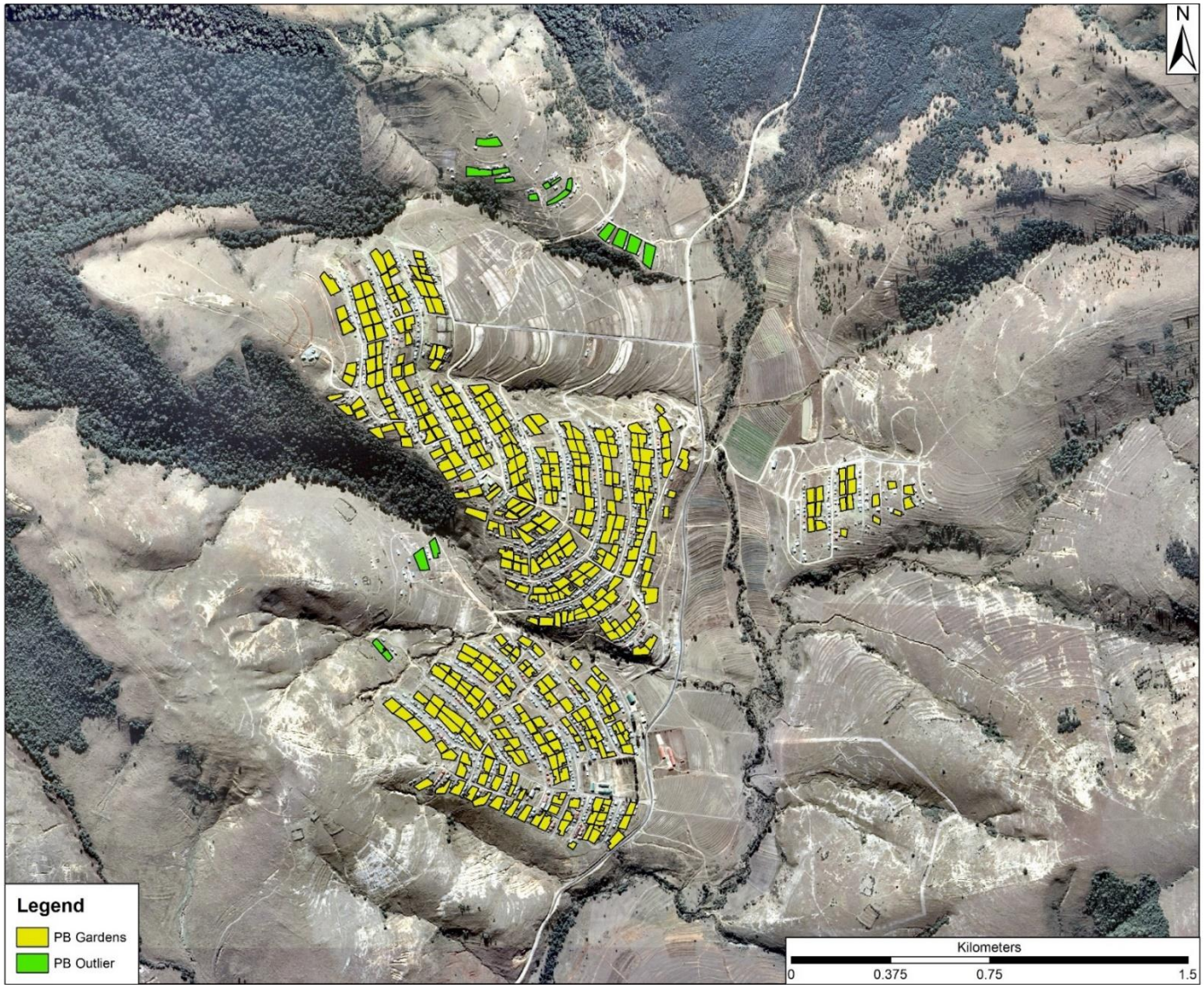

Figure I.1: Enlarged aerial imagery illustrating mapped locations of post-Betterment gardens indicating outliers (QGIS)

ww

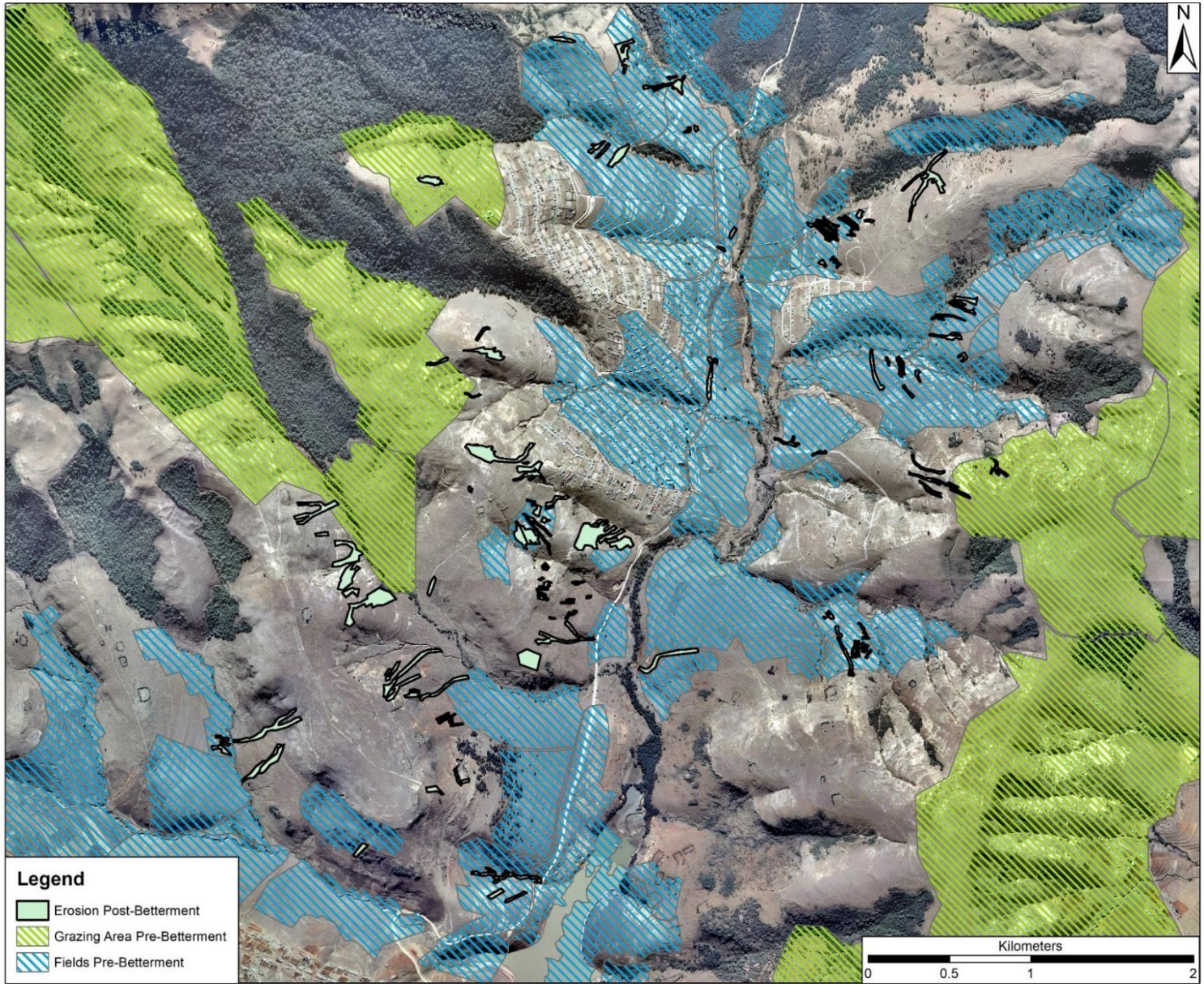

Figure I.2: Enlarged aerial imagery illustrating mapped locations indicating erosion gullies post-Betterment (QGIS)

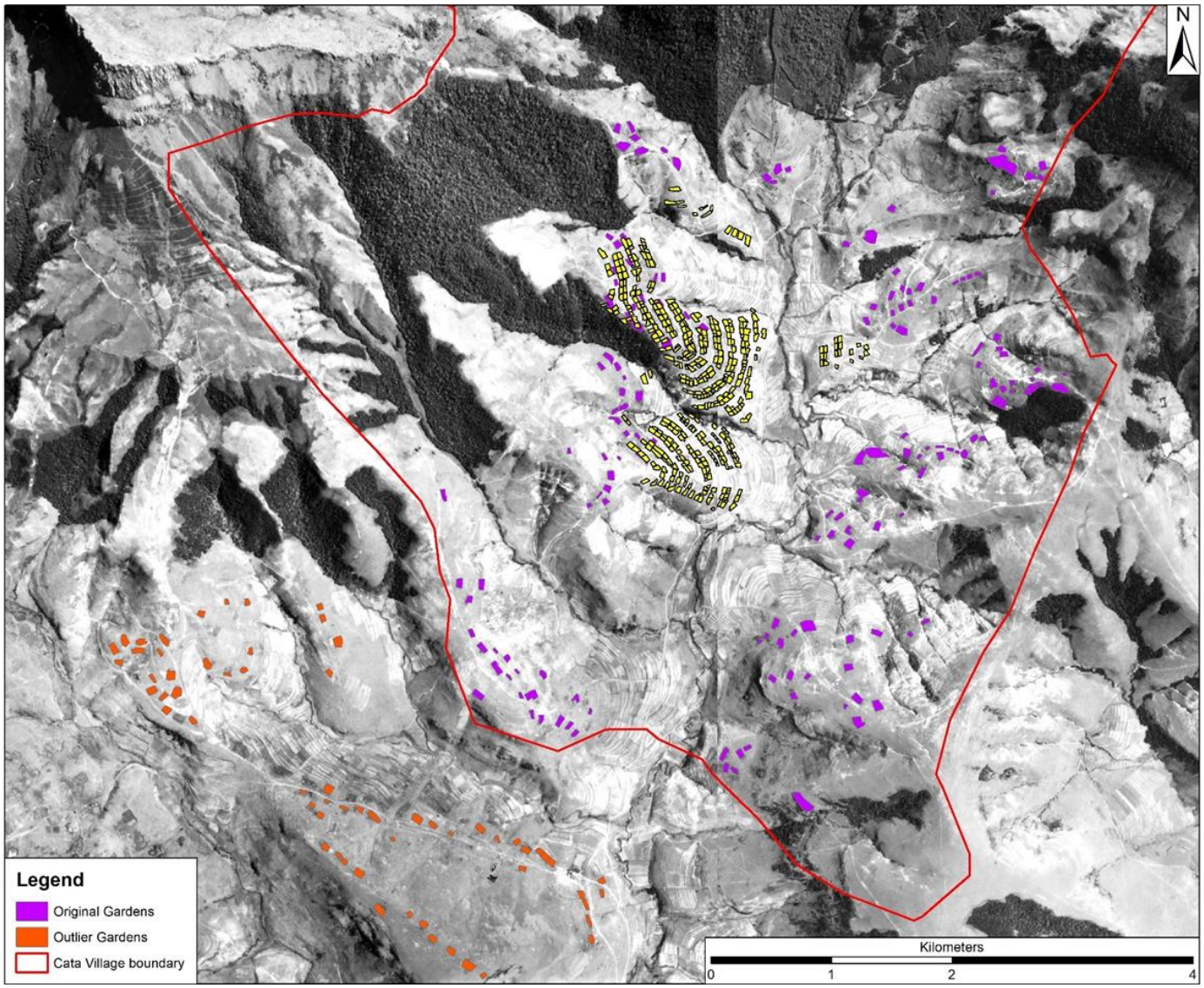

Figure I.3: Enlarged aerial imagery illustrating mapped locations of gardens pre and post-Betterment (QGIS)

yy

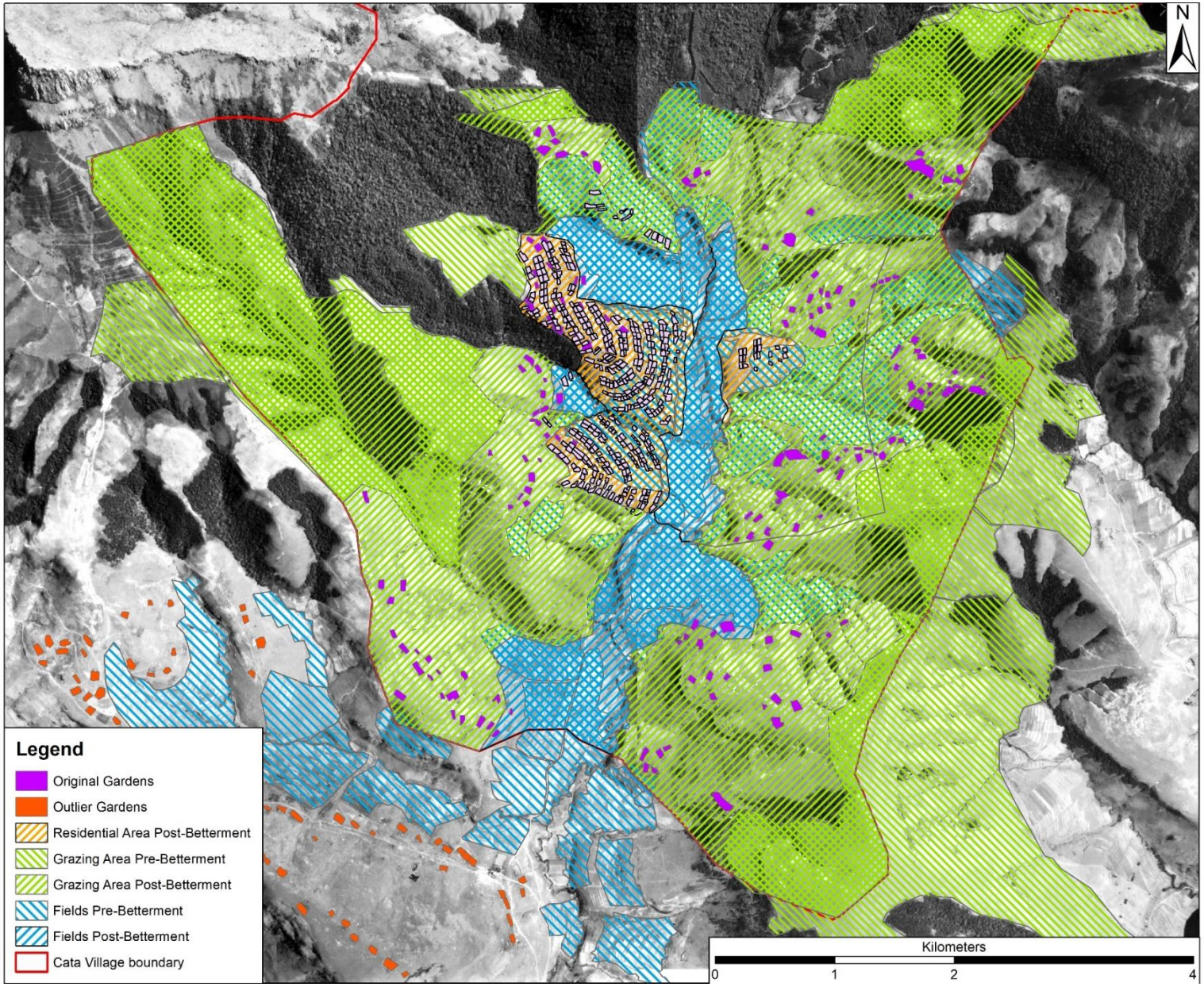

Figure I.4: Enlarged aerial Imagery illustrating pre and post-Betterment gardens, fields and grazing areas (QGIS)

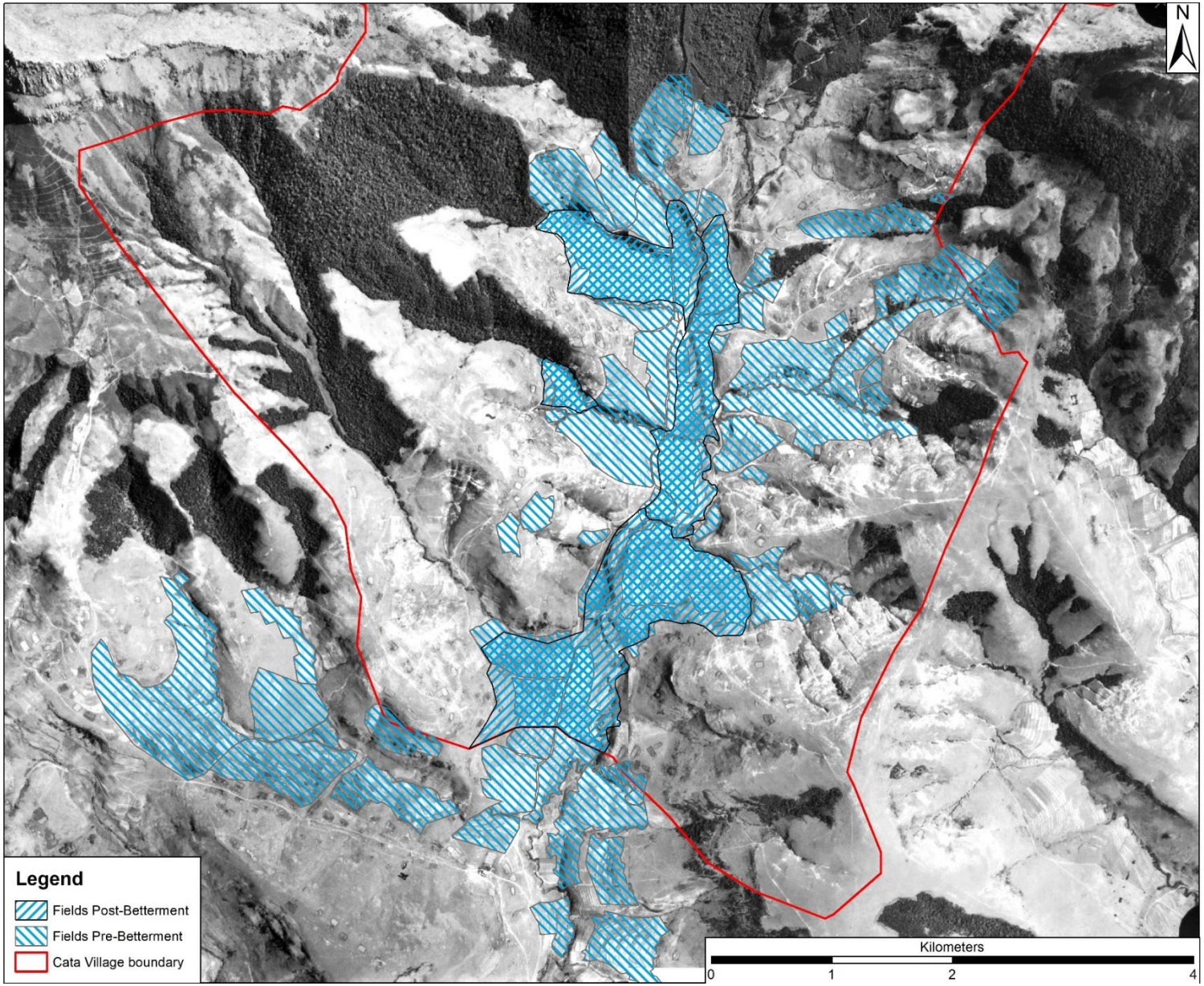

Figure I.5: Enlarged aerial imagery illustrating mapped locations of field areas pre and post-Betterment (QGIS)

aaa

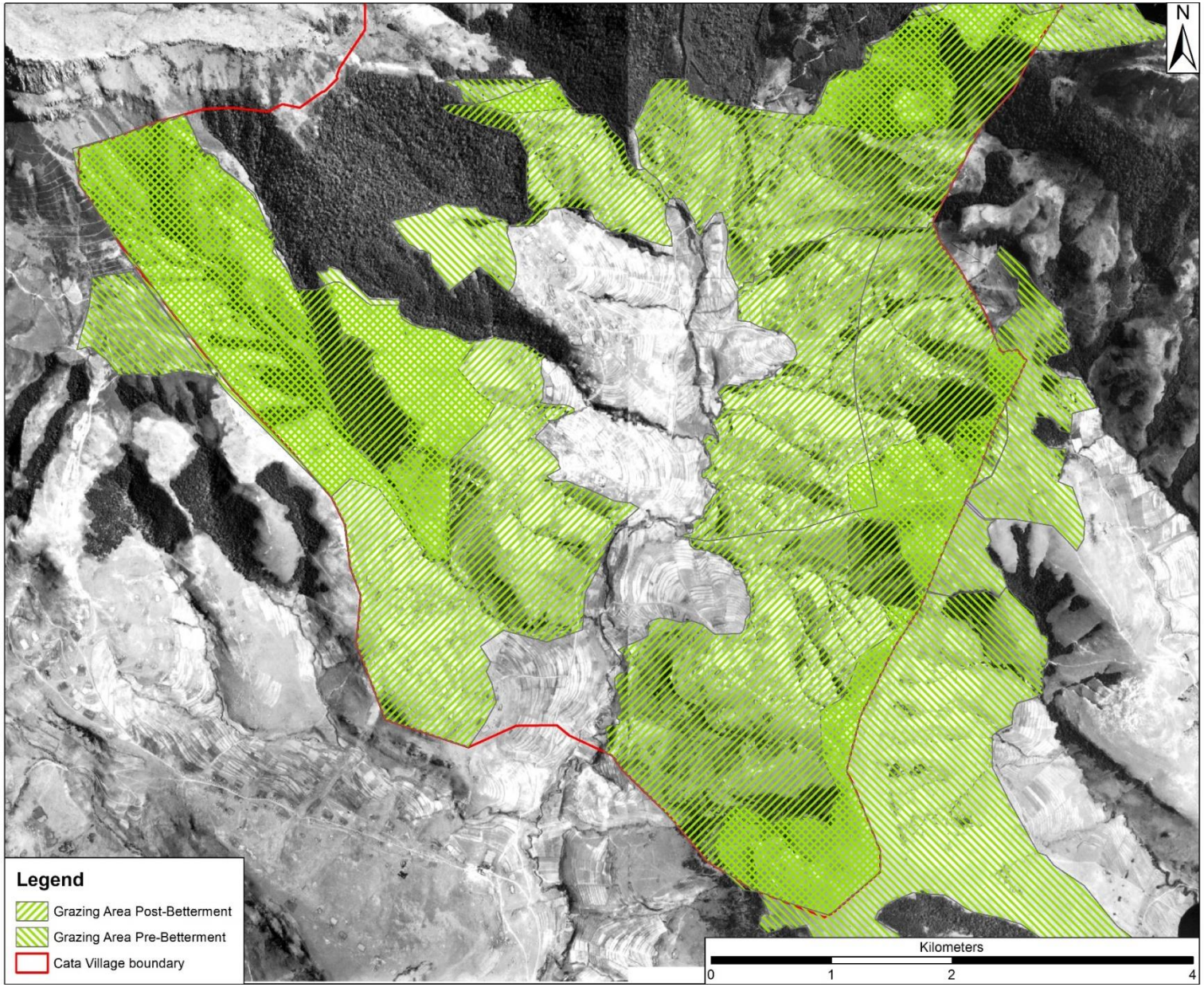

Figure I.6: Enlarged aerial imagery illustrating mapped locations of grazing areas (QGIS)

bbb

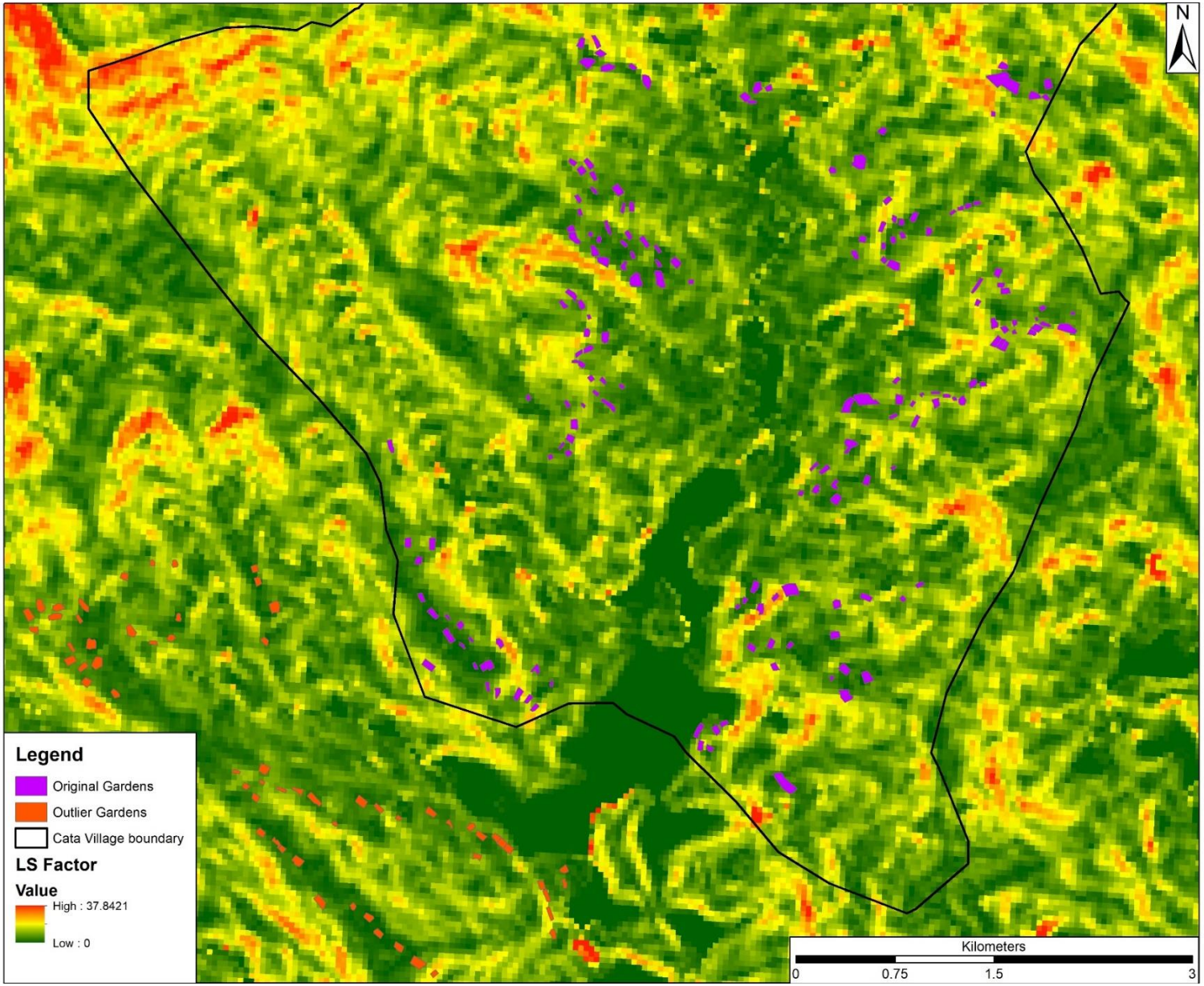

Figure I.7: Enlarged LS-Factor of Cata with the location of pre-Betterment gardens (QGIS)

CCC

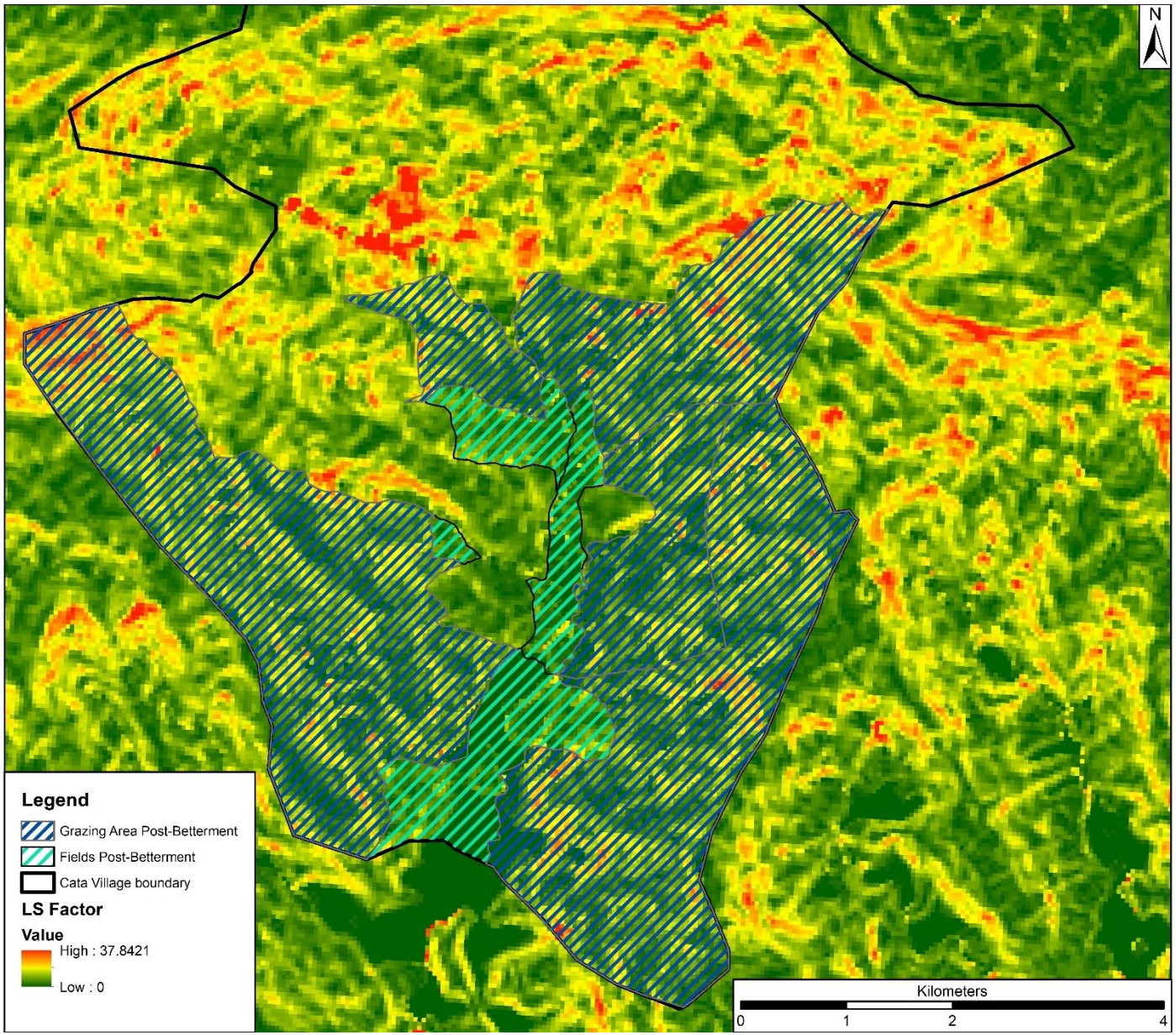

Figure I.8: Enlarged LS-Factor of Cata with the land allocation indicated (QGIS)

ddd

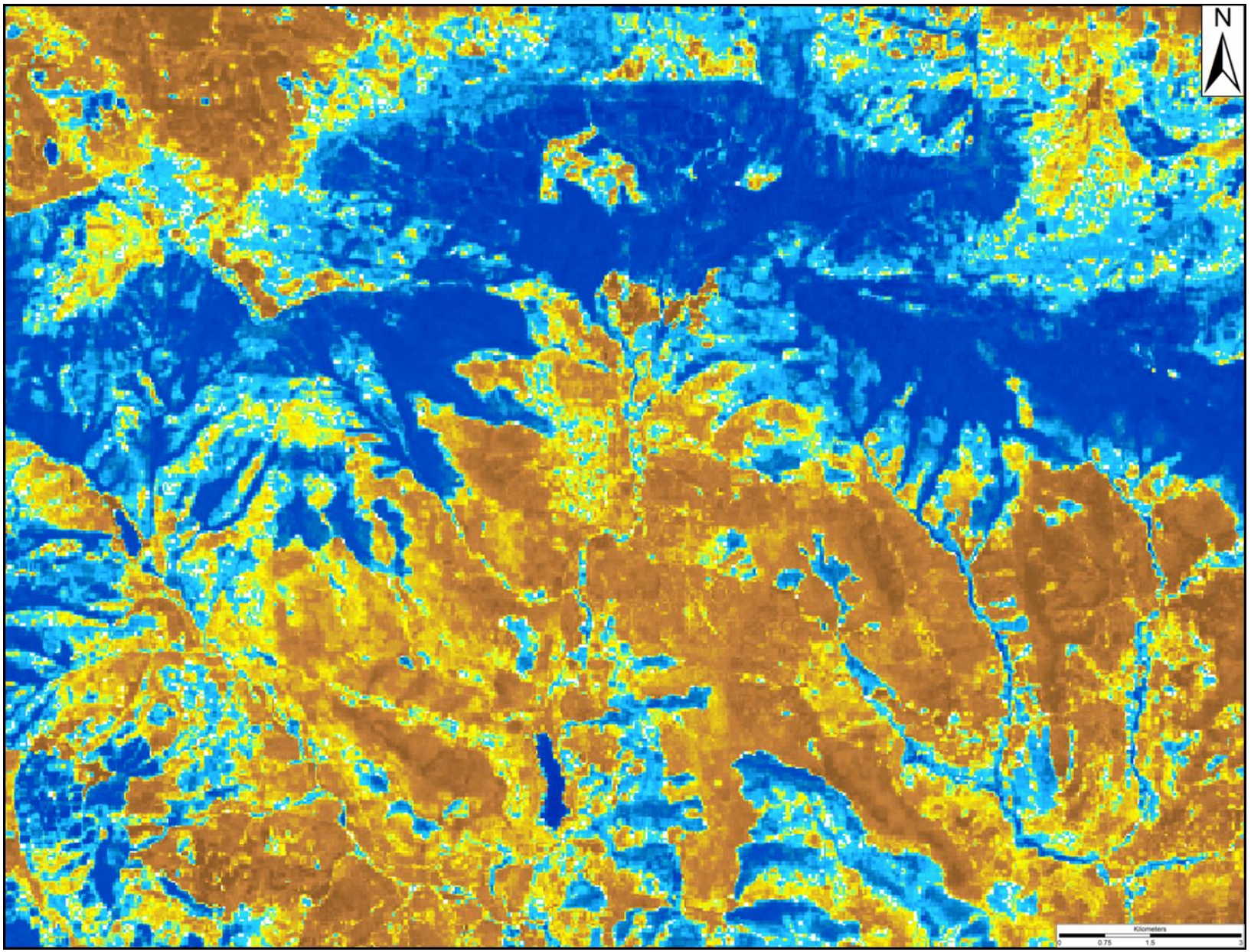

Figure I.9: Enlarged Normalised Moisture Index of Cata (Landsat)

eee

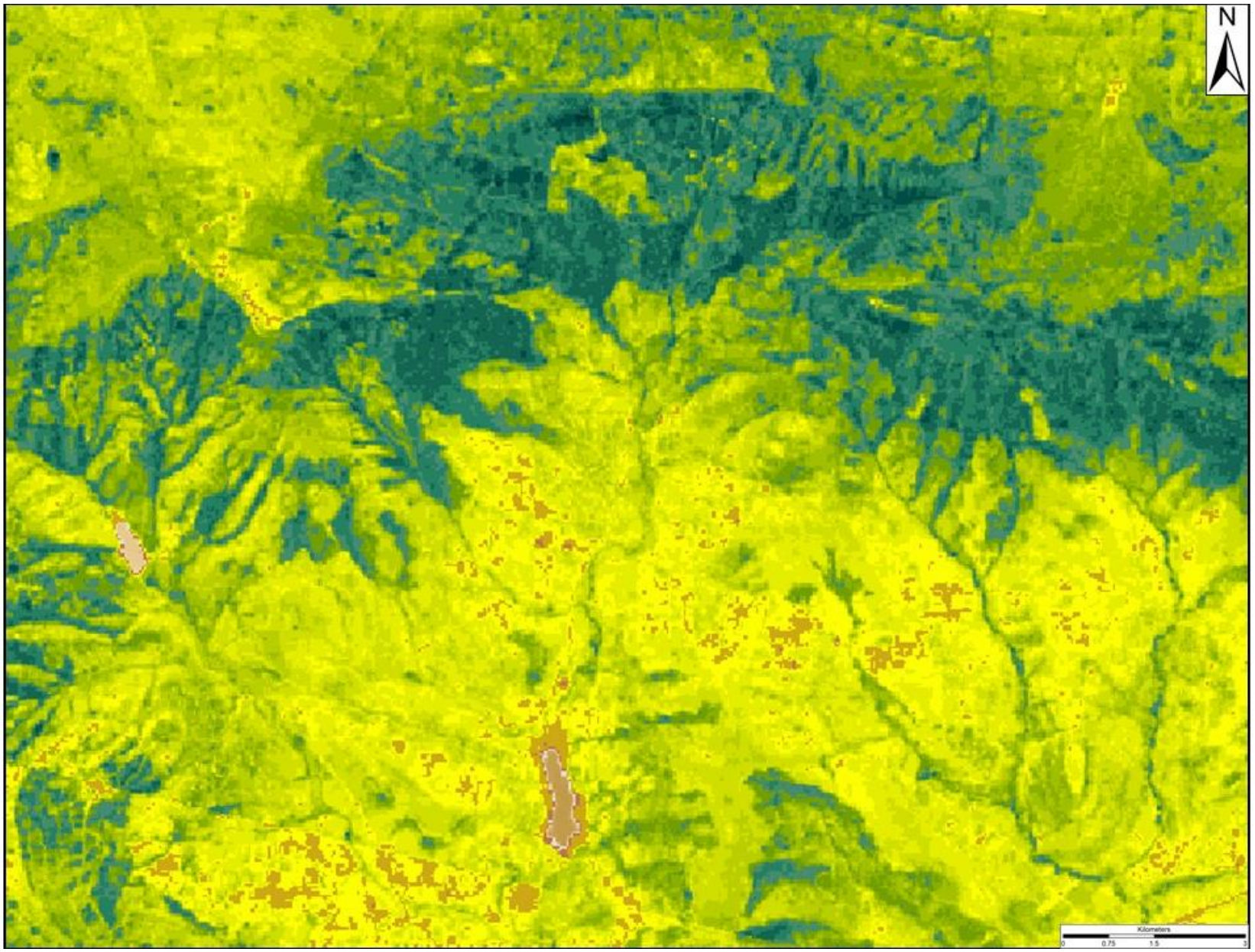

Figure I.10: Enlarged Normalised Difference Vegetation Index of Cata (Landsat)

fff

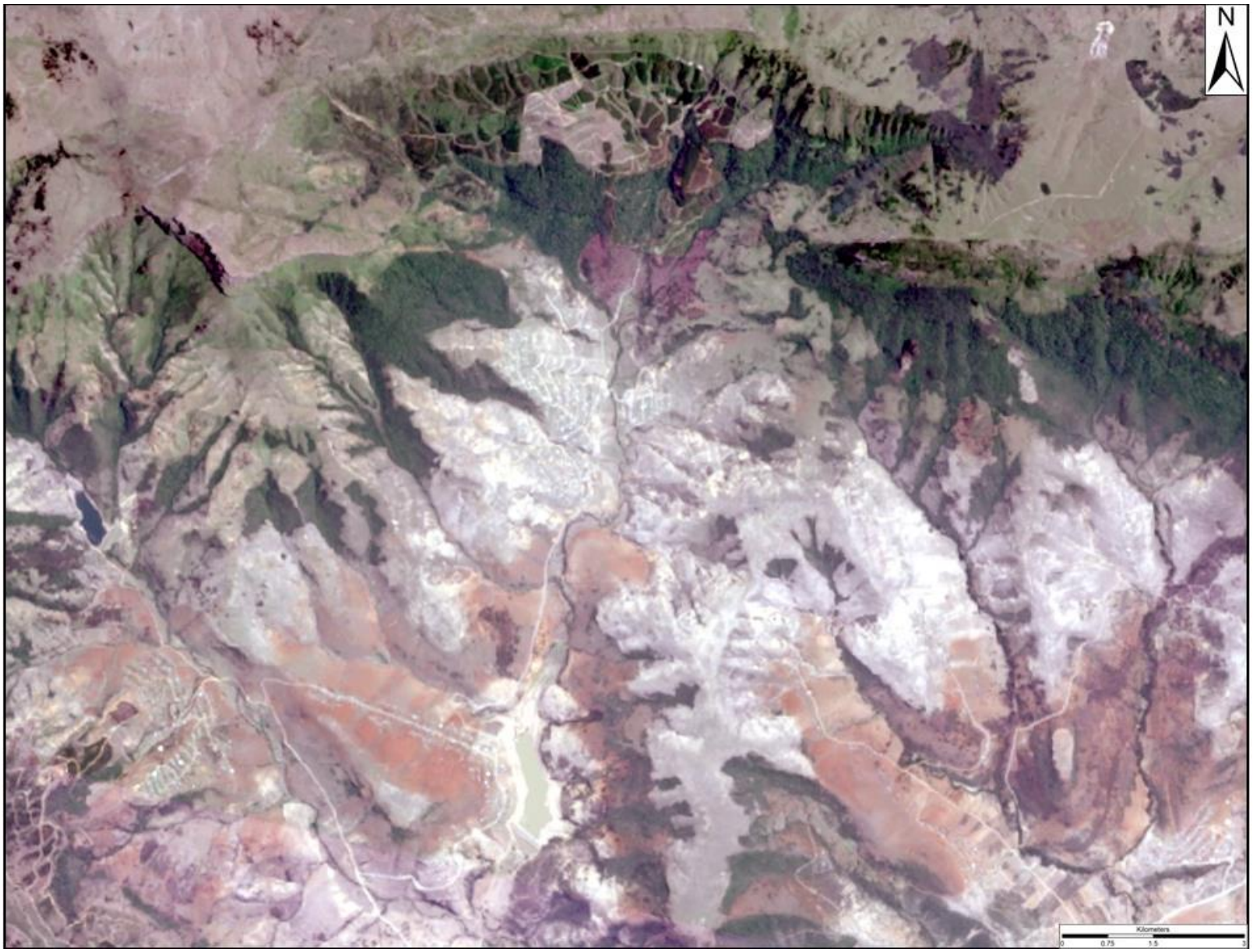

Figure I.11: Enlarged Natural Colour Rendering of Cata (Landsat)

ggg

Appendix J – Topographic map of Cata, Eastern Cape

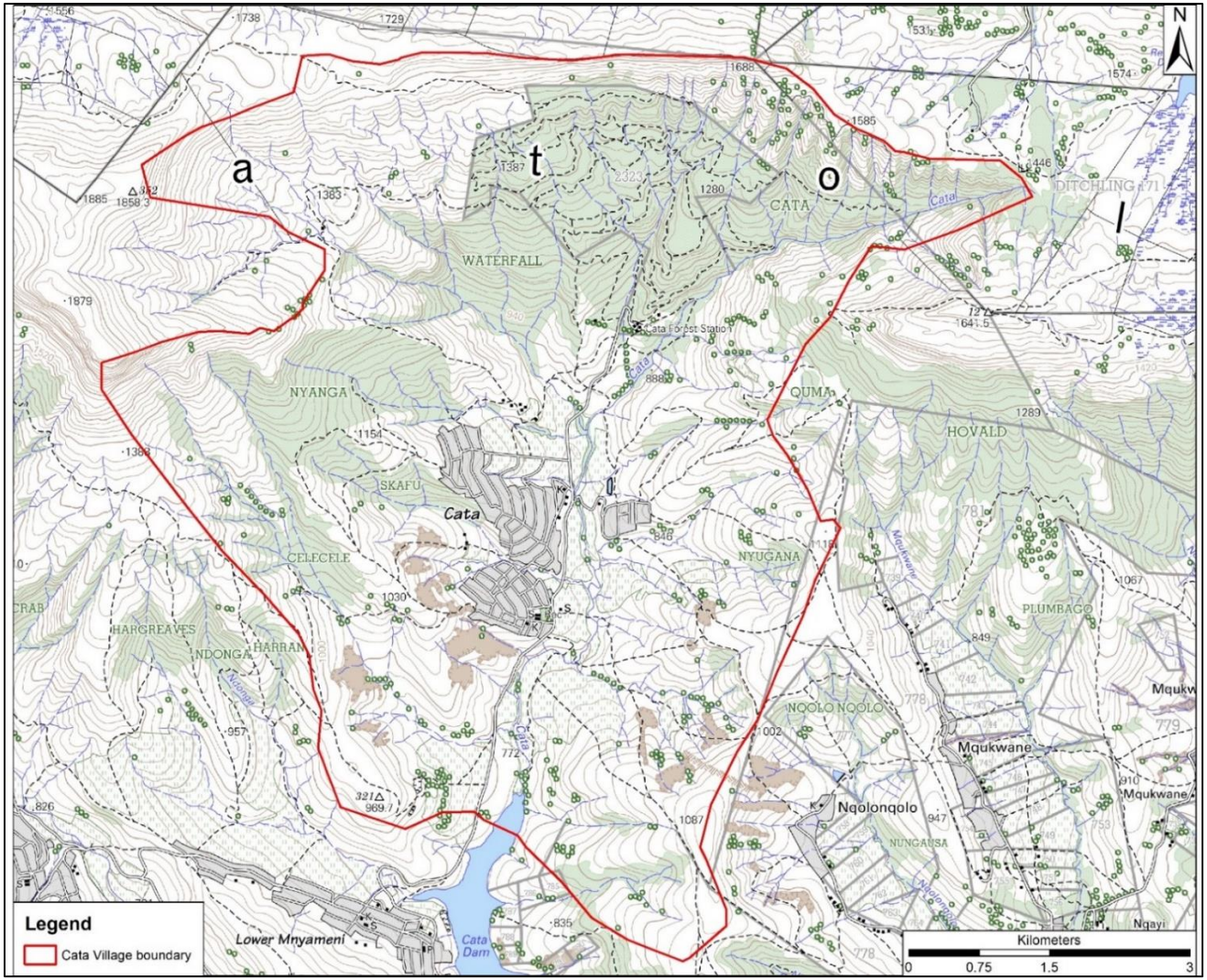

Figure J1: Topographic map of Cata indicating boundary

hhh