Human trampling as an agent of archaeological disturbance: An experimental study of the effect of trampling on ceramic shard preservation and distribution

Nokusho Ngobeni (717085)

Supervisors:
Prof. MH Schoeman
Prof. DJ Stratford

Department of Archaeology, School of Geography, Archaeology and Environmental Studies

Declaration

I declare that this dissertation is my own, unaided work. It is being submitted for the Degree of Master of Science by coursework and research report, to the University of the Witwatersrand.

It has not been submitted before, for any degree or examination in any other University.

Signature: Date: 7/12/2020

Abstract

Bokoni sites comprise stonewalled homesteads with associated agricultural terraces and roads. Unlike other southern African Farming Community sites middens are absent from Bokoni sites. Instead, pottery shards have been found in terrace excavations, and scattered across the sites with evidence for sudden abandonment. In order to identify processes that contributed to pottery distribution and taphonomy in these areas, this study explored the impact of human trampling on the distribution, and condition of ceramic shards in two contexts. The first context is similar to an agricultural terrace, and the second simulates path conditions.

This study uses a methodology derived from experimental archaeology. The application of this method in this Research Report aids in understanding the archaeological record better. Archaeological material and experiments were replicated to reconstruct past human activities (i.e. trampling). This technique informed on the processes (trampling) behind site formation, and how they affect the integrity of archaeological record. Variables that were controlled are the shard volume, size, distribution, trampling direction and duration of trampling.

The results generated in this study revealed that trampling modification is high for both the terrace and path experiment. Fragmentation is the dominant factor leading to size reduction of shards, rather than abrasion. Various sized shards are spatially distributed vertically and horizontally on the paths plot, whereas, the shards on the terrace are only displaced horizontally. The spatial distribution of the shards before trampling for both the two experiments was clustered, but trampling resulted in two different spatial distribution patterns. The terrace ended with a dispersed pattern, while the path experiment resulted in a more limited pattern of dispersion.

Contents

List of Tables

List of Figures

Chapter 1 - Introduction

Bokoni is a stone walled settlement region in northeastern South Africa. The area is characterised by stone walled homesteads, terraces and roads that intersect the agricultural terraces and link the homesteads to the surrounding landscape (Delius *et al.* 2012; Henshall 2016: 23). Unlike other southern African farming sites where potshards and other forms of household refuse are mostly found in middens, in Bokoni middens are largely absent, and potshards are found scattered across the sites. Delius *et al.* (2012: 411) attributed this pattern to the use of domestic ash and associated refuse in the fertilization of terraces. This scattered pattern means that in Bokoni sites pottery would be affected by different taphonomic processes than pottery concentrated in middens.

These processes would have included movement through the site as a whole, and on terraces. Cattle and people were moved from the homesteads to drinking areas by roads that intersected the terraces, and smaller paths linked various parts of the towns (Delius *et al.* 2014). According to Snead *et al.* (2009) roads, trails and paths that enable the movements of people should be studied as part of constructed landscapes.

This Research Report details the results of an examination of the impact trampling has on the size, surface condition, and the movement of ceramic shards on a terrace and path surface. I gathered data through a trampling experiment on a slope, and flat surface that replicated path and terrace surfaces in Komati Gorge, Bokoni. This was followed by a comparative analysis of the pottery used in the trampling experiment, focussing on fracturing and abrasion of the shards, and a spatial examination of the movement of pottery.

Pottery was chosen as the material culture type to trample in this experiment because potshards are the most common artefacts excavated on Bokoni sites. Potshards have been found in domestic and agricultural terrace contexts. It is likely that domestic refuse was discarded in terraces as part of soil fertility management (Henshall 2016: 98). In spaces such as the non-domestic areas (terraces) shards of various sizes, thicknesses and varying states of preservation were found (Collett 1979, 1982; Henshall 2016: 26, 59 & 67).

My research makes an important contribution because there is limited research on the effects of trampling on ceramic shards. Understanding these trampling processes is crucial to identifying and controlling site formation processes affecting the integrity of archaeological assemblages yielded from excavations at Komati Gorge in Bokoni. Most studies have focussed on faunal and lithic trampling experiments. This includes for example Malinsky-Buller *et al.* (2011) and Weitzel *et al.* (2014: 98) whose research focussed on bone and lithics, Huisman *et al.* (2014) and Benito-Calvo *et al.* (2011) and Reynard (2014) and Reynard and Henshilwood (2018), who examined fauna, and Marwick *et al.* (2017) and Pargeter (2011) who focused on lithics.

Experimental archaeology is useful because past people are no longer living and thus able to aid archaeologists in interpreting and practically reconstruct past activities; Experimental archaeology provides information with which archaeologists can reconstruct past events. Kelly and Thomas (2013: 179-182) advocate the use of different methods as a successful way that might lead to a possible technique to interpret past events. Reaching the right method, that is one that might successfully test a hypothesis requires research, at times might require repeated experiments.

When conducting trampling studies, agency should be considered because it has an impact on the archaeological materials (Balirán 2014: 92). Agency can be defined as voluntary and intentional actions undertaken by people that shape or modify the archaeological record, and much of the scholarship has focussed on active agency (Dornan 2002: 306-325). The presence of pottery on the terraces can be viewed as the material residue of women's agency in farming. Trampling of ceramics, however, also speak to other forms of agency, or the involuntary acts resulting from other deliberate daily acts.

This research report comprises six chapters. In Chapter 1 I introduce the project and set out the aims and context. Chapter 2 is the literature review, in which I start with a discussion of relevant previous research on the archaeology of Bokoni (including the settlement layout, geology and geomorphology of the area, and material culture), as well as the site adjacent to my experimental site, which is Komati Gorge Village 1. The second part of this chapter reviews relevant experimental archaeology case studies, and trampling activities in a broader context. Chapter 3 serves to present methods and approaches utilised to conduct the trampling in the field, as well as the laboratory analysis of the data generated in the field. I present the data collected during the trampling experiment in Chapter 4, this data is discussed in Chapter 5. The Research Report concludes with a summary of the achievements of this paper, and a proposal of future research.

Chapter 2 - Literature review

This chapter reviews pertinent literature on the archaeology of Bokoni and experimental archaeology. I highlight important elements of previous research on spatial artefact distribution, and the modification of archaeological artefacts that underwent trampling.

2.1. Bokoni archaeological region

Bokoni is situated in northeast South Africa (Fig. 2.1). The archaeological region is characterised by stone-walled sites. These sites include densely occupied towns, as well as scattered homesteads, which were built by African farming communities, who spoke seKoni (Delius & Schoeman 2008; Delius *et al.* 2012; also see Van Hoepen 1939: 61, 73; Huffman 2004).

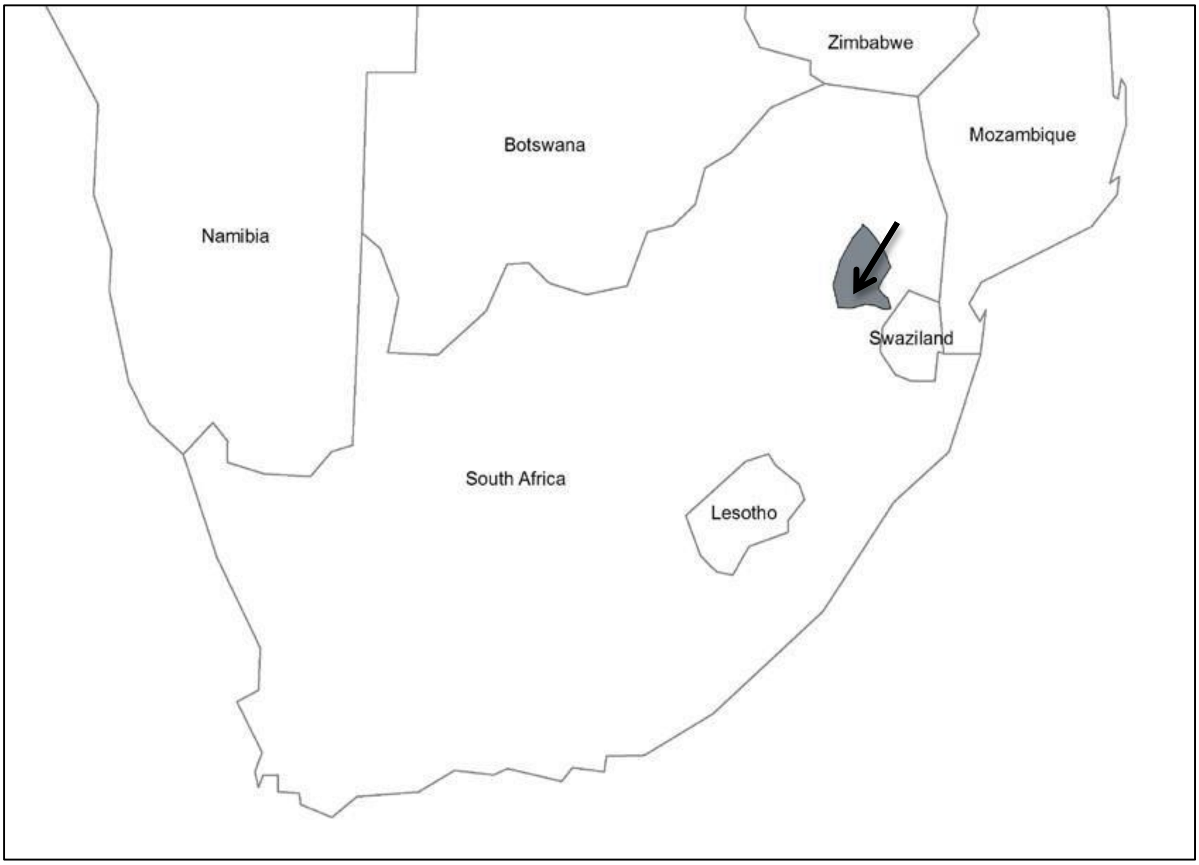

Figure 2.1. Map showing the location of Bokoni archaeological region (Widgren *et al.* 2016: 35).

Evers (1973) stated that the Pedi people occupied Bokoni. He said that this is traceable through the layout of the settlement and the evidence of ceramics style reflecting the modern Pedi shards. Schoeman (1997), however, argued that this is not true, because the Pedi attacked the Koni at Kutoaneng (Khutwaneng) in the Badfontein valley, where one of the large stonewalled towns are located. Consequently, she argued that the first settlers of this archaeological zone were Koni speakers. Huffman (2004: 98) and Delius and Schoeman (2008) stated that based on the oral tradition the original settlers of the site were Koni people, but Huffman (2004) defined this group as the homogenous Nguni community belonging to the Langa lineage. Whereas, Delius *et al.* (2012, 2014) harnessed archaeological and historical data to argue for diverse population origins.

2.2. Settlement Sequence

The topographic context in which the sites were built changed over time. Phase 1 and 2 southern and central sites were built on gentle slopes, while phase 3 sites in the north were constructed on steep slopes (Delius *et al.* 2012).

Phase 1, which signals the start of the Bokoni occupation by terrace farmers, started in the late fifteenth, or early sixteenth centuries AD (Birin 2017; Ramaoka 2018). These occupations were on hills in open grassland, and were configured around agricultural production. Phase 1 sites include the sites clustered along the Komati River. One of these was Komati Gorge Village 1 (Solomon 2016; see Delius *et al*. 2012 for a discussion of the occupation phases) (Fig. 2.2). The landscape at Komati Gorge had rich and fertile soils, which are excellent for hoe cultivation, although erosion risk was high due to soil types, steep slopes, and rocky surfaces (Schoeman 2013). Terracing helped prevent soil erosion.

Phase 2 settlements, that probably started in the seventeenth century AD, also are located on arable open grassland. Similar to phase 1, these settlements are without defensive structures (Delius & Schoeman 2008: 158; Delius *et al*. 2012: 404; Henshall 2016: 9). This phase differs from phase 1 in terms of population size; the phase had a denser population and saw the development of chiefly villages. One of these, according to Delius *et al.* (2012; also see Prinsloo 1936), was Moxomatsi situated near Belfast.

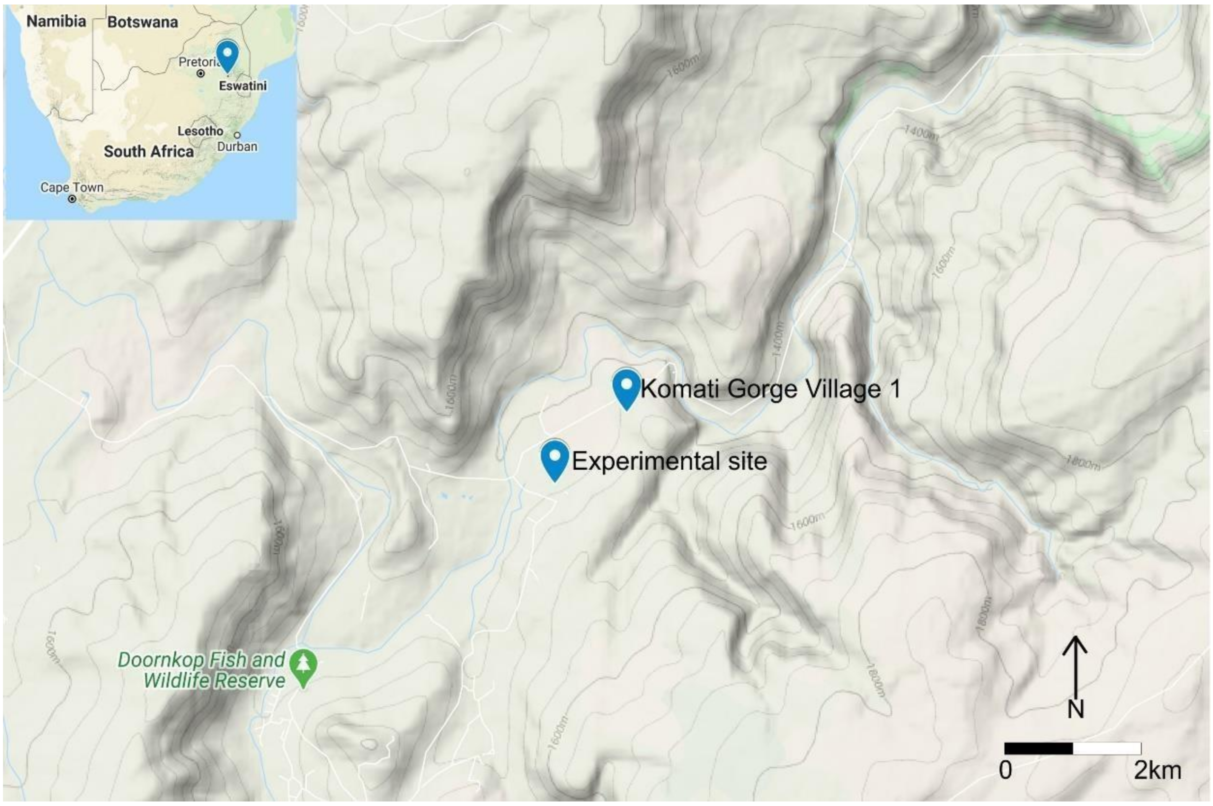

Figure 2.2. Map indicating the location of the study area.

According to Delius *et al.* (2014: 404) these communities had easy access to trade via the Komati River. Trading ivory and slave raiding, however, resulted in conflict. Moxomatsi was also attacked by 'the Mapono' (an unknown group) in the late seventeenth or eighteenth centuries AD. Consequently, the community was forced to relocate the core of their settlement to Mohlo-Pela, to the east of Machadodorp and Khutwaneng in the Badfontein areas, to less fertile sites.

Phase 3 was characterised by conflict. This phase probably started in the late eighteenth century AD (Delius *et al*. 2012: 406-407; Henshall 2016: 9). The conflict led many individuals to seek refuge in kloofs in the neighbouring communities. However, the kloofs could not sustain the population indefinitely, leading individuals to disperse to neighbouring communities (Delius & Schoeman 2008; Delius *et al.* 2012; Schoeman *et al.* 2019).

The fourth and final phase marks the end of Bokoni as an economic-political entity, and the establishment of Pedi and Boer authority over what previously had been Bokoni (Delius *et al.* 2012: 407).

2.3. Geography, environment and climate in Bokoni

Bokoni inhabit a high-lying grassland Savannah biome (Sjöström's 2013: 9-10). During the Bokoni occupation the area experienced unstable climatic conditions. The site normally receives seasonal rainfall with high volumes in summer accompanied by high temperatures. In winter the Komati Gorge annual temperature drop to 16 degrees Celsius (Hattingh 2013: 16). According to Hattingh (2013) phytoliths from Komati Gorge Village 1 show that the site experienced environmental and climatic change during it occupation. These included a significant regional temperature drop between AD 1690 and 1740 (Sjöström *et al.* 2017: 275) predating the Bokoni and Komati Gorge occupations, as well as a severe regional drought that started in the late eighteenth century AD and lasted well into the nineteenth century ADs (Schoeman *et al.* 2019).

2.4. Farming in Bokoni

Agriculture and cattle farming were the main economic activities in Bokoni (Maggs 2008: 180). Agricultural produce provided an opportunity for the people of Bokoni to interact with other communities through economic exchange of cattle and agricultural surplus. Macro botanical remains and phytolith analysis indicates that sorghum and millet were cultivated (Hattingh 2013).

According to Maggs (2008) and Delius *et al.* (2012) the economic successes resulted in demographic growth, and this created a need for intensive agriculture. Agriculture in Bokoni involved terrace building, hoeing, hand weeding and manual harvesting (see Delius *et al.* 2014). Intensive agriculture required significant amounts of labour. Young people were organized into age groups in order to assist in food production (Delius & Schoeman 2008). Complex agricultural systems are proxies for geographical labour divisions (Widgren *et al.* 2016).

Bokoni site selection was based on soil fertility, but this was altered through site formation processes. Three major formation processes shaping Bokoni sites were (i) erosion (ii) terracing and (iii) hoeing. These three processes significantly affected the soils present on the sites. As noted above, erosion was a concern, therefore people constructed terraces to prevent soil erosion (see Marker & Evers 1976; Solomon 2016). The significant depth of clay rich reddish–brown soil on parts of the site was a result of this terracing. Some of the soils in the terraces were placed there deliberately, while the rest accumulated when the terraces trapped soils that eroded further upslope. The clay rich soil lies above the weathered saprolite. The top soils on the terraces were then mixed through hoeing (Ramaoka 2018).

French and Whitelaw (1999) noted that most archaeologists do not pay attention to taphonomic processes on agricultural terraces. They further stated that academic researches on agricultural terraces are limited to economic and social issues (French & Whitelaw 1999; cf. Isager & Skydsgaurd 1992: 81-82; Foxhall 1996).

2.5. Settlement layout and material culture

All Bokoni homesteads contained central livestock enclosures built in stone (Fig. 2.3). These would have been surrounded by houses built with poles, *dakha* and grass (see Collett 1979, 1982). These homesteads were surrounded by agricultural terraces, and were connected through a network of roads and paths (Delius *et al.* 2012).

Terraces were used to modify slopes, and thereby increase the area of suitable lands to farm (Widgren *et al.* 2016). Through the construction of artificial terraces, erosion of soils was controlled, and moisture was managed (Marker & Evers 1976; Maggs 2008; Widgren *et al.* 2016). The roads tend to run perpendicular to the terraces. These roads are well-defined through stone walling, and create a way for the cattle to go for grazing, and for people to travel from and to their homestead (Delius *et al.* 2012: 408).

Figure 2.3. Image depicting the settlement layout in Bokoni (Widgren *et al.* 2016).

Homesteads, livestock enclosures, road walls and terraces were constructed using drystones. Walls included small and large rocks (e.g. Widgren *et al.* 2016). Henshall (2016: 113) found that potsherds were included into some of the constructed walls.

Bokoni sites are generally poor in material culture, and middens are very rare (Delius *et al.* 2012: 411). A few grindstones that would have been used in food preparation have been recovered (Collett 1979, 1982; Maggs 2008: 180). While pottery was used to cook and store the food, archaeologists have found relatively little pottery on Bokoni sites. This in part is due to the absence of middens (Delius & Schoeman 2008).

2.6. Experimental archaeology and trampling

Experimental archaeology started in the early 1800s (Callahan 1999: 4), although rigorous protocols only developed more recently. Broadly defined experimental archaeology involves sets of replicable experiments, that test hypotheses about past activities. Stoops (1989) indicates that experimental archaeology serves to reconstruct past activities through investigating a number of hypothesis, facts and assumptions about archaeological artefacts. Stoops (1989) highlight that older definitions of experimental archaeology (cf. e.g. Ingersoll *et al.* 1977) defined experimental archaeology " . . . as a systematic approach to the explication of data” that imitates and tests series of methods, site formation processes, as well as taphonomic processes (Stoops1989: 13-16). To do this it:

(I) makes use of modern methods to reconstruct archaeological material and structures to mimic ancient remains,

(II) makes use of the modern technology to replicate raw materials similar to past artefacts, and

(III) present the behaviour of an artefact when it is utilised.

Stoops (1989: 16), however, criticises the above approach to experimental archaeology. He states that experimental archaeology was only limited to replication. Stoops (1989) utilises a definition by Tringham (1978: 170) that states that “experiments as part of archaeological investigations . . . comprises a series of observations on behaviour that is artificially induced. [This] may involve more or less rigorously controlled conditions and recorded results”.

According to Kelly and Thomas (2013: 179-182), Shanks and Tilley (1992) and Callahan (1999) explained that experimental archaeology is a method that utilises scientific techniques and involves physical testing. This method is viewed as modern and controlled observation (Kelly & Thomas 2013: 179-182). Shanks and Tilley (1992), state that these experiments are preceded by hypothesis that might be tested valid or invalid.

Trampling in this study is viewed as a process of alteration on archaeological materials (Stoops 1989; Nielsen 1991; Balirán 2014: 86). It is defined as the behaviour caused by human and animal foot pressure on archaeological artefacts (Stockton 1973; Madgwick 2014). This activity as Madgwick (2014) argues is not an incidental occurrence, it is a method used to comprehend the functional use of defined space (such as agriculture). Trampling activities can be reconstructed to identify the processes that led to the alteration of deposited artefacts (Nielsen 1991). When doing so certain variables, such as object size, are kept constant in order to assess other variables (Stoops 1989).

Trampling is one of the site formation processes that can change the distribution, organisation, and surface condition of cultural materials. Human trampling as a post depositional process can contribute to the modification of artefacts and their context. Understanding the influence of human trampling on the archaeological record may allow more nuanced interpretations of archaeological assemblages (Nielsen 1991). According to Reynard and Henshilwood (2018), Domínguez-Rodrigo *et al.* (2009), Fernandez-Jalvo (2016: 101) and Olsen and Shipman (1988), the change of the condition of the artefacts is due to the force and pressure exerted on the objects lying on the ground. Objects are used and discarded on the ground, or in any other designated space. When these spaces, such as an agricultural field or road, were used the exposed materials were intentionally, or unintentionally stepped on. The process includes scuffing, kicking, and applying foot pressure over objects lying on the surface (Nielsen 1991).

Trampling leads to fragmentation and modification of archaeological objects because as Madgwick (2014) stated, trampling disturbs the state and preservation of material culture. Trampling modifies surfaces by causing striations, such as shallow, deep and/or parallel marks (Fernandez-Jalvo & Andrews 2016). Modification is also important because it can be used to track back the processes that led to the disturbance of the artefacts (Weitzel *et al.* 2014).

The outcome of trampling comes in two forms. These are physical and spatial (Stockton 1973: 113-115; McPherron *et al.* 2014: 70). The focus of the physical aspect is on the modification, or change on the surface of the material. Human trampling causes physical modification of the archaeological artefacts. Physical modification refers to the linear marks (shallow or deep lines), scratches, pitting, cracks and fissures (Reynard & Henshilwood 2018).

Taphonomic studies mimic trampling through experiments in response to errors noted when trampling disruptions were reported (Nielsen 1991). Challenges raised by previous taphonomic studies led to the expansion of experimental archaeology (Nielsen

1991: 484). Furthermore, trampling studies can be conducted under various controllable degrees (Nielsen 1991; cf. Stockton 1973; Tringham *et al.* 1974; Flenniken & Haggerty 1979; Lindauer & Kisselburg 1981; Villa & Courtin 1983; Gifford-Gonzalez *et al.* 1985; Muckle 1985; Behrensmeyer *et al.* 1986; Pintar 1987; Olsen & Shipman 1988; Pryor 1988; Reynard 2014).

2.7. Modification

Trampling modification includes surface modification on artefacts, as well as size reduction as a result of abrasion (Edwards 2009) and breakage (Blackham 2000). The spatial change refers to the distribution, horizontal or vertical movement of archaeological materials (Nielsen 1991; Benito-Calvo *et al.* 2011: 3653; Weitzel *et al.* 2014: 97). Horizontal displacement happens when the artefacts are displaced parallel to the surface. While vertical displacement happens when artefacts are displaced up and down beneath the surface of the soil. The vertical movement of shards results in the process of mixing of various shards.

Experimental archaeology, according to Weitzel *et al.* (2014), is crucial in understanding the processes that led the modification of artefacts. Trampling for example, which is the focus of this Research Report, is one of the causes of modification that can be traced through experimental archaeology. Madgwick (2014) stated that trampling modification could be used to mimic the sequence of material deposited on the archaeological site.

Weitzel *et al.* (2014), point out that analysing modification is vital in understanding and presenting the data. Their work considers different variables that contribute to the condition of the artefacts. These variables are the maximum length, width and raw material. Reynard and Henshilwood (2018) utilised trampling modification to measure population intensity. Another advantage of assessing modification is that the technique does not require complicated, expensive technology to identify the damage, a hand lens can be sufficient (Reynard & Henshilwood 2018).

Several challenges in studying modifications have been identified. Lopinot and Ray (2007) noted that too much attention is paid to edge damage, with many studies analysing only the edges of the artefacts and not the artefact as a whole. Olsen and Shipman (1988: 545), argued that identifying scratches on artefacts with the naked eye may be problematic as they may be misidentified for linear marks. Instead, they suggest that identification through microscopic analysis could be clearer.

2.8. Trampling modification

Olsen and Shipman (1988) conducted an experiment to examine trampling effects on archaeological artefacts. They argued that until then knowledge was based on assumptions with claims that trampling activities on archaeological materials create modification. Therefore, they adopted an experimental approach to study the physical modification of artefacts. They identified a number of modifications, such as abrasion and striation marks, on long bone.

Reynard and Henshilwood (2018) observed similar trampling modifications on bone. However, their research was conducted to understand occupational intensity at the Middle Stone Age site of Blombos Cave. Their research shows that abrasion, linear marks, pitting, breakage, and scratches on bone are the indicators of occupational intensity (Reynard & Henshilwood 2018). They set out criteria to rate the impact of trampling, for instance pitting was rated as “1” meaning that the damage is less, damage was rated “3” if it is moderate, and if all the characteristics (including abrasion) of trampling are present, then the condition was rated “5”. They also examined the relationship between trampling modification and intensity, and indicated that there is a strong correlation between abrasion and trampling, and a weak correlation between intensity and bone fragmentation. This is important because Weitzel *et al.* 2014, stated that fragmentation is affected by the thickness of the artefacts, and that all variables are sensitive to the other.

Pargeter (2011; also see Pargeter & Bradfield 2012) explored different techniques to understand macro-fracture on stone tools, focussing on whether the macro-fractures are relevant in the identification of stone tools used as weaponry. Until he conducted his experiments, it was not clear whether macro-fractures were only caused by hunting. He also examined the role of human and animal trampling, as well as knapping in damage to stone tools (Pargeter 2011: 2882-2883). Pargeter (2011) and Pargeter & Bradfield (2012) found that trampling leaves marks on stone and bone tools, and can produce pseudo tools. Fractures on flakes included: snap, hinge/ feather, terminating fractures and notches (Pargeter 2011: 2885-2887; also see de la Peña & Witelson 2018).

Muckle's (1985) focussed on shell midden formation, specifically the fragmentation on shells. The outcome of his experiment revealed that shell fragmentation depends on a number of variables, which are the morphology and post-depositional factors. His results indicate that thin, small sized and convex shells are more easily trampled compared to the large thick flat shells. He suggested that structural properties are significant factors in the fragmentation of the shells in response to the trampling activities.

2.9. Horizontal and vertical displacement

Nielsen (1991) examined spatial (horizontal and vertical displacement) and physical modification of artefacts as the result of trampling. Nielsen (1991) replicated different types of material culture (shards, bone, lithic, wood and brick), and then recorded the vertical and horizontal movements of brick, bone, lithic and wood. He did not record the movement of shards because he discovered that the shards were being displaced at a very small mean distance (less than 7cm).

The general results for vertical movement indicated that on a compacted soil artefact move less than 2cm, and do not disturb the stratigraphic sequence. The experiment recorded no size sorting for the small fragments of shards, but vertical displacement limits small artefacts from horizontal displacement. Horizontal displacement depended on the weight of the artefact, and Nielsen (1991) noted that denser artefacts moved less. While the small sized artefact greater maximum movement (Stoops 1989). The less dense artefacts were displaced to the zone marginal to the traffic. He concluded that flat objects tend to stay flat, and do not move, but irregular shaped artefacts are displaced from their initial position. Small artefacts are buried in the subsurface (Nielsen 1991).

Villa and Courtin (1983: 227), and Gifford–Gonzalez *et al.* (1985: 811), however, found that there is no significant correlation between the variables: size, weight and vertical movement. Madgwick (2014; cf. Muckle 1985; Pintar 1987; Nielsen 1991) on the other hand argued that there is a vital relationship between the identified variables with vertical displacement of artefacts, for example small objects tend to move more, with a maximum movement of 1.5cm. Skibo and Schiffer (1997: 313) and Nielsen (1991), also noted that despite the movement and fragmentation, when the small sized artefacts are continuously trampled they reached a stage in which they resist trampling, and are no longer reduced.

Nielsen (1991) recorded some abrasion and breakage of pottery shards due to trampling. A slight rounding on the shards' edge indicated abrasion. Breakage was the most dominant variable leading to size reduction. Nielsen (1991) and Skibo and Schiffer (1997: 313) noted that once potshards were highly reduced, they reached a state in which they resisted breakage.

Nielson (1991) focused his attention mostly on stone and lithics, and excluded pottery shards saying they skewed his calculation for other variables. His approach is problematic because Stockton (1973: 76) observed that different variables affect each other, for instance he noted that breakage has an impact on edge damage, and that if the artefact is broken it can no longer be analysed for edge modification.

Benito-Calvo *et al.* (2011: 3653) analysed the dip and orientation of archaeological materials affected by human trampling activities in order to understand archaeological artefacts from the Cova Gran de Santa Linya, Spain. A site associated to the Middle/ Upper Palaeolithic transition. Fabric of shards before and after trampling were analysed, as well as the vertical and horizontal movement of objects from one point to another (Benito-Calvo *et al.* 2011: 3653). They found that fabric depends on size, shape, weight and slope. The experiment they replicated began with artefacts exhibiting planar fabric, but ended with greater isotropy where little planar and linear patterns were observed. Horizontal movement occurred at the bottom of the slope.

The displacement of material created distinct patterns in each of the zones linked with differences in slopes (Benito-Calvo *at el*. 2011: 3660). This corresponds with Reynard and Henshilwood's (2018) study, which found that trampling processes can be regarded as a direct evidence for human occupation areas (marginalised and traffic zones). This horizontal transportation of artefacts creates clustered patterns, which are characterised by larger and medium objects (Landa 2014; also see Nielsen 1991).

2.10. Spatial structural analysis

Spatial structural distribution patterns of archaeological artefacts are recognised using fabric analysis. Stratford (2013: 23) viewed fabric analysis as a method that serves to assess the orientation and dip of archaeological artefacts (also see Esdale *et al.* 2001). The fabric deals with statistical data and how material is organised through space. In archaeology, fabric analyses were firstly utilised by Bar Yosef, Schick and Kaufulu (Lenoble & Bertran 2004). They introduced this technique with the intention of investigating the formation processes of the French Palaeolithic sites, by using it in slope contexts to understand the organisation of archaeological material.

Edwards (2009: 160-175), analysed the distribution pattern of the pottery by weight. This was important in order to understand how artefacts organize themselves in space. Through the QGIS application cluster patterns of the shards with varied sizes were analysed. The cluster from the slope plot and flat plots were compared. A paper by Nielsen (1991) and Benito-Calvo *et al.* (2011: 51) discuss the use of the GIS application to understand the direction and distribution of artefacts. This Research Report drew on these methods to understand the relevancy and purposes of using the explained methods. Through GIS application a distribution map was created to interpret the spatial pattern observed, a distance was calculated to understand the trend between size, movement and direction of the displaced objects.

2.11. Limitations

Recent archaeological experiments sought to correct previous assumptions. In terms of spatial analysis, Marwick *et al.* (2017) recorded that different types of variables impact on both the horizontal and vertical displacement of artefacts. Variables including volume, width, length, and thickness of objects contribute to the vertical migration of materials, while elongation contributes to the horizontal movement of artefacts.

The effects of trampling have limitations, for example, Marwick *et al.* (2017) stated that an object buried deeper than 1 meter is not considered as an outcome of vertical trampling. It, however, can be influenced by other processes or activities, which have a greater impact than trampling such as the natural migration of materials.

Methodological inconsistency is another concern in taphonomic studies that replicate archaeological processes. Of particular concern is the issue of equi-finality as a result of numerous methods being used, thus leading to different end results instead of one-end result (Nielsen 1991: 484; Gaudzinski-Windheuser *et al.* 2010; Weitzel 2014; Reynard & Henshilwood 2018).

Chapter 3 - Methodology

This chapter presents the methods and approaches used in this report, which set out to answer the research question: How trampling affects the size, surface condition and the movement of ceramic shards on a flat surface (terrace proxy) and slope (path proxy).

Trampling contributed to the site formation in Bokoni. There would have been two forms of trampling on Bokoni sites. The Bokoni people had to walk from their homesteads to agricultural fields, and water sources. These people would have been channelled by the paths, and the outer walls that separated livestock enclosures and homesteads. The roads and paths restricted people to walk bidirectional, whereas as in the open agricultural terraces movement was less restricted.

I used techniques similar to Nielsen's (1991). Their research followed the experimental archaeology levels outlined by Stoops (1979). My quarry was similar to Nielsen's (1991), in that I examined whether trampling activities cause spatial (vertical and horizontal displacement) and physical modification (damages, abrasion, breakage and micro-flaking) of archaeological artefacts. However, whereas I used ceramics, he used a variety of artefacts and excluded ceramics when he analysis the movements of the artefacts. Marwick (2017) also only studied the movement of lithics as the results of trampling activities.

This chapter discusses all the significant protocols and methods used in this Research Report. The field techniques included the generation of various sized ceramic shards, construction of the two experiment areas, placing the shards on the experimental grid, and photographing and plotting their initial and final location before and after trampling activities. Laboratory analysis focussed on spatial analysis using Geographic Information Systems (GIS) tools.

3.1. Field experiments

Two experiments were set up in a borrow pit with silty clay soils, similar to the archaeological soils found in the nearby Komati Gorge Village 1, in Bokoni Mpumalanga (Fig. 2.2). These experiments mimicked human trampling activities on Bokoni sites. The experiments were performed on two plots, a flat surface which mimics the terraces as well as a slope, which mimics the paths (Fig. 3. 1).

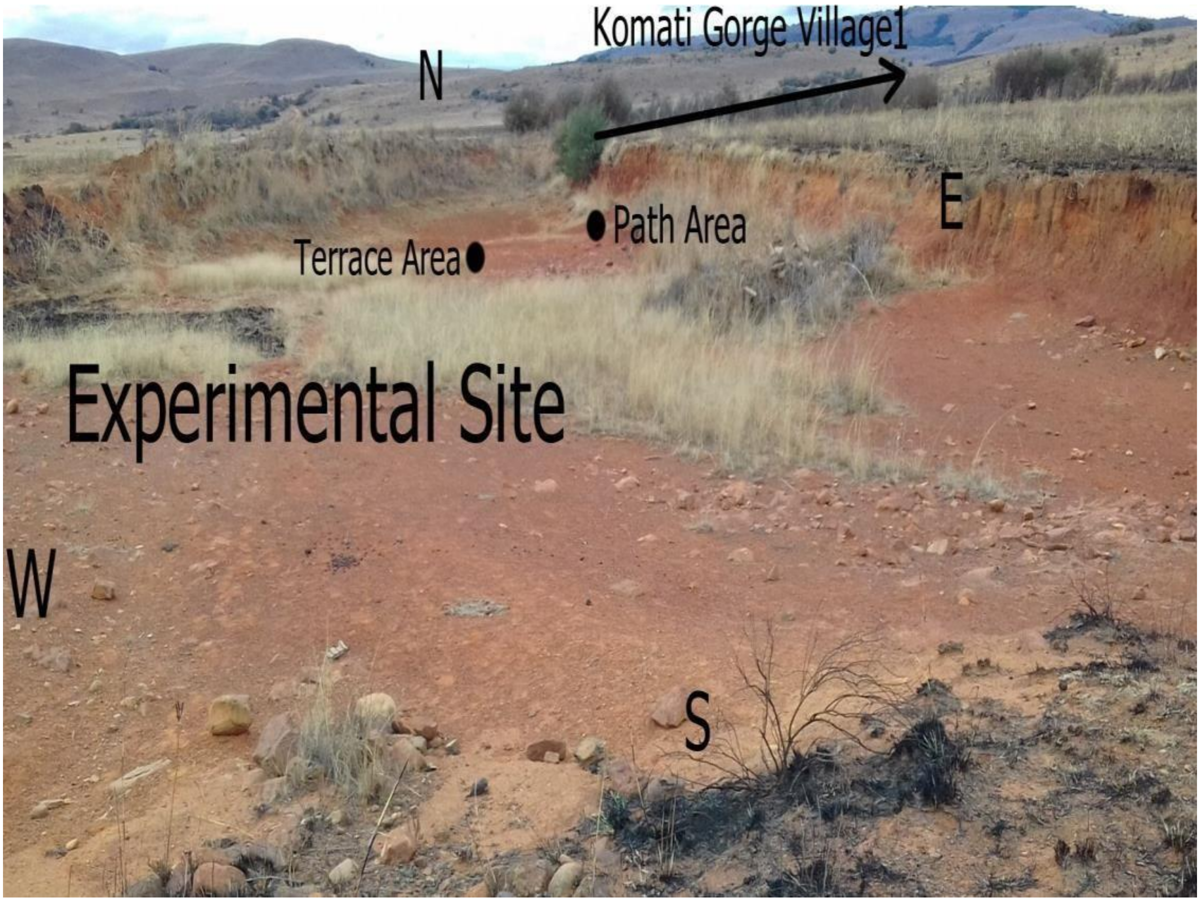

Figure 3.1. Photograph showing the borrow pit in Bokoni nearby Komati Gorge Village 1. Ref. N: North; E: East; W: West; S: South.

According to Stoops (1979) modern approaches and materials must mimic archaeological artefacts when reconstruct past human behaviours. I used ceramics because Bokoni archaeological material culture largely comprise potsherds (see Evers 1975; Collett 1979, 1982; Henshall 2016). Shards of various thicknesses, sizes, decoration were found dispersed in different areas such as the domestic and nondomestic spaces (Henshall 2016).

Two traditional round undecorated clay pots were purchased to be used for this experiment (Fig. 3.2). Similar to Nielsen (1991), I spray-painted the artefacts to make it easier to identify them at the end of the experiment, and to identify the damage created by the trampling activities. The pots utilised here were spray painted on the inside and outside with lurid pink paint for easy identification and left to dry for 15 minutes (Fig. 3.2).

Figure 3.2. Photographs of the pots that were broken to replicate potshards.

The two pots were dropped onto the ground from a height of 1.5m following Nielsen (1991), who dropped pots with an intension to replicate potsherds recovered from excavations. This was the best height for the pot to break into various sized fragments (Fig. 3.3).

The broken pieces of the shards were labelled from F1-F22 (on the flat surface representing a terrace) and 1-23 (on a slope representing a path), and their centres were marked with the letter 'X' (Fig. 3.3). This followed Marwick (2017) who marked the artefacts, in order to identify the fragments. Nielsen (1991) also used the same technique to identify the artefacts and trampling damage.

Figure 3.3. Photographs of the labelled potshards.

After giving the shards unique codes the size of each of the shards was measured using a CD-8"AX digital calliper. Size is the significant variable in this study. Each shard's medial length and width was measured before and after the trampling experiment. This followed Blackham (2000: 479) who referred to the length as the longest side of an object, and the width as the perpendicular to the length. These two variables, specifically the length, are noted to be susceptible to trampling activities (Blackham 2000: 481). Comparing size sorting on archaeological objects is much easier when there are variations in the size of the artefacts. Sizes of the individual shards were also measured because a size reduction was expected, as Blackham (2000: 475) noted trampling reduces the size of the artefacts. Thereafter photographs of the shards were taken. All the information gathered was recorded on an excel spreadsheet.

3.2. Experimental grid and trampling

Nielsen (1991: 466) and Marwick *et al.* (2017) created 1m x 1m grid areas for their experimental research. Their research work modelled closed air archaeological sites such as caves. In contrast, this experiment relates to open air sites, therefore bigger experimental grids were set up to represent open systems. The experimental grid areas were set up in a borrow pit near Komati Gorge Village 1 (Fig. 3.1). The first grid area, mimicking a path, was 3 X 5m wide, and was located on a slope characterized by an uneven gradient (Fig. 3.4). The second grid area mimicked a terrace; this plot was on a relatively flat area with dimensions of 7 X 5m (Fig. 3.5).

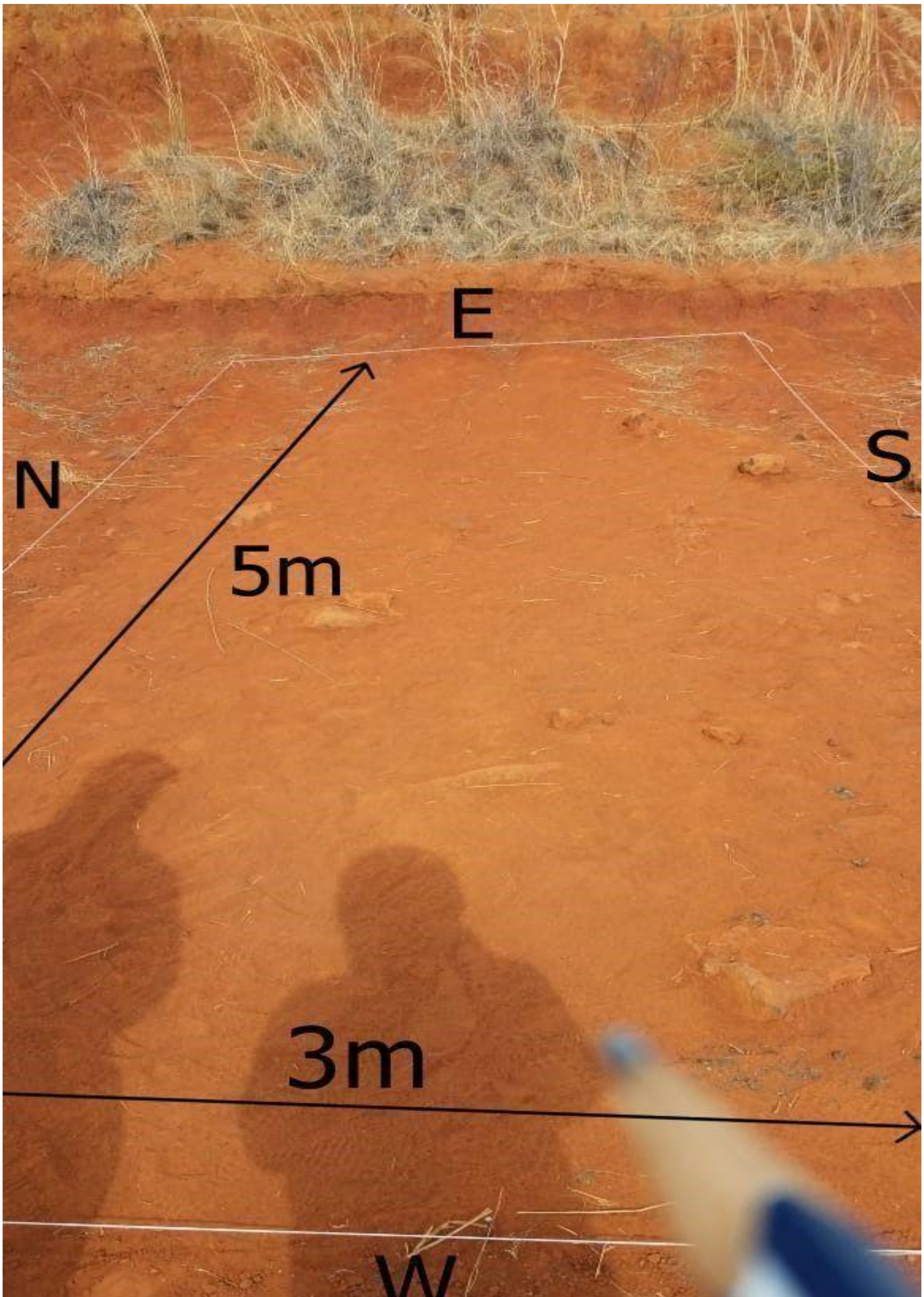

Figure 3.4. Photograph showing the experimental grid mimicking a path. Ref: N:North; E:East; W:West; S:South.

The boundaries of both plots were mapped using a Nikon Nivo 5C total station to plot eight points [the south (S), southwest (SW), southeast (SE), north (N), north west (NW), northeast (NE), west (W) and east (E)]. After creating the boundaries, the shards were laid on the flat and sloping surfaces (Fig. 3.5). A total station was used to measure the distance and angle. Total stations allow for very accurate measurements, and are able to store great amount of information (Gill & Aryan 2016: 157-159).

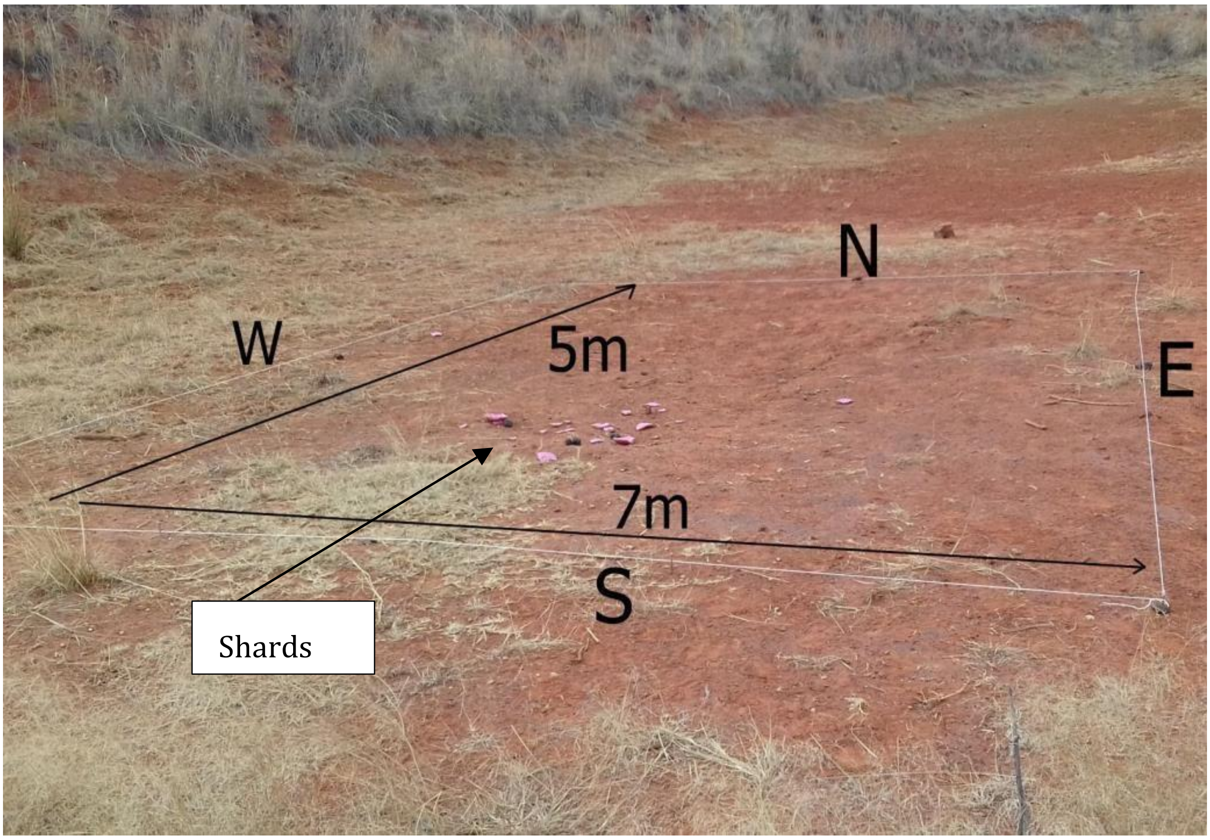

Figure 3.5. Photograph showing shards placed on the experiment area (path area). Ref: N:North; E:East; W:West; S:South.

After laying the shards on the demarcated experiment grids the co-ordinates were taken using the total station. The dip of the artefacts was not recorded because there were no elongated shards. Therefore, the flat and slope experiment boundaries were measured in degrees using the clinometer function on a Brunton geological compass. These measurements were taken to give the gradient of the slope and flat experiment areas. This information informs us about the gradient of the two experiment areas (see Table 1).

Table 1. Table showing the gradient of the slope and flat experiments.

	Gradient for the slope plot (^{0})	**Gradient for the flat plot (^{0})**
N	5	9
NE	4	5
NW	5	11
S	10	9
SE	12	9
SW	11	6
W	6	8
E	8	9

Eleven 2nd and 3rd year student volunteers, consisting of five males and six females of different weights trampled the shards. They wore soft-solid shoes. The students walked bi-directional (east to west) on the path plot, and in random directions on the flat plot (Figs 3.6 & 3.7). They walked 1000 steps at a constant pace. They each walked for 6-7 minutes (cf. Marwick *et al.* 2017).

Figure 3.6. Image showing trampling activities. Ref: N: North; E: East; W: West; S: South.

Figure 3.7. Image showing the flat experimental grid mimicking the terrace. Ref: N: North; E: East; W: West; S: South.

After the trampling activities, the co-ordinates of the trampled sherds on the slope and flat experimental areas were plotted using the total station. The plotted sherds were then collected by hand for further analysis in the laboratory. Only two shards were buried under approximately 2cm of loose soil. These two potshards were partially visible (colour was very bright) and were recovered using fingers only in order to prevent additional scratch marks. The shards were carefully placed in plastic bags so that no further surface modifications took place when transporting them back to the laboratory at the University of the Witwatersrand.

3.3. Challenges in the field

Various challenges were experienced in the field as a result of weather conditions. While setting up the total station, we encountered difficulties in levelling the instrument in the ground due to strong winds. This resulted to delays as we had to wait until the wind settled down. Rainfall, also restrained us from setting up the experiment at the time it was planned. In order to ensure mapping took place at a fast pace, I used the laser from the total station as this instrument allows the experiment to be performed at a fast pace without an assistance.

3.4. Analytical method

After the field experiment was completed, the shards were analysed at the University of the Witwatersrand. The analysis focused on (i) fragmentation, (ii) surface modification and (iii) displacement of shards after the trampling experiments (cf. Gifford-Gonzalez *et al.* 1985; Nielsen 1991; Marwick *et al.*
2017).

3.4.1. Computerising data

The generated data from the field (e.g. plotted co-ordinates) were recorded in the micro-soft excel spreadsheet in the computer. This consisted of the name, description, total station number and co-ordinates (X, Y & Z co-ordinates) of the shards before and after the trampling events. In the excel sheet I added the measurements of the shards (length and width), distance travelled by shards and direction of movement. The shards before and after trampling information on the spreadsheet was used to match the original shards to their matching trampled shards. The shards were examined one by one to find out which original shard they belong to.

3.4.2. Measuring size

A CD-8"AX digital calliper was used to measure the medial length and width of individual shards. This is important in comparing various sized artefacts exposed to human trampling (see Driscoll *et al.* 2016: 135; Marwick *et al.* 2017). Through the measurement of assemblages, a relationship between the size of the objects and trampling damages (abrasion) can be analysed. The trend between fragmentation and size of the artefacts can also be assessed (see Edwards 2009: 152-153; also see Bradley & Fulford 1980: 86). In addition, impacts on the size of the assemblages have an effect on the shape of the objects (see Stratford 2013).

3.4.3. Photographs

Thirty-four broken shards from both the flat and slope experimental areas were photographed using a Nikon D8000 camera with a microscopic lens. The chosen shards provided a good example of trampling damage and breakage. The photographs were taken in the laboratory for assessment (identification of human trampling surface modification) (cf. Olsen & Shipman 1988). Some of the human trampling marks were very hard to see by naked eyes, but were easier to identify through microscopic analyses.

3.4.4. Modification criteria

To analyse the shards' surface modification, I compared the damage to published examples. The following are the indicators of human trampling on archaeological objects.

- Linear marks as defined by Fernandez-Jalvo and Andrews (2016: 25) are "marks with lengths that are four times their breadth and longer". Domínguez-Rodrigo *et al.* (2009) and Olsen and Shipman (1988) noted the lines as 'trampling marks'. These authors and Reynard and Henshilwood (2018) divided these lines into two categories; shallow lines and deeper grooves are identified based on their orientation and shape of the lines.
- Scratches are trampling marks that resemble scrapping marks (Reynard & Henshilwood 2018). They are also referred to as 'micro-abrasion or chatter marks (Reynard & Henshilwood 2018: see Domínguez-Rodrigo *et al.* 2009).
- Pits as defined by Fernandez-Jalvo (2016: 101) as the superficial marks and Reynard and Henshilwood (2018) view these marks as resembling impact craters. Reynard and Henshilwood (2018) identified the pits as having a diameter of 0.5mm.
- Cracks are defined by Fernandez-Jalvo and Andrews (2016) as openings on the surface of artefacts, indicated by an open line on the artefacts.
- According to Brain (1967) and Madgwick (2014) abrasions are smooth and sometimes polished surfaces created when the objects are exposed to some sort of friction such as trampling.

- Weitzel *et al.* (2014), identified two types of fracture patterns. That is the (i) transverse bending and (ii) bending breakage (Jennings 2011).

3.4.5. Quantitative comparative analysis

For comparative analysis Stoops' (1989) method was used to evaluate the difference between the flat and slope experiment. Below are the steps that were undertaken to compare breakage, trampling marks and abrasion modifications that were visible for both the flat and slope conducted experiment (see Tables 2 & 3).

The minimum, maximum and mean values are presented in order to understand how shards classified under various sized categories (see Table 4) behave as a result of human trampling. Minimum values are identified to show the lowest possible impact of human trampling on the three variables (trampling modification marks, breakage and abrasion). Maximum values are provided to show the highest possible impact of human trampling on the three variables mentioned above. The mean value is given to show the average impact of human trampling on the modification marks, breakage and abrasion.

The minimum, maximum and mean values are given to understand the trampling modification, breakage and abrasion of the shards. These three variables are assessed to generate the theoretical frequency of occurrences that will inform about spatial behaviours of the shards. In addition, the values reckoned are used to assess the impact and compare the rate of trampling for the two-varying areas (flat and slope surface) (see Table 4). The minimum, maximum and mean values of the trampling modification of the shards are generated through the assessment of the shards classified under various categories (Figs 4.8, 4.9 & 4.10).

3.4.5.1. Breakage

Three variables were considered. These are the length (l), width (w) and maximum area (lxb). For the comparison of distributions, the following variables were generated: the maximum dimensions (lxb/highest values), minimum dimension (lowest values), mean dimension (average) and standard deviation. All these variables were recorded and used to generate a descriptive statistical data and histograms of comparative distribution (Stoops 1989). The data generated from the above assessed variables informs about the type of break a shard was likely to exhibit.

3.4.5.2. Trampling marks

The trampling marks were categorised using the modification criteria that were described in section 3.4.4. The extent of trampling modification was also ranked from Low to High (Table 2). This data was combined with size data to establish whether there was a relationship between shard size and trampling marks. Size was established by using the breakage calculations described in the previous section. The shard sizes before and after trampling were compared using the criteria described above.

Table 2. Table illustrating trampling categories.

Category	**1**	**3**	**5**
Low	• Pitting		
Moderate		• Pitting • Scratches • Abrasion	
High			• Pitting • Scratches • Abrasion • Linear marks

3.4.5.3. Abrasion

Abrasion was assessed against the modification criteria described in section 3.4.4. Abrasion was ranked based on varying levels of abrasion from Level 1 (low) to Level 4 (severe). The correlation between abrasion and shard sizes in in the two different environments (slope and road) was also assed. This combined abrasion and size data. The size data was generated using the breakage shard size calculations described above.

3.4.6. Geographical Information System

Geographic Information System (GIS) applications are used for different purposes. Various scholars (e.g. Clark & Evans 1954; Edwards 2009) have used the application to calculate spatial relationship between entities. Edwards (2009: 160-175) applied GIS to measure distance between pits. In this paper, the software was used to record the change by the shards in centimetres. The space travelled by the artefacts was measured from the initial point to the final point. Only shards that match with their parent shards are measures to calculate the distance travelled. McPherron (2005) also used a GIS to identify orientation.

3.4.7. Spatial analysis

Capturing spatial data in order to investigate correlations between shard modification and distance moved in the two simulated depositional environments is a significant aspect of this project. As discussed above, before and after the trampling events the shard positions were surveyed at sub-cm resolution using a Nikon Nivo 5C total station. The centre points of shards were surveyed where possible to provide consistency in plotting protocol. Shard points exported and visualised in QGIS, different qualitative and quantitative variables are visualised and analysed spatially.

Spatially the distance travelled (cm) by the individual shard were measured using the measuring tool from QGIS. Measuring the distance of the individual shards is important because it tell us if either trampling activities displace artefacts from one point to another. That also informs us whether the shards were displaced vertically or horizontally (Marwick *et al.* 2017). The QGIS software was used to assess the direction (north, east, south and west) the shards travelled. This is because the movement direction has an impact on the shard direction. Furthermore, the spatial distribution maps were created (e.g. Fig. 4.1).

- Vertical movement is defined as a process that happens when archaeological artefacts are displaced downward from the surface as the results of trampling activities (Stoops 1989: 8).
- Horizontal movement happens when the objects are displaced parallel to the surface due to trampling activities (Stoops 1989: 9).

For the measurements of distance in this Research Report the study follows Edwards (2009), where he measures distance between pits. Displacement of the shards was

measured in centimetres using the QGIS. Two layers of shards (before trampling and shards after trampling) distance are measured for the two separate experiments.
Four maps were created. These are:

(1) a map showing shards before trampling on a flat surface mimicking terrace,

(2) a map showing shards after trampling on a flat surface mimicking terrace,

(3) a map showing shards before trampling on a sloped surface mimicking a path, and

(4) a map showing shards after trampling on a sloped surface mimicking a path.

3.5. Challenges faced when analysing the shards

When the shards were analysed in the laboratory a few challenges were encountered. Recording these problems is important for future studies that might conduct similar trampling experiments.

The first problem was the blank spaces between the numbers I wrote on potshards. This could be avoided by not leaving gaps between the numbers marked on the shards. It also was very difficult to figure out whether some of the numbers on close to fracture lines were double (e.g. 36) or single (e.g. 3) digit numbers. This skewed the parent shard data statistically, because some shards could not be matched to a parent shard, and therefore I could not measure the distance they travelled. This dilemma could have been avoided by having symbols to distinguish numbers with one digit and two digits.
For instance, a line under the number would have been a best solution. When it comes to double digits such as 11 or 22 different symbols could have been used. Therefore, double digit numbers should be marked with different symbols, and the digits must be close to each other.

Another challenge faced was variation in setting up the total station on different days. This resulted in the invention of co-ordinates. The co-ordinates were corrected by a GIS specialist. The only co-ordinates that I lost were for the elevation of the flat surface, and that was not significant because the surface was flat.

Chapter 4 - Research results

This chapter presents the results from my trampling experiments on a slope and flat surface. The outcome of this experiment will be summarized and illustrated through tables, graphs and pie charts.

4.1. Sample size

The twenty-two shards that originated from the first clay pot I broke were placed on the sloped surface. While I placed the shards in the plot, shards no. 2 and no. 18 broke. Shard no. 2 broke into two pieces and shard no. 18 into three pieces. The new part of shard no. 2 was labelled and 2a, and the new fragments of shard no. 18 were labelled 18a and 18b.

Trampling further broke the original 22 (24 after the breakage described in the previous paragraph) shards into 145 shards. Out of the 145 shards, only one was not recovered, and 49 of the shards could not be matched to the parent shards. This included two shards that were either no. 12 or no. 18, and one shard that was no. 18 or no. 8.

Twenty-three shards from the second clay pot I broke were laid on the surface of the flat plot, and these further broke into six extra shards while being placed. These were identified as 1, 1a, 1b, 1c, 1d and 23, 23a, 23b. Human trampling activity fragmented this sample into 245 shards. Of these, 101 shards were matched with their parent shards, while143 shards could not be linked to their parent shards, and it was not clear if one shard was 23, or 23a.

Below are results illustrations and interpretation explaining trampling impacts on shards.

4.2. Spatial analysis

4.2.1. Pre-trampling

Before trampling the shards on a flat surface were mapped (Fig. 4.1). When trampling began shards were clustered in a random pattern at the centre of the N, NE, NW, W and E boundaries. Figure 4.1 illustrates the location of the shards before trampling. There was no size sorting and all the shards were located within the boundary of the flat experiment grid (Table 3).

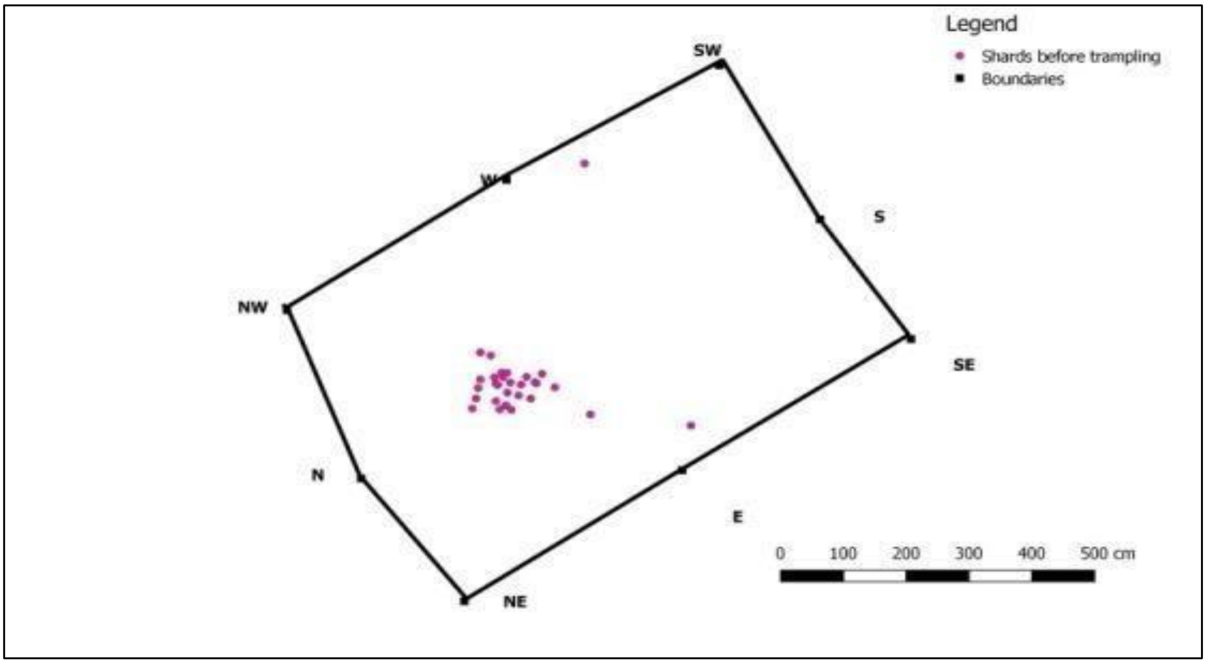

Figure 4.1. Map showing the shards laid on the flat experiment before trampling activities. Ref: N: North; NE: North east; NW: North west; S: South; SE: South east; SW: South west; E: East; W: West.

The experiment on a slope representing a path was also mapped (Fig. 4.2). The artefacts clustered at the centre of the W, E, NE, N, NW boundaries. There was no size sorting at this stage (Fig. 4.3; Table 3).

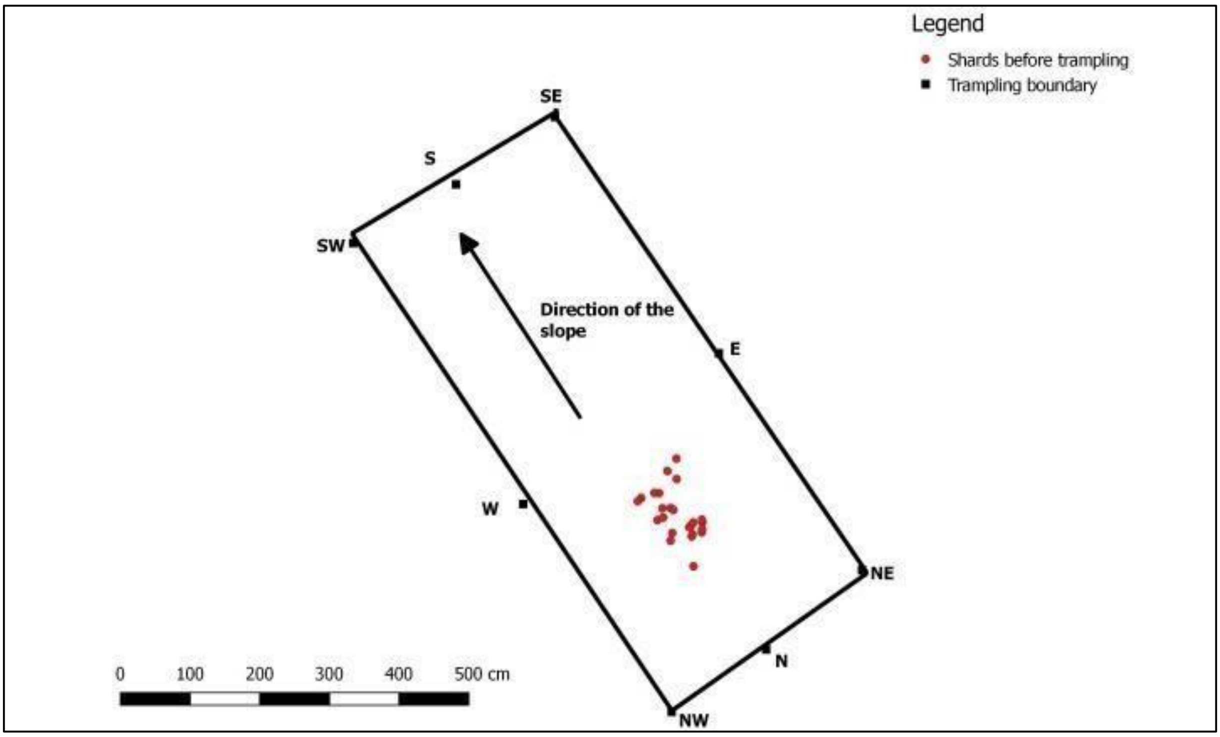

Figure 4.2. Map showing the shards laid on the path experiment before trampling activities.

Table 3. Various sized shards classified into relevant categories.

Max area	Flat surface	Slope surface
0-25mm	14	14
26-50mm	5	2
51-75mm	1	2
76-100mm	1	2
101-125mm	0	1
126-175mm	1	1

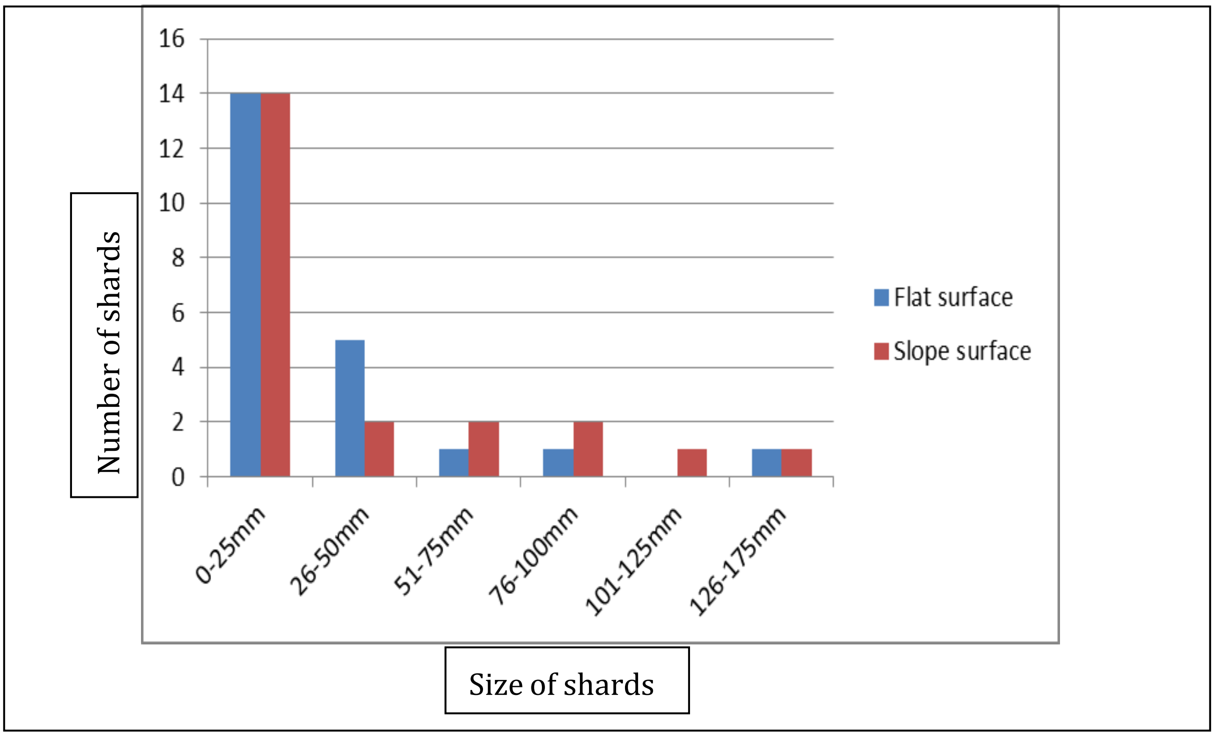

Figure 4.3. Graph showing various sized shards after trampling event for both the flat and slope surface.

The results generated here were calculated according to the statistical methods used by Stoops (1989). He, however, measured a number of variables whereas in this paper only two variables are considered. These variables are the length and width of the shard. Using the length and width variables the maximum, minimum, mean dimension, standard deviation and chi-square are calculated and presented in Table 4. Significantly, the main purpose of using this method is for comparison of data sets. Table 4 shows that there is little variation between the mean averages compared to the standard deviation.

Table 4. Showing descriptive statistical variation of shard dimensions between the slope and flat surface. Ref: St. dev: standard deviation; Max: maximum; Min: minimum; L: length; b: breadth.

Descriptive statistics						
	Dimension	**No. shards**	**St. dev**	**Mean**	**Max**	**Min**
Slope experiment	Lxb (cm)	22	5.085928299	3.666666667	14	1
Flat experiment	Lxb (cm)	22	5.354126135	3.666666667	14	0

4.2.2. Post-trampling

The scatter pattern of shards on a flat surface was changed by the trampling activities (Fig. 4.4). The blue dots that represent shards before trampling show an increased scatter pattern after the experiment on the flat surface, when compared to the shards before trampling. Shards spread randomly outwards from the centre of the shards before trampling. One of the shards was trampled outside the experimental grid and four of them are on the boundary of the grid. The areas close to the line grids are called the marginalised zones according to Nielsen (1991). In these spaces the artefacts no longer experience trampling modification.

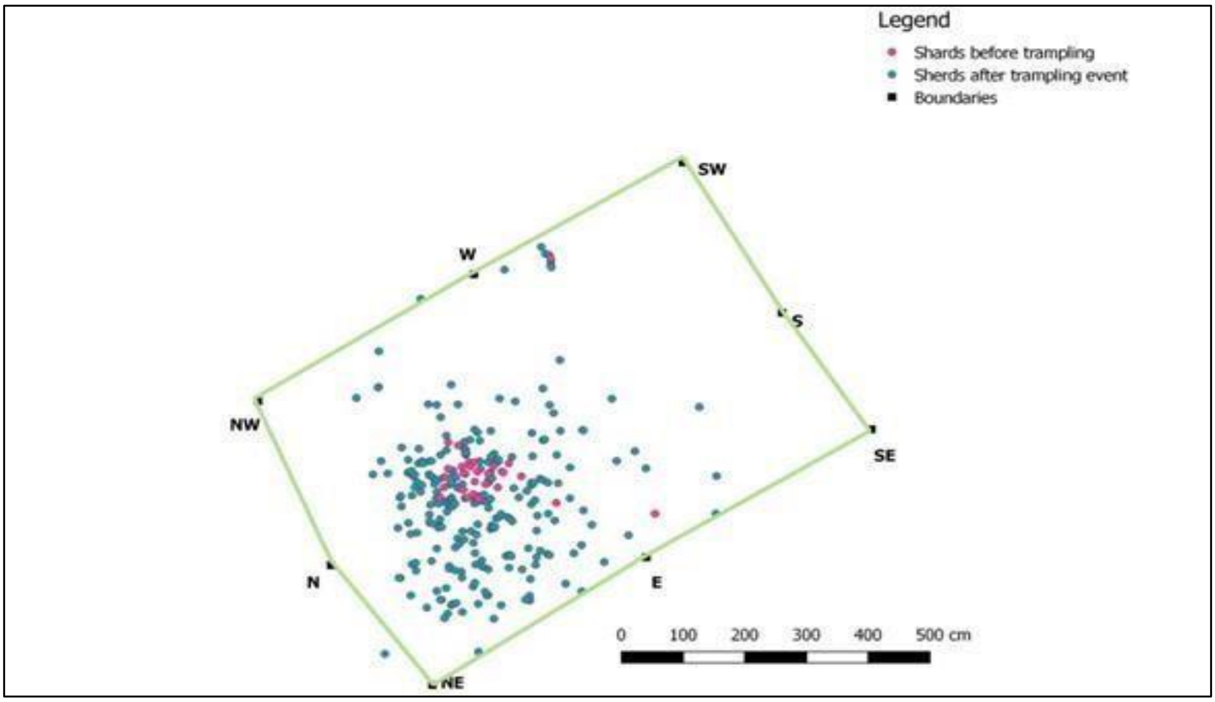

Figure 4.4. Plan showing the trampling events before (shard in pink) and after (shards in blue) trampling activities on a flat experiment area representing a terrace.

Similarly, the artefacts on the slope, representing the path, showed a dispersed pattern after trampling activities (Fig. 4.5). These shards were dispersed along the NE, NW, E and W boundaries. Similar to what was observed on the terrace, the shards spread outwards from the centre where they were laid down. This included significant downslope movement. These shards remained in the traffic zone [defined as a zone where trampling took always taking place (see Nielsen 1991), and only one of the shards was trampled to the margins. No size sorting was observed, but in terms of displacement small fragments moved further than expected.

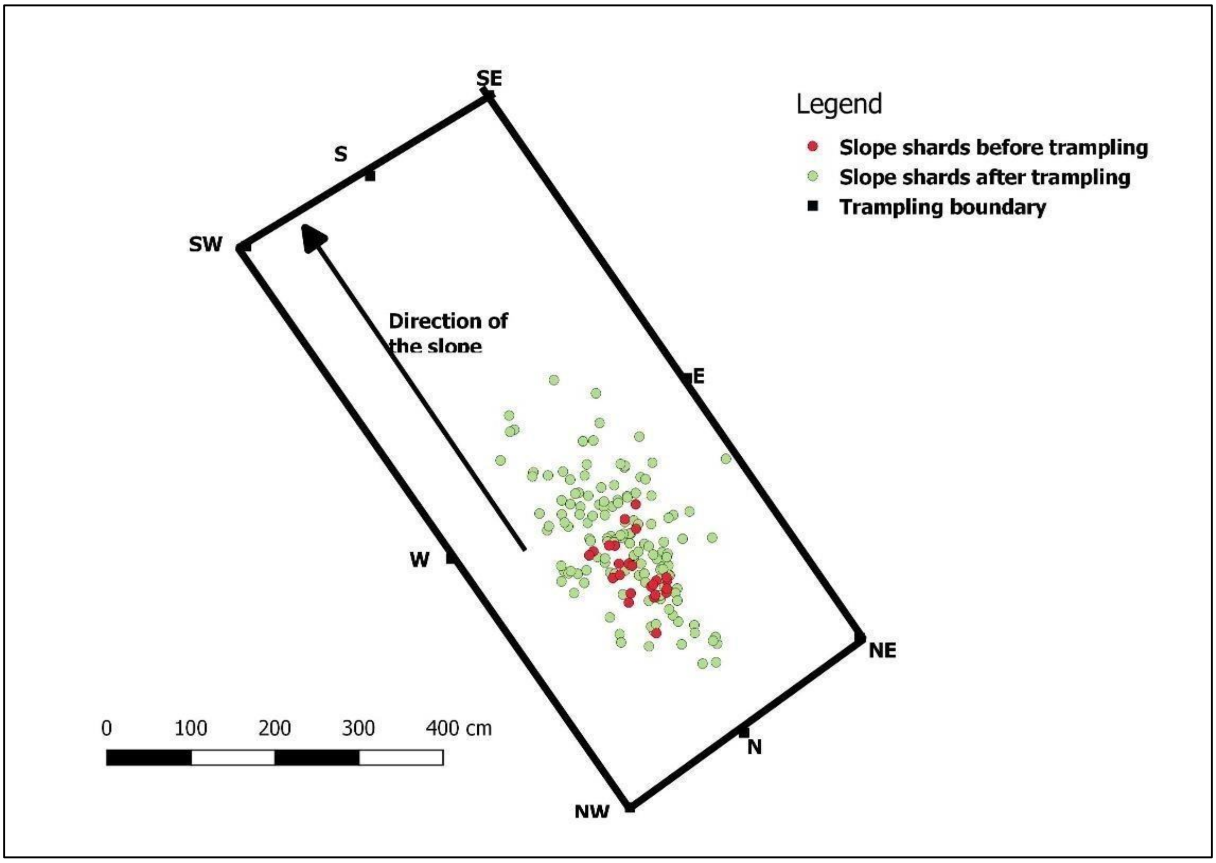

Figure 4.5. Map showing the trampling events after trampling on the path experiment area.

4.3. Types of trampling damage / modification observed

Damage resulted from trampling in both the slope and flat experimental plots. Six types of damage were observed. These are linear marks (deep and shallow lines), pitting, abrasion, cracks, scratches and fissures (Figs 4.5 & 4.7).

Image 1a: deep lines

Image 1b: shallow lines

Image 1c: Pits

Image 1d: Fissures

Figure 4.6. Images of shards from the slope and flat experiments showing trampling modification after trampling activities.

Image 1e:crack

Image 1f: scratches

Figure 4.7. Images of shards from the flat experiments showing trampling modification after trampling activities.

4.4. Trampling modification

Trampling modification was classified into low, medium and high (Figs 4.8, 4.9 & 4.10). The dominant trampling modification were linear marks, and cracks were minor (see Tables 2, 5 & 6).

Category 1: Low

Description: pitting

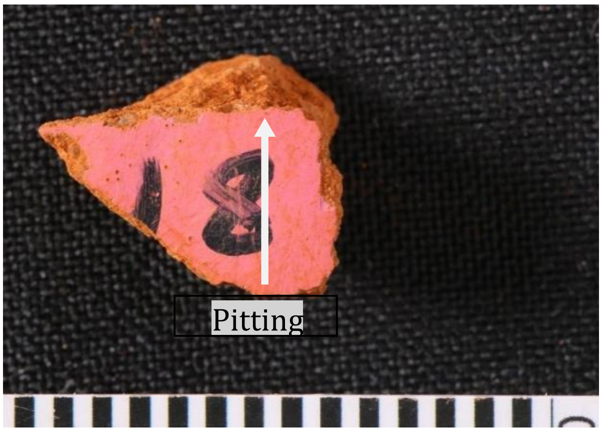

Figure 4.8. An example of an image showing shard indicating low trampling intensity.

Category 2: Medium

Description: pitting, scratches and abrasion.

Figure 4.9. An example of an image showing shard indicating medium trampling intensity.

Category 3: High

Description: pitting, scratches, abrasion and linear marks.

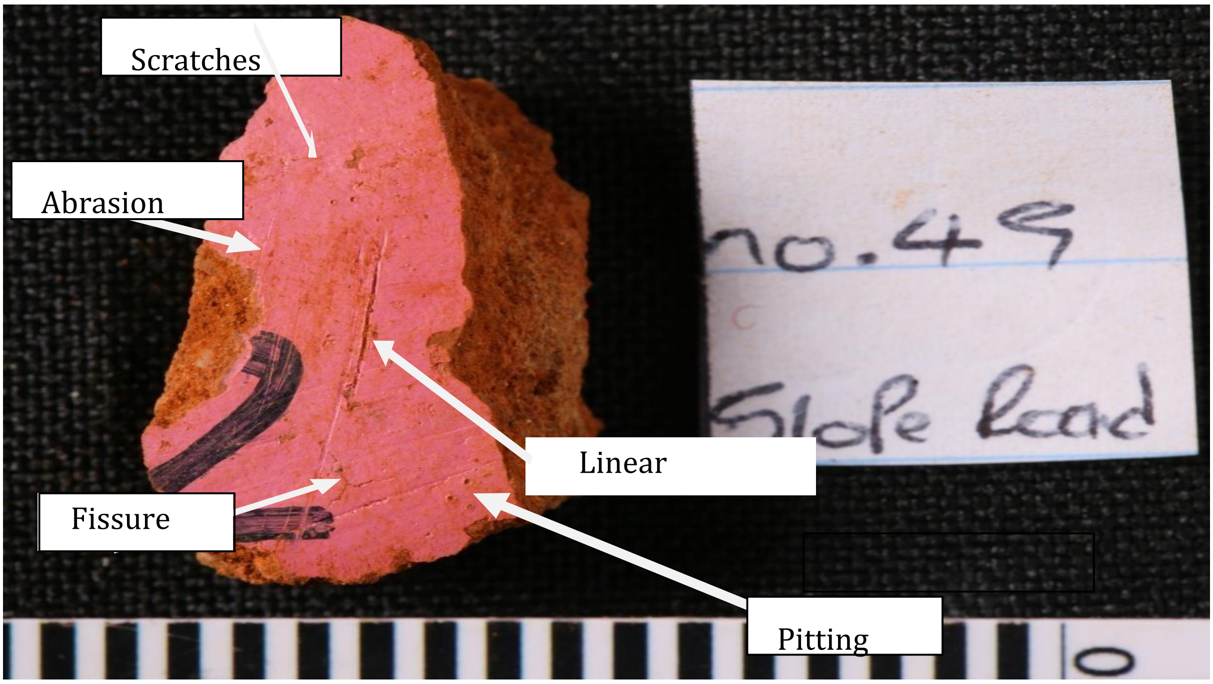

Figure 4.10. An example of an image showing shard indicating high trampling intensity.

Table 5. Quantification of trampling modification for the slope and flat experiments.

Trampling modification	Slope no. shards (% of 145 shards in total)	Flat no. shards (% of 245 shards in total)
Lines (deep & shallow) and scratches	103 (71%)	180 (73%)
Cracks	30 (21%)	50 (20%)
Shards found intact (found together but fragmented)	7 (4%)	4 (2%)
Abrasion	143 (99%)	243 (99%)

4.5. Abrasion

There also was evidence of abrasion on shards from the slope and flat experiments. Abrasion rates are presented according to the degree of abrasion. Based on varying degrees of abrasion, levels of abrasion are here defined as ranging from level 1 to level 4 abrasion (Fig. 4.11).

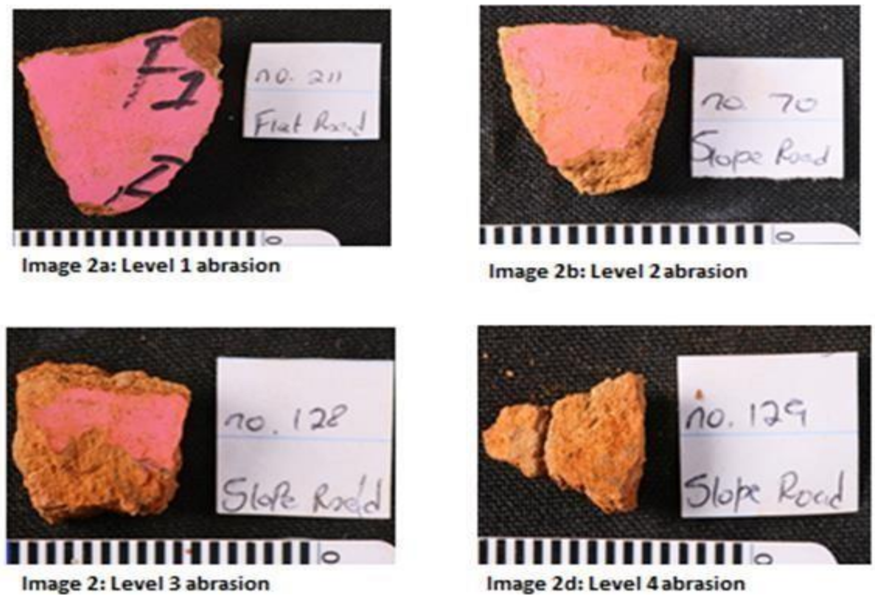

Figure 4.11. Images of shards showing examples of the levels of abrasion for both the flat and sloped surface after trampling.

The rate of abrasion in a percentage form on a flat and slope experiments were different (Figs 4.12, 4.13 & 4.14; Table 6). As can be seen, the highest percentages of abrasion in both was level 1 abrasion, and the lowest percentage of abrasion in both was level 4 abrasion. Based on varying degrees of abrasion, levels of abrasion here defined as rounding on the shards' surface and edges (Nielsen 1991), here I provide the evidence of four different levels of abrasions observed on the shards.

Table 6. Summary of the shards abraded.

Abrasion state	**None or little**	**Low abrasion**	**Medium abrasion**	**High abrasion**
Abrasion level/category	1	2	3	4
Slope surface no. of shards (% of a total of 145 shards)	107 (74%)	30 (21%)	3 (2%)	4 (3%)
Flat surface no. of shards (% of a total of 245 shards)	224 (91%)	10 (4%)	4 (2%)	5 (2%)

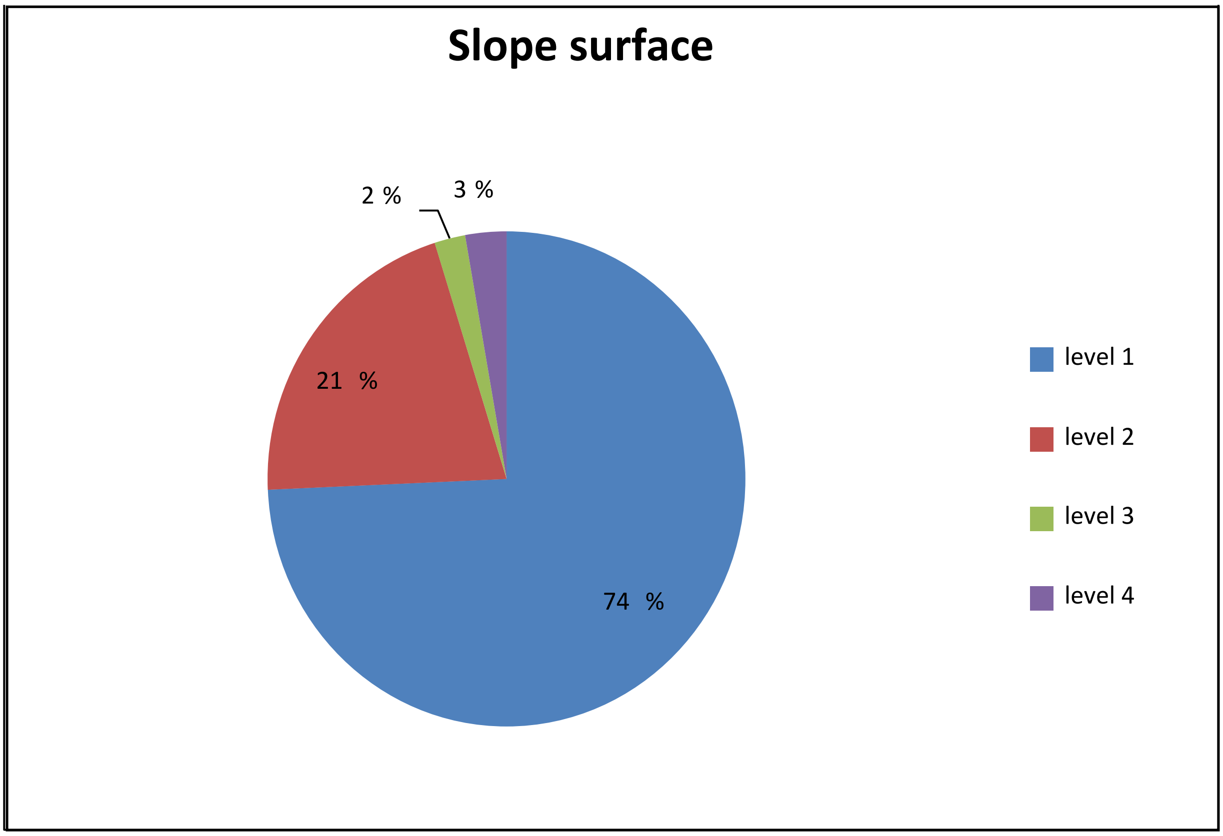

Figure 4.12. Chart showing abrasion percentages for the path experiment after trampling.

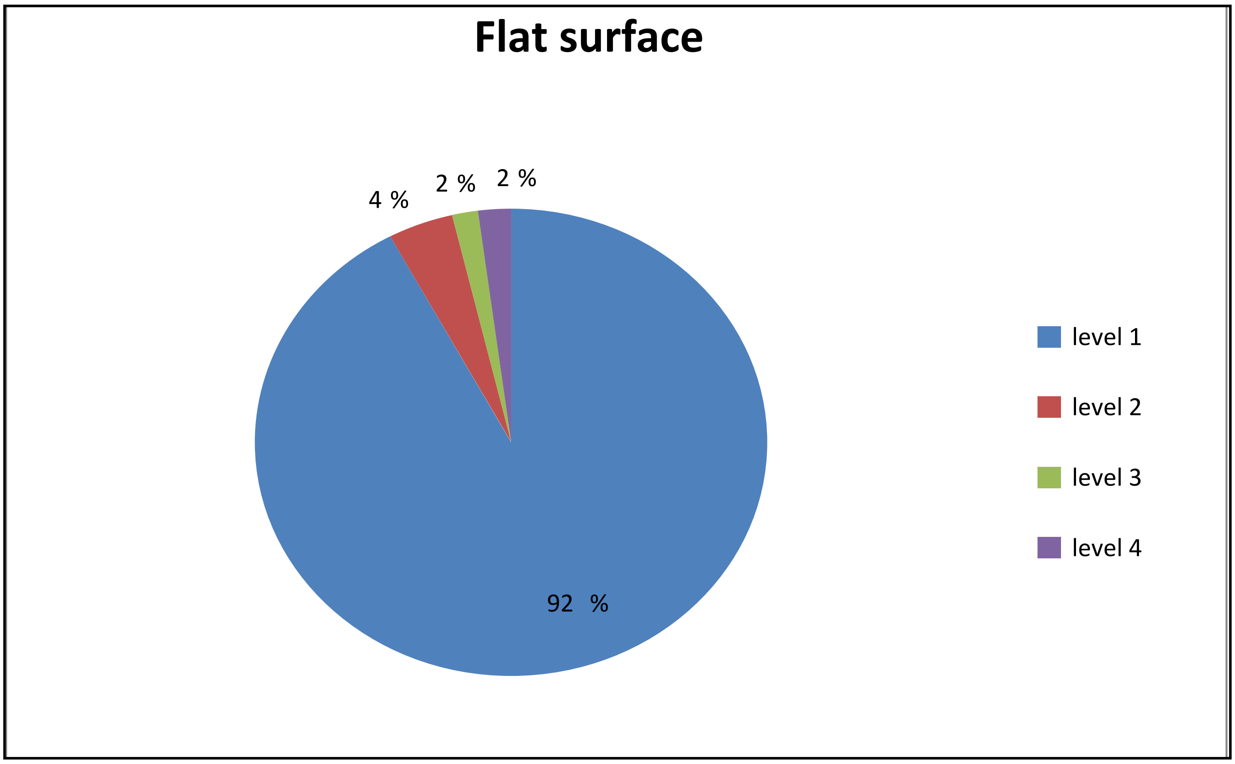

Figure 4.13. Chart showing abrasion percentages for the flat experiment after trampling.

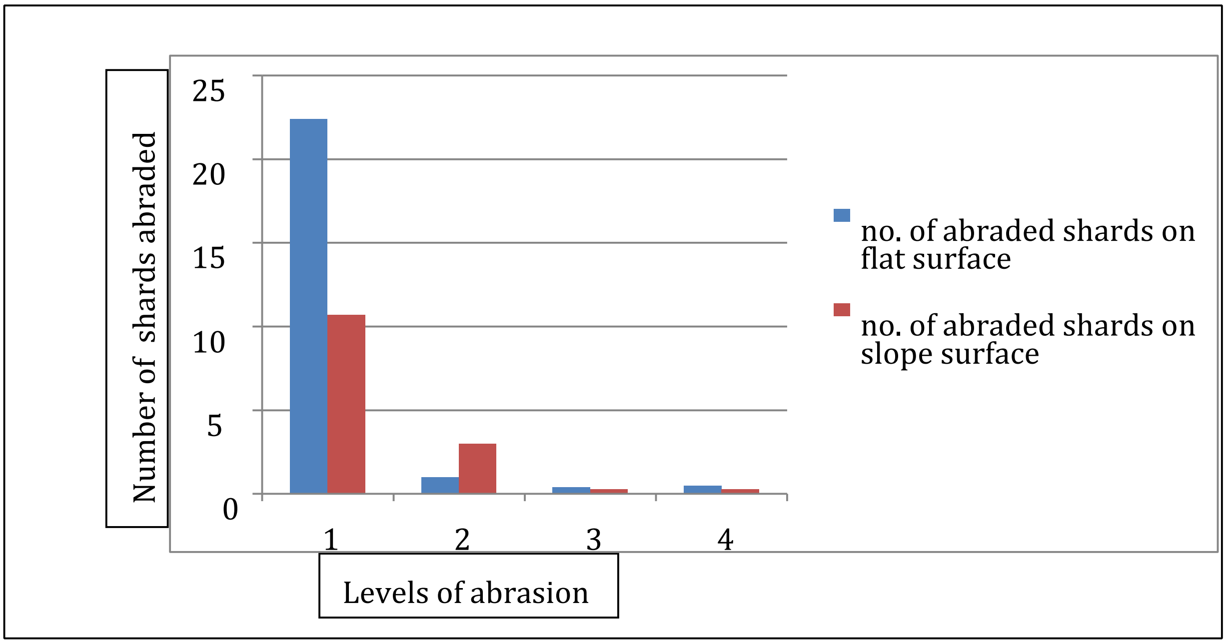

Figure 4.14. Distribution of abraded shards on slope and flat surface.

4.6. Breakage

When shards broke, they formed different types of bending (Fig. 4.15). Figure 4.15 image 3c shows a bend break, and image 3d a radial break. These breaks can be compared with those that Driscoll *et al.* (2016) found. The number of fragments resulting from the two plots were different, but not statistically significant (Fig. 4.16; Tables 7 & 8).

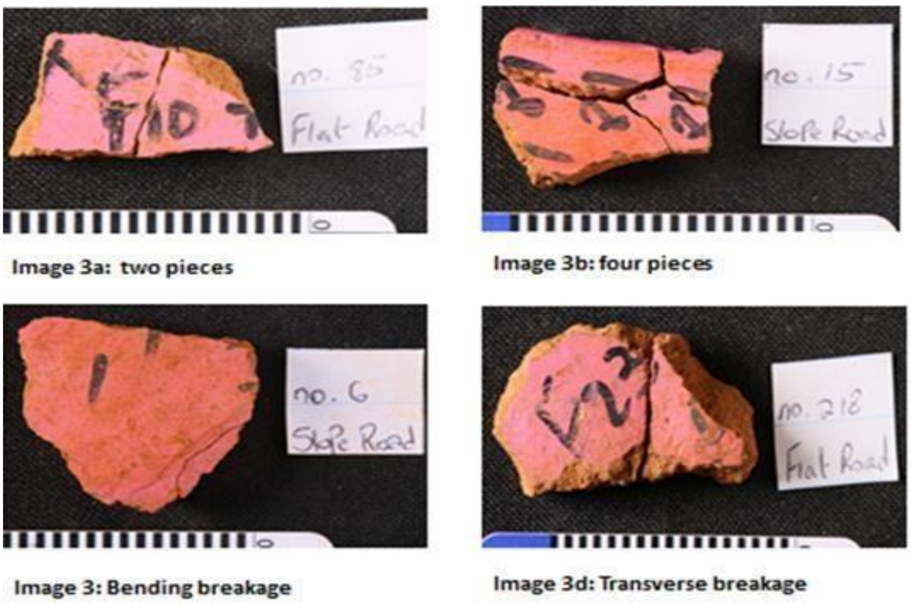

Figure 4.15. Images of shards showing fragmentation for both the flat and sloped surface after trampling.

Table 7. Table showing number of shard fragments produced after trampling events on slope versus flat surfaces.

Original shard	**No. of shards fragmented on flat surface after trampling**	**No. of shards fragmented on slope surface after trampling**
1	16	10
2	3	6
3	2	
4	1	4
5	5	2
6	14	8
7	1	4
8	2	1
9		2
10	3	
11	2	
12	1	10
13	3	11
14	2	1
15	1	
16	1	1
17	2	1
18	5	30
19	6	6
20	1	
21		
22	5	
23	26	

Table 8. Descriptive statistics for the number of fragments on flat and sloped surfaces. Ref: Min; minimum; Max: maximum; St. dev: standard deviation.

Descriptive statistics					
	No of fragments	**Min**	**Max**	**Mean**	**St. dev**
Flat surface	102	1	26	4.857142857	6.31098815
Slope surface	97	1	30	6.466666667	7.43415541

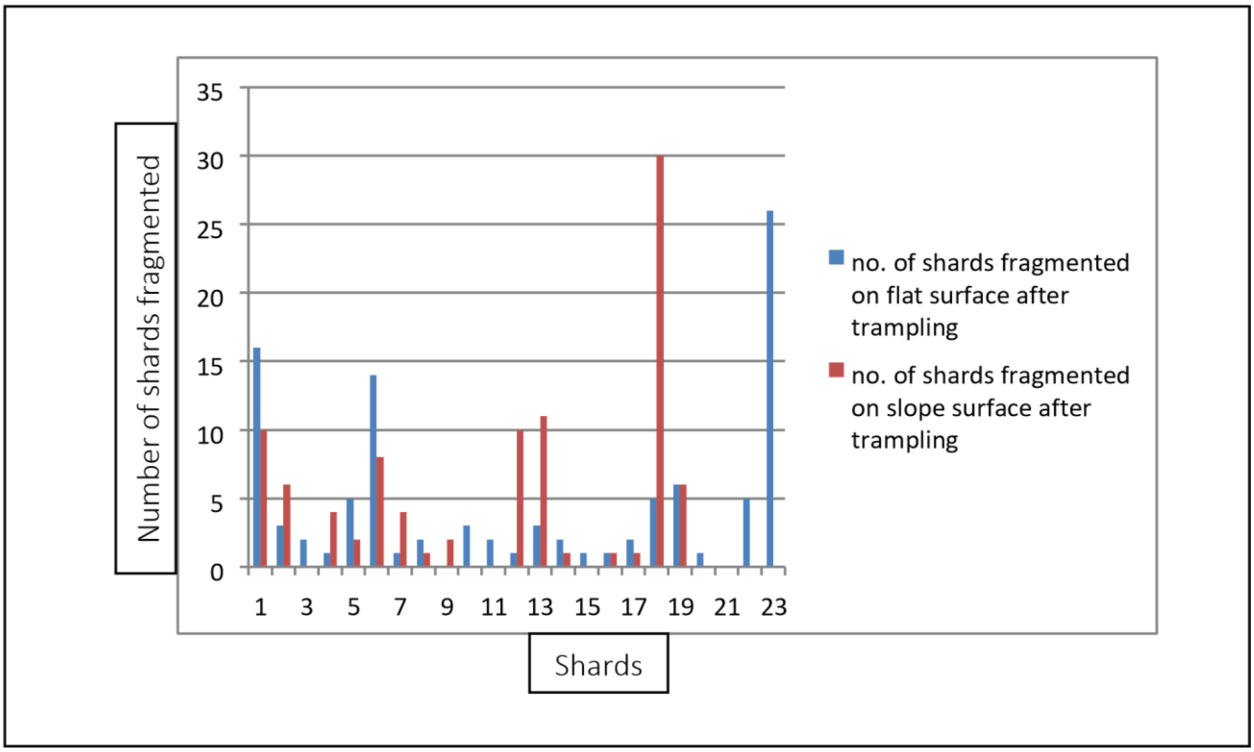

Figure 4.16. Graph showing the relationship between the shards and shards fragmentation on slope and flat surface.

4.7. Average size

I used the average size (length and width) of artefacts to calculate the mean difference between the sizes before and after the trampling activities. The shards were divided into small (shard length ≤ 7.4cm for the slope and ≤ 6.61cm for the flat surface) and large (shard length ≥7.5 cm for the slope and ≥6.62cm for the flat surface) fragments. The measurements of the shards before the experiment were recorded as the 'original' sizes, and during the experiment the shards broke into a larger number of shards, but tended to maintain their size classes. For example, after trampling on the terrace, the large shard number 23 further broke into four big pieces (Tables 7, 9 & 10). The maximum length of sloped surface shards after breakage was 14.8cm, and for the flat surface the largest size was 13.4cm in length.

Table 9. Average size of shards before and after trampling experiment in the slope and flat experiment.

Size (Average cm)			
Flat experiment before trampling		**Slope experiment before trampling**	
Length	**Width**	**Length**	**Width**
5.81	4.40	5.94	4.3
Flat experiment after trampling		**Slope experiment after trampling**	
2.49	1.90	2.3	1.7

Table 10. Summary of the frequency of big fragments from large shards before and after the experiments on the terrace verses the path.

Context & size	**Shard number** & *number of shards*							
Sloped surface								
Shards ≥7.4cm before trampling			**1**	**2**	**6**	**12**	**13**	**18**
Shards 7.5 to 14.8cm after trampling			**1**	**2**	**6**	**12**	**13**	**18**
Duplicated/fragmented no. of shards as a result of trampling			*1*	*3*	*2*	*4*	*1*	*4*
Flat surface								
Shards ≥6.61cm before trampling	**1**	**2**	**4**	**5**	**16**	**19**	**22**	**23**
Shards 6.62 to13.4cm after trampling	**1**	**2**	**-**	**5**	**16**	**19**	**22**	**23**
Duplicated/fragmented no. of shards as a result of trampling	*7*	*2*	-	*1*	*1*	*2*	*1*	*4*

4.8. Spatial analysis

The shards in the flat experiment travelled greater distances compared to the slope experiment (Fig. 4.17; Table 11). One of the shard on the flat experiment travelled a distance of 500-599cm, whereas the greatest distance travelled by the shards on the slope was 300-399cm.

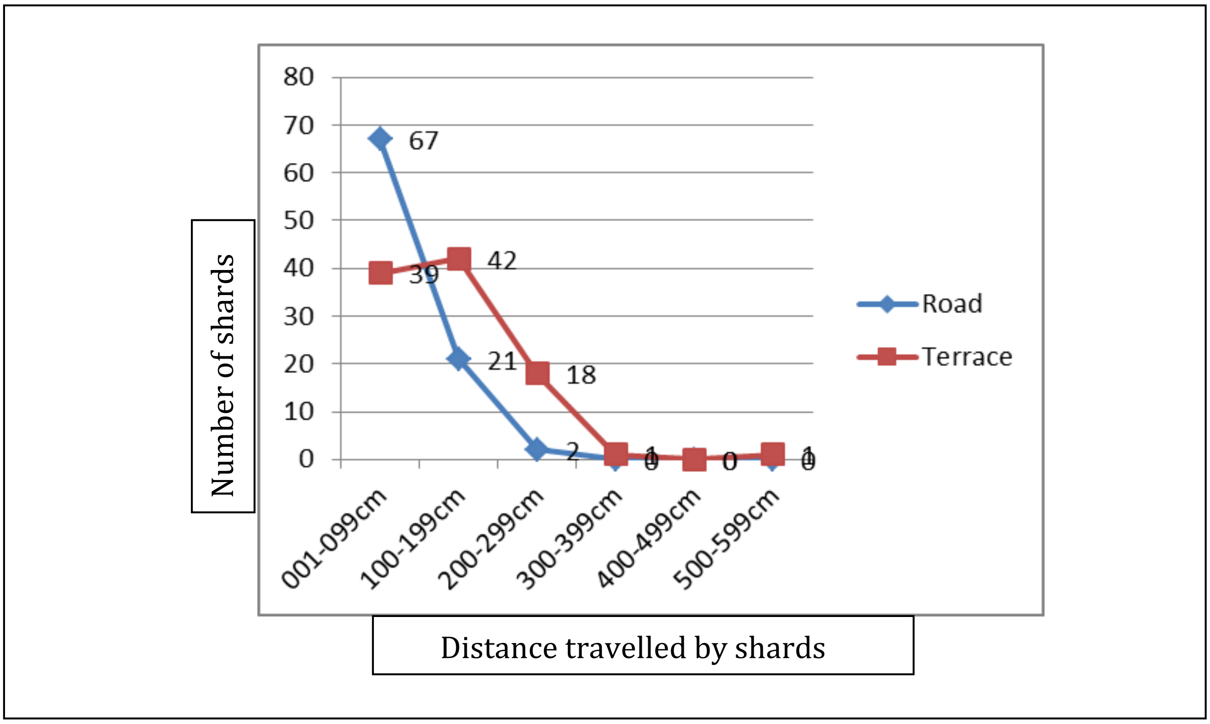

Figure 4.17. Graph showing distance travelled by the shards after trampling activities for the slope and flat surface experiment.

Table 11. Distance moved by Shards 22 and 23.

Shard 22	**Distance**	**Area**	**Shard 23**	**Distance**	**Area**
	1.85	5.1282		3.77	13.224
	1.38	4.29		2.55	10.1505
	0.33	3.4544		3.51	6.7024
	0.19	1.9352			

The shards displaced widely in all directions within the flat plot. Twenty-four shards are orientated on the NE, (20) E, (12) N, (17) W, (7) S, (4) SE, (4) SW, (24) NE and (13) NW. This might reflect the random directions in which the tramplers walked. This pattern suggests that pottery that was placed on Bokoni terraces would be distributed across the terrace, and end up scattered. This pattern might explain why shards have been found scattered, rather than concentrated, on Bokoni terraces.

Chapter 5 - Discussion

In this chapter, I discuss the implication of the results obtained above. Furthermore, this chapter presents the limitations and prediction of the study of trampling were to continue for long-term observation.

As indicated in the introduction trampling could be considered as a form on indirect agency (Balirán 2014; Dornan 2002), and should thus not be viewed in purely mechanical terms, but rather as acts that modified the potshards that became scattered in communal spaces across sites. Consequently, I view trampling as involuntary acts that form part of broader manifestations of agency. Although, intentional human actions, such as discarding pottery had little to do with the displacement of shards, human trampling does. The direction of the shards depends on the direction of the tramplers (Marwick *et al*. 2017). Vertical movement contributed little towards the displacement of shards. That is because the surface was not loose enough to allow shards to move vertically. There are processes that aid for the shards to move deeper, such as burrowing (Marwick *et al.* 2017; see Gonzalez *et al.* 1989; Villa & Courtin 1983).

5.1. Trampling modification

As discussed in the previous chapter, trampling modifications were observed on the shard assemblages. These are linear marks (deep & shallow lines), scratches, pits, abrasion, breakage, cracks and fissures. The trampling marks show no clear orientation, and only appear on the outer surface of the shards.

Low intensity trampling shards were rated under category '1', this means that the object showed pitting only. Mid intensity was rated under category '3', this means that the object shows scratches and abrasion. Highest intensity was rated under category '5', this means that artefact showed pitting abrasion, linear marks and scratches. This project found that the trampling activities led to the high frequency of trampling modification on the shards for both experiments (Table 4; Figures 4.8, 4.9 & 4.10). However, little abrasion was observed on shards (see Tables 6; Figures 4.11, 4.12 & 4.13). Malloy (2019: 9) studies shows that trampling has greater impact on ceramic dispersal and breakage pattern.

There was a higher frequency of the trampling marks on the flat experiment as opposed to the slope plot (Table 6). High frequencies entail a greater trampling intensity and thus indicate that the spaces on the terraces were utilised more often at Komati Gorge.

5.2. Abrasion and size reduction

All the shards were measured, and the data shows that no shards retained their original size after trampling. That means all the shards were reduced by trampling.
Size reduction occurred when the shards experienced abrasion and breakage.

Abrasion processes occurred on both the flat and slope plot. Few shards were highly abraded, with the majority of the shards occupying level 1 state which have none or little abrasion (see Table 6; Figures 4.11, 4.12 & 4.13). The differences between the two data sets are also clearly visible in the histogram (Fig. 4.14).

The dominant factor that leads to a size reduction in shards was breakage. This could indicate the fragility of the material composition of the pottery. In terms of fragmentation, the majority of the shards could be linked to the shards they originated from (e.g. Tables 7 & 10). Two types of breakage pattern were identified. These were transverse and inward bending.

An average size of shards in terms of length is 5.94cm and an average width is 4.3cm for the experiment mimicking a path. After the experiment the average length is 2.1cm with an average width of 1.7cm. The average difference for the length is 3.84cm and for the width is 2.6cm. That means size reduction is high. This means that if similar breakage patterns are observed in the archaeological record it can be assumed that the trampling intensity was relatively high.

No correlation was found between the two variables (abrasion and fragmentation) and trampling. All various sized shards were highly sensitive to breakage, and a little susceptible to abrasion. Both the path and flat experiment showed similar damage. I contend that the reason for the high breakage was the type of material the shards are composed of, as well as the compact soil the shards were trampled against (also see Kirkby & Kirkby 1976).

5.3. Spatial analysis

5.3.1. Distance, displacement and direction – flat experiment

The analysis of the movement of shards on the flat indicate that the majority of the large shards travelled longer distances. Shard no. 22 fragmented into four large pieces (Table 11), of these the largest fragments travelled longer distances when compared to the smaller one within the large category. This is similar to the movement observed for the other large shard (shard 23) in that its largest shards travelled the furthest (Table 11). Therefore, I suggest that there is a correlation between the size of shards and their displacement in regards to differing environments.

Size sorting is noted where the larger shards are displaced to the marginal zones. In these zones trampling does not impact results further. Majority of the smaller shards remained in the traffic zone. The longest distance travelled is over 500cm on the flat surface, suggesting that there is scope for further movement through trampling on terraces than on paths. This is because the larger shards travelling longer distance were cast out of the experimental area, whereas the smaller shards are trampled back and forth within the experimental boundary. The distance for the small shards is not stable.

5.3.2. Distance, displacement and direction – slope experiment

The analysis of the data from the slope experiment found that the majority of small shards travel larger distances. This points to the size as a variable that is susceptible to trampling. The smallest shards in both the small category and the large category travelled the greatest distance. These finds are similar to what Villa and Courtin (1983; also see Nielsen 1991: 488) and Stoops (1989) noted about the smaller objects moving long distances compared to the large ones. Fewer large shards in the slope experiment travelled furthest but most of the large shards travel lesser distances. The shards general direction was up (N) and down (S) the slope. Although one shard moved to the peripheral zone on the east. This kind of pattern (upward and downward) may also be linked to trampling direction (bi-directional or up and down).

The directionality of movement in the slope experiment suggests that pottery that was discarded on paths in archaeological sites on Bokoni could be transported up and downslope, although other processes such as water running downslope might impact on this distribution.

The patterns observed in my experimental study suggests that it is likely that trampling had an impact on site formation processes in Bokoni. The stone walls were constructed to protect the integrity of the Bokoni settlement, and the terraces protected the soils from erosion. Pottery were placed on the terraces as part of household refuse mixed in with the ash used to fertilise the foil. The results from my flat surface experiment suggests walking on the terrace surfaces would have displaced them from their original location and scattered them across the surface. This pattern is in line with the random distribution observed in the archaeological record. Pottery on sloped surfaces would also scatter, and might migrate down slope.

Henshall (2016) suggested that shards found on domestic and non-domestic areas were affected by natural processes (e.g. weathered shards with rounded/smothered edges). My experimental data suggests that natural activities were not the only processes that affect the settlement structure at Bokoni. Trampling by people could also have resulted in surface modification.

While not part of my experiment, livestock trampling is likely to have had a significant impact on pottery. Cattle tracks were constructed to prevent cattle from straying onto terraces, and their access to parts of the site were constrained (Henshall 2016: 55, 58). Nevertheless, their impact on the shard modification in the areas they could access, such as the cattle enclosures, might have been higher when compared to human trampling. Their impact on pottery is likely to be similar to their impact on lithics observed by Pargeter (2011: 2884-2885). In his study on the difference between human and cattle trampling on lithics, he found that cattle produce high modification on lithics compared to human activities.

5.4. Expectations

If this experiment were to be conducted over a longer period, it is expected that different types of modification, displacement and spatial organisation would take place for both the flat and slope experiment.

5.4.1. Flat surface (terrace) experiment

One would expect four different outcomes if the experiment was carried out for a longer period. These are different types of 1) modification, 2) the displacement of shards, 3) size reduction, and 4) size sorting.

All the shard exposed to trampling activities will either shows one, two, or all types of trampling modification. These modifications are linear marks (shallow/deep lines), pitting, cracks, scratches, and breakage (Fernandez-Jalvo & Andrews 2016; Reynard & Henshilwood 2018). These marks would be the result of the foot force applied on the archaeological materials against the soil surface (Reynard & Henshilwood 2018).

Two types of movement will occur when trampling takes place. These are vertical displacement and horizontal displacement. The silty clay soil at Komati Gorge is compact and hard and therefore vertical movement is unlikely to exceed 5cm. Consequently, I expect most shards to move horizontally, and fewer shards to move vertically.

It is likely that there will be a relationship between artefact size and sorting through trampling. Larger shards will be displaced to the marginalised zones and the small sized shards will either remain on the traffic zone, or get buried to the soil. Breakage is the dominant variable that is likely to lead to size reduction, because the material itself is fragile. Abrasion processes will also take place, but at a lower frequency. However, it is likely that the artefacts will reach a stage where shards resist fragmentation as Edwards (2009) observed that artefacts reach the stable state in which material is no longer reduced.

5.4.2. Slope (path) experiment

I expect to see similar modification that are likely in the terrace experiment, but noting the possibility of down slope movement it is possible that trampling modification marks will be orientated on the surface of the shards. Breakage and abrasion will probably affect the size of the shards. The breakage will be the dominant factor having the impact on the shards.

It is likely that all the pieces of shards will be displaced horizontally downslope along the slope. Larger shards are likely to travel larger distances. Whereas the smaller pieces of shards will travel smaller distances, and remain in the traffic zone where further trampling modification take place.

I expect to see size sorting of the artefacts in the slope experiment. The larger fragmented pieces of shards will be displaced down the slope in the marginalised zone. The smaller fragmented pieces of shards will be displaced at the traffic zone where intense trampling activities take place.

Overall my trampling experiments produced similar results to hoeing, which would have been another key factor in terrace site formation processes. Hoeing, which was practiced in pre-colonial southern Africa, is not well understood, but might be similar to ploughing. Landa *et al.* (2014) stated that ploughing has a significant impact on the archaeological record. This is because of the heavy tools used. Ots (2008) and Harvey (2012) found that ploughing contributes to the horizontal displacement and Dunnel & Simek (1995) reported on the vertical displacement. This activity has a high rate of mixing stratigraphic context of the archaeological record. The ploughing activity can horizontally displace the archaeological material to an extent of 15m (Odell & Cowan 1987). Furthermore, Ots (2008) and Harvey (2012) said that the process of ploughing on agricultural fields results into fragmentation of materials deposited on the surface. Landa *et al.* (2014) stated that ploughing results into size sorting, where lager artefacts are displaced to the marginalised areas and the small pieces are continually fragmented.

Chapter 6 - Conclusion

This chapter summarises the main achievements of this research report. It also discusses further research possibilities.

6.1. Summary of achievements

This dissertation contributes to the body of archaeological experimental knowledge, as well as to understanding site formation processes in Bokoni, where the trampling experiments were conducted. The trampling analysis found that trampling has an impact on shards of all sizes. Most of the shards experienced trampling modification (linear marks, scratches, pitting, cracks, abrasion, breakage and fissures). Scratches are the dominant modification on the shards for both the flat and slope experiments. In regards to size reduction, breakage was the dominant variable on the flat surface, whereas in the slope experiment abrasion was dominant. No relationships have been noted between trampling modification and size.

Trampling has an impact on the spatiality of shards. Walking patterns in both the flat and slope experiments influenced the distribution of shards. Random trampling resulted in the horizontal distribution of shards on the flat plot, with one shard displaced outside the experimental boundary. A small number of shards travelled over 500cm. In the flat experiment area, bi-directional trampling displaced shards up and down following the direction of tramplers. Most of the shards moved horizontally and only two shards were vertically displaced by 2cm under the soil. The greater distance travelled was experienced by the shards in the flat experiment compared to the slope experiment. There were no relationships recorded regarding displacement, distribution and trampling.

The observed pattern suggests that it is unlikely that clusters of pottery will be found on terraces, while pottery might cluster up and downslope on paths.

6.2. Future research

This study was limited to a small number of variables; it only focussed on the trampling, physical condition, size and spatiality of shards in Bokoni. However, this is the first trampling experiment conducted in this area. In future research human trampling studies at Bokoni could focus on other taphonomic processes, such as hoeing and animal trampling.

This research focused on the size of the shards, further research could focus on more variables such as thickness and shape of the artefacts. In addition, the upcoming projects could conduct the trampling activities for longer, and the observation duration could be longer. This approach would recognise the insights of Marwick *et al.* (2017; cf. Gaudzinski-Windheuser *et al.* 2010) who stated that observation duration of trampling is very important in experimental archaeology. His experiment took a short observation time scale, but he noted that it would be interesting to see what pattern could have been formed if they exposed the archaeological artefacts for longer.

References

Balirán, C. 2014. Trampling taphonomic, and experiments with lithic artefacts in the southern Bagueles Range (Santa Cruz, Argentina). *Intersecciones en Antropologia* 15(1): 85-95.

Behrensmeyer, A.K., Gordon, K.D. & Yanagi, G.T. 1986. Trampling as a cause of bone surface damage and pseudo-cutmarks. *Nature* 319(6056): 768-771.

Benito-Calvo, A., Martínez-Moreno, J., Mora, R., Roy, M. & Roda, X. 2011. Trampling experiments at Cova Gran de Santa Linya, Pre-Pyrenees, Spain: Their relevance for archaeological fabrics of the Upper-Middle Palaeolithic assemblages. *Journal of Archaeological Science* 38(12): 3652-3661.

Birin, R.A. 2017. The application of luminescence dating to constrain the construction and habitation period of KG80 and KG81, Komati Gorge, Mpumalanga, South Africa. Unpublished Honours project. Johannesburg: University of the Witwatersrand.

Blackham, M. 2000. Distinguishing bioturbation and trampling using pottery sherd measures, Tell Fendi, Jordan. *Geoarchaeology* 15(5): 469-497.

Bradley, R. & Fulford, M. 1980. Sherd size in the analysis of occupation debris. *Bulletin of the Institute of Archaeology* 17: 85-94.

Brain, C.K. 1967. Bone weathering and the problem of bone pseudo-tools. *South African Journal of Science* 63(3): 97-99.

Callahan, E. 1999. What is experimental archaeology. In: Wescott, D. (ed.). *Primitive Technology: A Book of Earth Skills*: 4-5. Salt Lake: Gibbs Smith.

Clark, P.J. & Evans, F.C. 1954. Distance to nearest neighbour as a measure of spatial relationships in populations. *Ecology* 35(4): 445-453.

Collett, D.P. 1979. The archaeology of the stone walled settlements in the Eastern Transvaal, South Africa. Unpublished MA dissertation. Johannesburg: University of the Witwatersrand.

Collett, D.P. 1982. Excavations of stone-walled ruin types in the Badfontein valley, Eastern Transvaal, South Africa. *South African Archaeological Bulletin* 37(135): 34-43.

de la Peña, P. & Witelson, D. 2018. Trampling vs. retouch in a lithic assemblage: A case study from a Middle Stone Age site, Steenbokfontein 9KR (Limpopo, South Africa). *Journal of Field Archaeology* 43(7): 522-537.

Delius, P., Maggs, T. & Schoeman, M.H. 2012. Old structures new paradigms? Rethinking pre-colonial society from the perspective of the stone-walled sites in Mpumalanga. *Journal of Southern African Studies* 38(2): 399-414.

Delius, P., Maggs, T. & Schoeman, M.H. 2014. *Forgotten World: The Stone-walled Settlements of the Mpumalanga Escarpment.* Johannesburg: Wits University Press.

Delius, P. & Schoeman, M.H. 2008. Revisiting Bokoni: Populating the stone ruins of the Mpumalanga escarpment. In: Swanepoel, N., Esterhuysen, A. & Bonner, P. (eds). *Five Hundred Years Rediscovered: Southern African Precedents and Prospects, 500* Years *Initiative 2007 Conference Proceedings*: 135-167. Johannesburg: Wits University Press.

Domínguez-Rodrigo, M., De Juana, S., Galán, A.B. & Rodríguez, M. 2009. A new protocol to differentiate trampling marks from butchery cut marks. *Journal of Archaeological Science* 36(12): 2643-2653.

Dornan, J.L. 2002. Agency and archaeology: Past, present, and future directions. *Journal of Archaeological Method and Theory* 9(4): 303-329.

Driscoll, K., Alcaina, J., Égüez, N., Mangado, X., Fullola, J-M., & Tejero, J-M. 2016. Trampled under foot: a quartz and chert human trampling experiment at the Cova del Parco rock shelter, Spain. *Quaternary International* 424: 130-142.

Dunnel, R.C. & Simek, J.F. 1995. Artifact size and plowzone processes. *Journal of Field Archaeology* 22(3): 305-319.

Edwards, B. 2009. Pits and the architecture of deposition narratives of social practice in the Neolithic of North-East England. Unpublished PhD thesis. Durham: Durham University.

Esdale, J.A., Le Blanc, R.J. & Cinq-Mars, J. 2001. Periglacial geoarchaeology at the Dog Creek site, Northern Yukon. *Geoarchaeology* 16(2): 151-176.

Evers, T.M. 1973. Three Early Iron Age sites in the North Eastern Transvaal Lowveld. *South African Journal of Science* 69: 324-325.

Evers, T.M. 1975. Recent Iron Age research in the eastern Transvaal, South Africa. *South African Archaeological Bulletin* 30(119/120): 71-83.

Fernandez-Jalvo, Y. & Andrews, P. 2016. *Atlas of Taphonomic Identifications: 10001 + Images of Fossil and Recent Mammal Bone Modification.* New York: Springer.

Flenniken, J. & Haggerty, J. 1979. Trampling as an agency in the formation of edge damage: An experiment in lithic technology. *Northwest Anthropological Research Notes* 13: 208-214.

Foxhall, L. 1996. Feeling the earth move: Cultivation techniques on steep slopes in classical antiquity. In: Shipley, G. & Salmon, J. (eds). *Human Landscapes in Classical Antiquity: Environment and Culture*: 44-67. London: Routledge.

French, C.A.I. & Whitelaw, T.M. 1999. Soil erosion, agricultural terracing and site formation processes at Markiani, Amorgos, Greece: The micromorphological perspective. *Geoarchaeology* 14(2): 151-189.

Gaudzinski-Windheuser, S., Kindler, L., Rabinovich, R. & Goren-Inbar, N. 2010. Testing heterogeneity in faunal assemblages from archaeological sites. Tumbling and trampling experiments at the Early-Middle Pleistocene site of Gesher Benot Ya'aqov (Israel). *Journal of Archaeological Science* 37(12): 3170-3190.

Gifford-Gonzalez, D.P., Damrosch, D.B., Damrosch, D.R. & Pryor, J. 1985. The third dimension in site structure: An experiment in trampling and vertical dispersal. *American Antiquity* 50(4): 803-818.

Gill, S. & Aryan, A. 2016. To experimental study for comparison theodolite and total station. *International Journal of Engineering Research & Science* 2(3): 153-160.

Harvey, K.G. 2012. Who needs a plow-zone? Using a common site mapping method in a new way at the Silvernale site (21GD03). Unpublished MSc thesis. Mankanto: Minnesota State University.

Hattingh, T. 2013. A phytolith analysis of Bokoni Soils. Unpublished MSc dissertation. Johannesburg: University of the Witwatersrand.

Henshall, T.F. 2016. The spatial configuration of agricultural practices and the role of resilience in farming at Khutwaneng, Bokoni. Unpublished MSc dissertation. Johannesburg: University of the Witwatersrand.

Huffman, T.N. 2004. The archaeology of the Nguni past. *Southern African Humanities* 16(1): 79-111.

Huisman, D.J., Ngan-Tillar, D., Tensen, M.A., Laarman, F.J. & Raemaekers, D.C.M. 2014. A question of scales: Studying Neolithic subsistence using CT scanning of midden deposit. *Journal of Archaeological Science* 49: 585-594.

Ingersoll, D.W, Yellen, J.E. & MacDonald, W.K. 1977. *Experimental Archaeology*. New York: Columbia University Press.

Isager, S. & Skydsgaard, J. 1992. *Ancient Greek Agriculture: An Introduction.* London: Routledge.

Jennings, T.A. 2011. Experimental production of bending and radial flake fractures and implications for lithic technologies. *Journal of Archaeological Science* 38(12): 3644-3651.

Kelly, R.L. & Thomas, D.H. 2013. *Archaeology: Down to Earth*. Belmont: Wadsworth Cengage Learning.

Kirkby, A. & Kirkby, M.J. 1976. Geomorphic processes and the surface survey of archaeological sites in semi-arid areas. In: Davison, D. & Shackley, M. (eds). *Geo-archaeology: Earth Science and the Past:* 229-253. London: Duckworth.

Landa, C., Pineau, V., Montanari, E. & Doval, J. 2014. Taphonomy of a village: The early 20th century site of Mariano Miro Chapaleufu department, La Pampa, Argentina. *InterSecciones en Antropologia* 15(1): 71-84.

Lenoble, A. & Bertran, P. 2004. Fabric of Palaeolithic levels: Methods and implications for site formation processes*. Journal of Archaeological Science* 31(4): 457-469.

Lindauer, O. & Kisselburg, J. 1981. Primary and secondary breakage. Unpublished paper presented at the 46th annual meeting of the society for American archaeology, San Diego.

Lopinot, N. & Ray, J. 2007. Trampling experiments in the search for the earliest Americans. *American Antiquity* 72(4): 771-782.

Madgwick, R. 2014. What makes bones shiny? Investigating trampling as a cause of bone abrasion. *Archaeological and Anthropological Sciences* 6: 163-173.

Maggs, T. 2008. The Mpumalanga escarpment settlements: Some answers, many questions. In: Swanepoel, N., Esterhuysen, A. & Bonner, P. (eds). *Five Hundred Years Rediscovered: Southern African Precedents and Prosp*ects, *500 Years Initiative 2007 Conference Proceedings*: 169-181. Johannesburg: Wits University Press.

Malinsky-Buller, A., Hovers, E. & Marder, O. 2011. Making time: 'Living floors', 'palimpsests' and site formation processes - A perspective from the open-air Lower Paleolithic site of Revadim Quarry, Israel. *Journal of Anthropological Archaeology* 30(2): 89-101.

Malloy, H. 2019. Experimental archaeology and formation processes: New experiments with spatial modelling. Unpublished Honours thesis. Burlington: University of Vermont.

Marker, M.E. & Evers, T.M. 1976. Iron Age settlement and soil erosion in the Eastern Transvaal, South Africa. *South African Archaeological Bulletin* 31(123-124): 153-165.

Marwick, B., Hayes, E., Clarkson, C. & Fullagar, R. 2017. Movement of lithics by trampling: An experiment in the Madjedbebe sediments, northern Australia. *Journal of Archaeological Science* 79: 73-85.

McPherron, S.J.P. 2005. Artifact orientations and site formation processes from total station proveniences. *Journal of Archaeological Science* 32(7): 1003-1014.

McPherron, S.P., Braun, D.B., Dogandzic, T. Archer, W., Desta, D. & Lin, S.C. 2014. An experimental assessment of the influences on edge damage to lithic artefacts: A consideration of edge angle, substrate grain size, raw material properties, and exposed face. *Journal of Archaeological Science* 49: 70-82.

Muckle, R. 1985. Archaeological considerations of Bivalve shell taphonomy. Unpublished Masters thesis. Vancouver: Simon Fraser University.

Nielsen, E.A. 1991. Trampling the archaeological record: An experimental study. *American Antiquity* 56(3): 483-503.

Odell, G.H. & Cowan, F.L. 1987. Estimating tillage effects on artifact distributions. *American Antiquity* 52(3): 456-484.

Olsen, S.L. & Shipman, P. 1988. Surface modification on bone: Trampling versus butchery. *Journal of Archaeological Science* 15(5): 535-553.

Ots, M.J. 2008. Study of disturbance induced by tillage on ceramic assemblages in Magua Amarga (Tupungato, Mendoza, Argentina). *Chungara: Revista de Antropología Chilena* 40(2): 145-160.

Pargeter, J. 2011. Assessing the macrofracture method for identifying Stone Age hunting weaponry. *Journal of Archaeological Science* 38(11): 2882-2888.

Pargeter, J. & Bradfield, J. 2012. The effects of class I and II sized bovids on macrofracture formation and tool displacement: Results of a trampling experiment in a Southern African Stone Age context. *Journal of Field Archaeology* 37(3): 238-251.

Pintar, E. 1987. Controles Experimentales de Desplazamiento y Alteración de Artefactos Líticos en Sedimentos Arenosos: Aplicaciones Arqueológicas. Unpublished undergraduate thesis. Buenos Aires: Universidad de Buenos Aires.

Prinsloo, C.W. 1936. Klank en vormleer van Sekoni. Unpublished MA dissertation. Pretoria: University of Pretoria.

Pryor, J. 1988. The effect of human trample damage on lithics: A consideration of crucial variables. *Lithic Technology* 17(1): 45-50.

Ramaoka, E. 2018. Optically stimulated luminescence dating of potsherds and sediment from Bokoni, Komati Gorge village 1, Mpumalanga. Unpublished Honours project. Johannesburg: University of the Witwatersrand.

Reynard, J.P. 2014. Trampling in coastal sites: An experimental study on the effects of shell on bone in coastal sediment. *Quaternary International* 330: 156-170.

Reynard, J.P. & Henshilwood, C.S. 2018. Using trampling modification to infer occupational intensity during the Still Bay at Blombos Cave, Southern Cape, South Africa. *African Archaeological Review* 35: 1-19.

Schoeman, M.H. 1997. The Ndzundza archaeology of the Steelpoort River valley. Unpublished Masters dissertation. Johannesburg: University of the Witwatersrand.

Schoeman, M.H. 2013. The archaeology of Komati Gorge. Forming part of the broader project Exploring precolonial agriculture and intensification: The case of Bokoni, South Africa. 1-9. Unpublished report.

Schoeman, M.H., Aub, B., Burrows, J. Hall, G. & Woodborne, S. 2019. Past climatic conditions for Bokoni at Buffelskloof, Mpumalanga using δ13C analysis of *Prunus Africana* and *Pittosporum viridiflorum* tree-rings. *Journal of African Archaeology* 7(2): 150-160.

Schoeman, M.H. & Delius, P. 2011. A short history of Bokoni. *The Digging Stick* 28: 17-19.

Shanks, M. & Tilley, C.Y. 1992. *Re-constructing Archaeology: Theory and Practice.* London: Routledge.

Sjöström, J. 2013. *Late Holocene Paleoenvironmental Reconstruction on a Peat Sequence from Northeastern South Africa, Using Grass Phytoliths as Main Proxy.* Masters thesis. Stockholm: University of Stockholm.

Sjöström, J., Norström, E., Risberg, J. & Schoeman, M. 2017. Late Holocene paleoecological reconstruction from Mpumalanga, South Africa. *Review of Paleobotany and Palynology* 246: 264-277.

Skibo, J.M. & Schiffer, M.B. 1997. Ceramic surface treatment and abrasion resistance: An experimental study. *Journal of Archaeological Science* 24(4): 311-317

Snead, J., Erickson, C.L. & Darling, J.A. 2009. Making human space: The archaeology of trails, paths and roads. In: Snead, J., Erickson, C.L. & Darling, J.A. (eds). *Landscapes of Movement: Trails, Paths and Roads in Anthropological Perspective*: 1-19. Philadelphia: University of Pennsylvania.

Solomon, L. 2016. Measuring growth potential: A geo-archaeological study of settlement location selection and associated land management practices in Bokoni, Mpumalanga. Unpublished MSc dissertation. Johannesburg: University of the Witwatersrand.

Stockton, E.D. 1973. Shaw's Creek shelter: Human displacement of artefacts and its significance. *Mankind* 9: 112-117.

Stoops, R.W. 1989. An experimental examination of trampling effect on the lateral movement of surface artifacts. Unpublished Masters' thesis. Knoxville: University of Tennessee.

Stratford, D.J. 2013. Biofabric analysis of palaeocave deposit. *Journal of Taphonomy* 11(1): 21-40.

Tringham, R. 1978. Experimentation, ethnoarchaeology, and the leapfrogs in archaeological methodology. In: Gould, R.A. (ed.). *Explorations in Ethnoarchaeology*: 169-199. Albuquerque: University of New Mexico Press.

Tringham, R.G. Cooper, G., Odell, G., Voytek, B. & Whitman, A. 1974. Experimentation in the formation of edge damage: A new approach to lithic analysis. *Journal of Field Archaeology* 1(1/2): 171-196.

Van Hoepen, E.C.N. 1939. A pre-European Bantu culture in the Lydenburg district. *Argeologiese Navorsing van die Nasionale Museum, Bloemfontein* 2(5): 47-74.

Villa, P. & Courtin, J. 1983. The interpretation of stratified sites: A view from underground. *Journal of Archaeological Science* 10(3): 267-281.

Weitzel, C., Borrazo, K., Ceraso, A. & Balirán, C. 2014. Trampling fragmentation potential of lithic artefact: An experimental approach. *Intersecciones en Antropología* 15(1): 97-110.

Widgren, M., Maggs, T., Plikk, A., Schoeman, M.H. & Westerberg. L. 2016. Precolonial agricultural terracing in Bokoni, South Africa: Typology and an exploratory excavation. *Journal of African Archaeology* 14(1): 33–53.