ASSESSING THE ABUNDANCE OF NON-TIMBER FOREST PRODUCTS IN RELATION TO FOREST SUCCESSION ON THE WILD COAST, SOUTH AFRICA

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PLAGIARISM DECLARATION

I, Afika Njwaxu, declare that this thesis entitled "**Assessing the abundance of non-timber forest products in relation to forest succession on the wild coast, South Africa**" is my own work. All content sourced from other material has been fully acknowledged and referenced. It is being submitted for the Masters of Science degree at Rhodes University.

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ABSTRACT

The number of people in the Eastern Cape, South Africa, that are engaging in arable cropping has declined markedly over the last few decades. This is due to a number of factors such as a decrease in human capital because of migration of able-bodied people to urban areas, disinclination to participate in farming, raiding of crops by livestock and lack of equipment. This has resulted in abandoned croplands being invaded by trees and shrubs as the start of forest succession leading to a change in species composition and the ecosystem benefits reaped from these sites. Key amongst these benefits is a variety of non-timber forests products (NTFPs) which are an integral part of livelihoods in the area.

The study was conducted in Willowvale, on the Wild Coast, South Africa. Aerial photographs were used to determine when cessation of cropping occurred in local fields and when revegetation began in order to determine the age of old fields. Botanical inventory and Braun-Blanquet scale were used to assess species richness, composition and abundance of vegetation in fields abandoned at different times. Focus groups were used to identify NTFPs found in these old fields, their uses as well as rank their importance to the local people.

Results showed an increase in woody cover with time since field abandonment. Species richness also increased with age of the old field with approximately three species gained per decade. When species richness was disaggregated by growth forms, herbaceous plants were abundant in the early stages of succession, shrubs in the mature stages and trees increased steadily with time. A total of 177 species were recorded from 50 plots that were sampled during the ecological data collection. Of these, 70 species (39.6%) were identified by the focus group participants as NTFPs. The participants grouped the NTFPs into six categories namely: food, building, medicinal, craft, cultural and energy. There was an increase of richness of NTFPs with forest succession; however the proportion of NTFPs decreased with age suggesting an increase in non-useful species. This suggests that harvesting from plots of different ages would be the optimal way for local people to get access to a large variety of NTFPs.

LIST OF ABBREVIATIONS AND SYMBOLS

%	Percentage
±	Plus minus/ Approximately
<	Less than
>	Greater than
ANOSIM	Analysis of Similarities
C	Carbon
Ca	Calcium
CEPF	Critical Ecosystem Partnership Fund
cm	Centimetre
Cmol/kg	Centimole per Kilogram
FAO	Food and Agriculture Organisation
DPME	Department of Planning, Monitoring and Evaluation
GDP	Gross Domestic Product
GIS	Geographical Information System
GPS	Global Positioning system
IDP	Integrated Development Plan
HIV/AIDS	Human Immunodeficiency Virus and Acquired Immune deficiency Syndrome
K	Potassium
m	Metre
m^2	Square Metre
MDS	Multidimensional Scaling
Mg	Magnesium
Mg/kg	Milligram per Kilogram
Mol/l	Mole per Litre
Na	Sodium
NH_4NO_3	Ammonium nitrate
NTFPs	Non-Timber Forest Products
p	p-value/probability value
P	Phosphorus
pH	Potential of Hydrogen

SIMPER	Similarity Percentage
SIMPROF	Similarity Profile Analysis
sp	Species
Stats Sa	Statistics South Africa

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CHAPTER 1

GENERAL INTRODUCTION

1.1 INTRODUCTION

Land use changes have significant impacts on environmental, social and economic dimensions of rural livelihoods (Kamwi *et al.,* 2015). This is because rural people are often highly dependent on the natural environment and are tied to primary sector activities such as agriculture and forestry (Kamwi *et al.,* 2015). However, because of urbanisation and aspiring for a better standard of living, many people are leaving rural areas in many countries, therefore abandoning primary economic activities. For example, in Thailand, only a small number of rural people are completely dependent on agricultural activities to meet their needs (Rigg and Nattapoolwat, 2001). Migration of people from rural areas to urban areas is an ubiquitous trend globally, resulting in increasing levels of agricultural land abandonment (Cramer *et al.,* 2008). Firstly, the proportion of people residing in rural areas declined by 11% globally during the period between 1960 and 1990 (Bryceson, 1996). Secondly, the amount of agricultural land that has been abandoned globally increased by over 150 million hectares from the 1940s to 1990 (Cramer *et al.,* 2008). As a result, Benayas *et al.* (2007) concluded that rural-urban migration is the main cause of abandonment of agricultural land in areas where rural people are offered new economic opportunities.

With increasing non-agricultural livelihood strategies offered to rural people, many communities move away from agricultural-based strategies to meet their daily needs, a process referred to as deagrarianisation. This is an inexorable process whereby a community or society moves away from a predominantly agrarian state (Bryceson, 1996). Bryceson (1996) defined deagrarianisation as the "process of economic activity reorientation, occupational adjustment and spatial realignment of human settlement away from agrarian patterns". Deagrarianisation represents a change in the state of rural economics, the decreasing economic importance of agriculture and agricultural production in rural economies and societies at large as well as the diversification of livelihood activities through the adoption of non-agricultural activities (Klimanek, 2013; Rigg & Nattapoolwat, 2001). Klimanek (2013) stated that the root of deagrarianisation is closely associated with the development of towns and the proportion of residents that engage in non-agrarian activities. This can be caused by a number of reasons such as degraded land, increase in farming expenses and movement of people away from rural areas (Benayas *et al*., 2007).

This process is openly demonstrated worldwide through a number of measures or indicators such as a decrease in number of people living in rural areas, agricultural labour in rural households, agricultural employment, and household self-sufficiency for basic needs, along with an increase in the rate of agricultural land abandonment (Bryceson, 1996). In any country, the core indicators of deagrarianisation are statistics on the number of people living in rural areas, the allocation of labour in different sectors of the economy and the proportion of GDP that comes from agriculture (Bryceson, 1996).

1.1.1 Drivers of deagrarianisation

Environmental and socio-economic changes such as soil erosion and rural-urban migration, respectively, are leading to increased levels of agricultural land abandonment worldwide (Benayas *et al*., 2007; Cramer *et al*., 2008). However, rural-urban migration appears to be the most commonly mentioned cause of deagrarianisation. This is attributed to the socio-economic factors that force people to find ways to make a living other than through agriculture. After reviewing several drivers of agricultural land abandonment, Benayas *et al*. (2007) concluded that movement of people from rural to urban areas was the main driver of this phenomenon. Shackleton *et al*. (2013) also found that migration to urban areas was one of the factors attributed by respondents as a cause of agricultural land abandonment on the Wild Coast, South Africa. Although, migration of people from rural areas may seem to be the main cause of deagrarianisation, there are others such as lack of capital, equipment and interest in farming as well as expensive farming inputs (Shackleton *et al*., 2013). Drivers of deagrarianisation range from socio-economic drivers to biophysical ones. Benayas *et al*. (2007) grouped drivers of deagrarianisation into three types, namely ecological, socio-economic and land mismanagement drivers. Among these, Benayas *et al*. (2007) concluded that socio-economic drivers are the main cause of land abandonment, followed by ecological drivers with mismanagement of land as the least common driver (Table 1.1).

Ecological drivers include factors such as declining soil fertility, increasing erosion and climate change. The world is currently undergoing rapid urbanisation, which, coupled with the changing climate is resulting in agricultural production constraints (Benayas *et al*., 2007). This leads to ecological drivers such declining soil fertility, increasing erosion and floods. For example, in western Lesvos, Greece, Bakker *et al*. (2005) found that erosion was an important driver for abandonment of cultivation land. Other examples include geo-physical factors such as limitations of slope, aspect, elevation and soil depth which may constrict agricultural production and consequently make it harder for farmers on such lands to make a viable living (Benayas *et al*., 2007).

Socio-economic drivers include market incentives, rural-urban migration, industrialisation and land tenure uncertainty. According to Khanal and Watanabe (2006) changes in the socio-economic conditions led to deagrarianisation in the Gandaki Basin, Nepal. For example, construction of a highway road that opened access to other areas and made it easy to import food at a cheaper price. Also, urbanisation and its benefits, such as better health care and education, attracted families to permanently move from the Gandaki Basin (Khanal & Watanabe, 2006). Changes in the socio-economic status of rural areas and households, such as levels of education and infrastructure development led to agrarian activities no longer being at the core of rural livelihoods. According to Bryceson (1996), investment in primary and secondary education has led to the majority of the youth to be more educated than their parents' generation, which often leads to dissatisfaction of the youth in a strictly agrarian work life. In Nepal, change in government policies such as high land rents are a direct cause of the increasing rate of land abandonment as they discourage families from leasing additional land for arable farming (Khanal & Watanabe, 2006). Mismanagement of land led to other drivers such as frequent flooding, barren land and increased soil erosion. These include any agricultural practises that led to exhaustion of land, land degradation and production losses (Benayas *et al*., 2007).

Table 1.1: Summary of drivers of agricultural land abandonment (Adapted from Benayas *et al*., 2007)

Type of driver	**Identified driver**	**Biome**	**Region**
Ecological	Slopes that constrain plant growth	Temperate mountain, Mediterranean	Northern Spain, Greece, Swiss mountains
	Increasing erosion, climate change, declining soil fertility	Mediterranean, tropical ecosystems, temperate grassland, wetlands and riparian forests	Greece, China
Socio-economic	Migration, rural depopulation	Dry shrubland, Mediterranean, tropical forest, temperate mountain, temperate forest	Central Mexico, Spain, Western Europe, Puerto Rico
	New economic opportunities (tourism, industrialization, housing)	Tropical forest, tropical coast, Mediterranean, wetlands and riparian forests	Puerto Rico, Tanzania, Brazil, tropics, Spain
	Land-tenure systems, accessibility by road, proximity to town or city	Temperate mountain, temperate forest, tropical forest	Denmark, Northern Spain, Brazil, Panama, Northern Italy, Peru, Swiss mountains
	Market incentives	Tropical forests, temperate grassland	Brazil, Panama, Eastern Europe, Peru
	Change in agrarian policy, increase in farmer age	Mediterranean, temperate grassland, temperate forests, wetlands and riparian forests	Spain, Europe, Denmark
	Input and output prices	Various	Europe
Mismanagement of land	Induced desertification, over-exploitation	Semi-arid shrubland, tropical forests, Mediterranean, temperate ecosystems	Northern China, Spain, Europe

1.1.2 Deagrarianisation in South Africa

South Africa has been long subjected to the process of deagrarianisation noticeable by the prevalence of abandoned agricultural fields, attributed to several drivers such as rural-urban migration, increasing dependence of the rural poor on government grants, the establishment of large supermarket chains and climate and environmental change (Andrew & Fox, 2004; Bank & Minkley, 2005; Nel & Davies, 1999; Porter & Phillips-Howard, 1997). This socio-economic shift results in people adjusting their livelihoods from largely agrarian to mainly non-agrarian livelihood activities. Deagrarianisation in South African is influenced by both the country’s discriminatory past and the recent democracy. This includes the dispossession of black farmer lands, white farmer favouritism and the recent changes in policy in pursuit of rectifying past transgressions (Nel & Davies, 1999; Neves & Du Toit, 2012). After 1994 in South Africa, the changed political setting resulted in a shift in policies that made it possible for people with disabilities, elderly, children to be assisted through social grants and pensions (DPME, 2014). This is an example of other economic opportunities afforded to people which have a contribution towards the abandonment of agricultural activities as primary livelihood strategies (Nel & Davies, 1999; Shackleton *et al*., 2013).

According to Neves and Du Toit (2012) processes of social change related to deagrarianisation are prominent in South Africa. The indicators for this include the contribution of the agricultural sector to the GDP, the number and area of agricultural fields that have been abandoned and the number of people migrating from rural to urban areas. These, according to Bryceson (1996), are the core indicators of deagrarianisation in any country. The evidence to support this in South Africa is the low contribution of agriculture to the GDP (less than four percent) and the occurrence of abandoned agricultural fields (5.4% increase in abandoned fields between 1961 and 2009 in Willowvale, South Africa) (Neves &Du Toit, 2012; Shackleton *et al*., 2013)

Deagrarianisation in South Africa is influenced by the country's racially discriminatory past (Plaatje, 2002 as cited in Ncube *et al*., 2014). Plaatje stated that under the apartheid regime, a decline in agricultural activities was aggravated by the the Natives Land Act No. 27 of 1913 which deprived black people from owning or leasing land outside of designated areas. The apartheid system played a role in the decline in farming by favouring the minority of white farmers who were heavily subsidised whilst black farmers suffered discrimination and were dispossessed of their land (Ncube *et al*., 2014; Porter & Phillips-Howard, 1997). However, after 1990, the new government vowed that there would be improvements in the lives of the black population that had lived under racially discriminatory conditions (Nel & Davies, 1999). According to Mtero (2012) the post-apartheid era government tried to mitigate the effects of deagrarianisation by introducing contemporary farming methods and agrarian business practises as well as an increased involvement of the private sector.

One of the consequences of deagrarianisation is abandonment of land, resulting in widespread old fields (Cramer *et al*., 2008). Such old fields are suitable lands for studying the general concept of succession because they provide a model system for testing how plants respond to different frequencies and intensities of disturbance over a manageable time scale (El-Sheikh, 2005). In many regions, abandoned fields undergo a decline of species that are naturally adapted to open spaces whilst stimulating the diversity of woody species characteristic of forests and shrublands (Benayas *et al*., 2007; Shackleton *et al*., 2013). Thus, a decline in engagement of arable agriculture globally is resulting in natural restoration of forests and woodlands (Gellrich *et al*., 2007; Shackleton *et al*., 2013).

1.2 FORESTS AND FOREST SUCCESSION

Both globally and locally, forests offer a number of social and ecological services such as provision of forest products, carbon sequestration, and water regulation (Shackleton *et al*., 2007a). About 31% of the world's land surface is forested, representing over four billion hectares of land (FAO, 2010). In most places, the amount of forested land is decreasing due to a number of factors such as increased demand for forest resources, land use change, degradation and disturbances such as fire and invasive species. Collectively, about 5.2 million hectares of forest was lost per year between 2000 and 2010, which was down from its peak of approximately 8.3 million hectares per year in the 1990s (FAO, 2010). The FAO (2010) defined forests as "Land spanning more than 0.5 hectares with trees higher than five meters and a canopy cover of more than 10%, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use". Several factors influence the composition of a forest, for example climate, soil type, and disturbances such as fire and harvesting of resources found in the forest. As stated by Corrigan *et al*. (2010) species richness of a forest is influenced by size, disturbance systems, proximity to other forests and the presence of dispersal corridors.

1.2.1 Forests in the South African context

In South Africa, the forest biome is the smallest, covering between 0.1 and 0.3% of the total land area (Corrigan *et al*., 2010; Shackleton *et al*., 2013). The forest biome is not contiguous because of natural fragmentation resulting in most patches being less than approximately 1 km^2 in extent (Lawes *et al*., 2004). Even with its fragmented nature, the South African forest biome supports significant animal and plant diversity (Eeley *et al*., 1999). According to Eeley *et al*. (1999) over 14% of the total terrestrial richness of forest birds and mammals in southern Africa are found in the South African forest biome. South African forests are among the richest temperate forests worldwide (Lawes *et al*., 2004). However, the species richness of forest trees in South Africa is lower than the east, west and central African rainforests (Lawes *et al*., 2004).

Around the world poor communities have been dependant on forests and forest products for millennia to sustain their livelihoods (Angelsen *et al*., 2014; Mukul *et al*., 2015). In South Africa, forests play a significant role in supporting rural livelihoods by providing benefits such as the provision of basic needs, cash saving and acting as a safety net during hard times (Shackleton *et al*., 2007a). Lawes *et al*. (2004) stated that forests and woodlands in South Africa are considered as poor people's safety nets. Poor people are highly dependent on resources provided by the natural environment and many among these are collected from forests. Harvesting timber, along with other disturbances such as wildfires and introduction of exotic species in forests, causes continuous change in species composition, size, age and ecosystem structure and function (Binelli *et al.*, 2000). After significant disturbance, a directional change of species composition with time occurs whereby herbaceous plants appear as early successional species and are later replaced by woody species, this is referred to as forest succession (Finegan, 1984; Wright & Fridley, 2010).

1.2.2 Forest recovery and succession

Succession is not a new concept; reflected in much of the literature being quite dated. According to Connell and Slatyer (1977) the study of succession dates as far back as the 19th century with key pioneer publications such as those of Cowles (1899), Cooper (1913) and Clements (1916). Different scientists and ecologists developed different models and theories to explain the process but Clements's theory of succession (Figure 1.1) received much support for many decades. Connell and Slatyer (1977) noted that studies in the mid-20th century described succession as a predictable sequence of species that sequentially establish in an area. Further studies in the 1960s described changes in other characteristics such as biomass, diversity and productivity as succession advanced (Odum, 1969). A more recent definition described succession as a non-seasonal and continuous process of the colonisation, establishment and extinction of species populations in a particular area (Zhang, 2005). Additionally, Guariguata and Ostertag (2001) defined forest secondary succession as a process whereby woody vegetation regrows after complete forest clearance for agriculture, pasture or other human activities. Moran *et al*. (2000) stated that to understand successional dynamics it is important to pay attention to land use and land cover. This is also emphasised by Guariguata and Ostertag (2001) who stated that the type and intensity of past land use are important to the process of succession. The recovery of the original vegetation and the whole process at large is influenced by the biological components of the previous species, their interaction with one another as well as abiotic components such as climate (Guariguata & Ostertag 2001). Primary succession occurs on land that previously had no vegetation, whereas secondary succession occurs on areas that were previously colonised by other plants, for example, the natural recovery of vegetation on abandoned crop lands (Binelli *et al*., 2000; Finegan, 1984; Zhang, 2005). Secondary succession occurs when disturbance has caused partial or complete removal of the vegetation in an area (Zhang, 2005).

Binelli *et al*. (2000) argued that disturbance is an important dynamic in forest ecosystems because it determines the succession of a forest. In addition, disturbance is one of the main reasons for spatial and temporal variations in species diversity (Mackey & Currie, 2001). Disturbance is an event that alters a niche and its opportunities, often leading to removal of biomass (Shea *et al*., 2004). Disturbance scale, frequency and intensity affect species richness, competitive relationships as well as the mix of early and late succession species (El-Sheikh, 2005). Following a significant large-scale perturbation, areas are initially colonised by pioneer species which are the early successional plants, followed by shrubs and early successional trees and later on by late successional species (Binelli *et al*., 2000). For instance, *Cecropia* and *Ochroma* are pioneer tree species that grow after 10 years of site abandonment in the Neotropics (Guariguata & Ostertag, 2001). Another example is *Vachellia karroo*, a dominant pioneer tree species in forest areas of South Africa (Shackleton *et al*., 2013).

The process tapers when the change in composition of species is undetectably slow or no longer changes due to limited variation in the state of the physical environment; this state of equilibrium is referred to as the climax community (Horn, 1974; Zhang, 2005). However, according to Zhang (2005), the concept of a climax state was questioned as early as the 1920s. Succession became viewed as a process that rarely reaches a climax state because of multiple and frequent disturbances and was therefore less predictable and could follow any of a number of multiple pathways (Zhang, 2005).

1.2.3 Different models of succession

Before recognition of multiple pathways, Clements' theory was the mostly widely used model of succession, stating that after a disturbance species would start to come back in a sequential manner to a state that would ultimately resemble the old community (Figure 1.1). According to Pickett *et al*. (2008) Clements focused on the successive replacement of herbaceous species by shrubs towards a mature climax state of a tree community. Although the idea of a climax state is debatable, the order of replacement described by Clements was not completely flawed. For example, results presented by Zhang (2005) in the eastern Loess Plateau of China showed three successional stages, namely grassland, scrubland and forest. The grassland stage started the year following the abandonment of croplands. This stage was characterised by rapid changes in the community, poor soils and a high community turnover. The scrubland stage started approximately 15 years after the croplands were abandoned. Shrubs dominated the vegetation in this stage. The soil is deep and with rich organic matter and better moisture conditions than the previous stage. Under natural conditions, the forest stage was established 30 years later developing from the scrubland. Forestation started to occur 40-50 years after the land was abandoned**.**

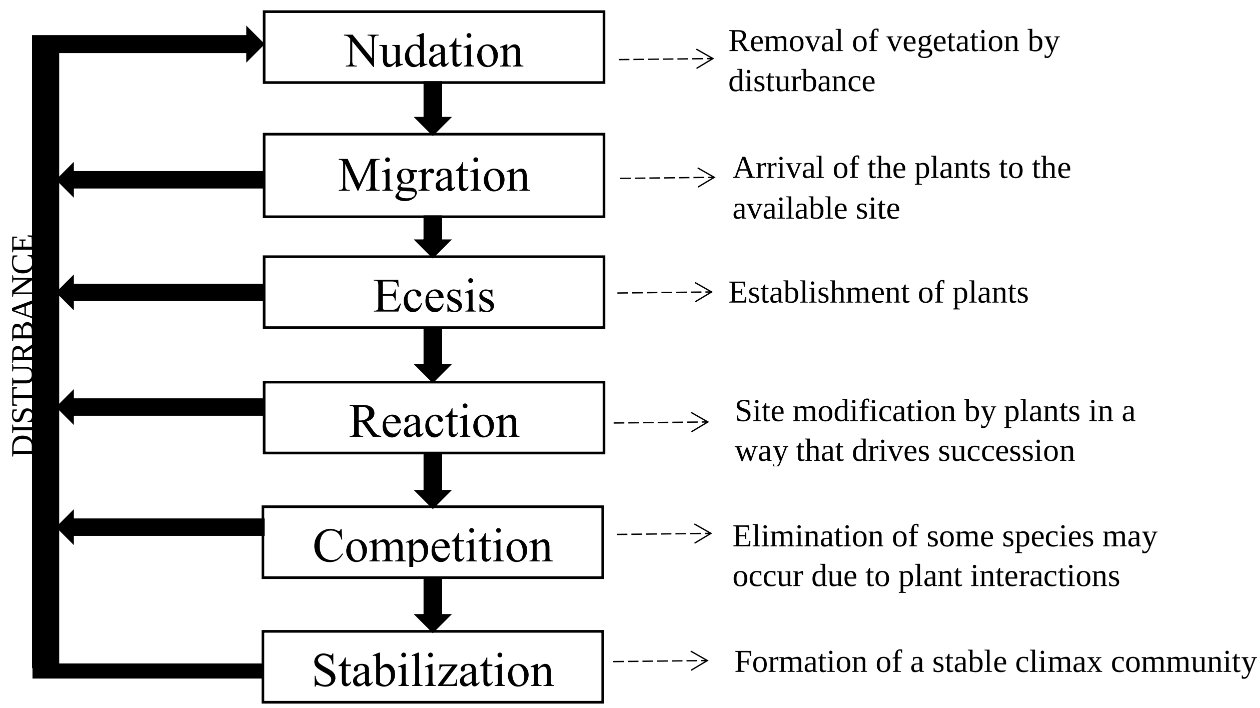


Figure 1.1: Clements' processes of successional change (Adapted from Pickett *et al*., 2008)

According to Cattelino *et al*. (1979) Clements' theory is a single pathway prediction of succession. Although Clements' theory had limitations and was questioned by many, it contained valuable ideas (Pickett *et al*. 2008). Among the models of multiple pathways, is the model by Connell and Slatyer (1977) that combines three models to predict the process of succession. Like Clements' theory, the Conell and Slatyer (1977) model begins with disturbance. The three models emphasise replacement sequences of species after disturbance (Cattelino *et al*., 1979). However, it assumes that no change will occur in the abiotic environment (Conell & Slatyer, 1977). The first model (1) assumes that certain species are able to colonise an area after a disturbance and these are referred to as early successional species. The second (2) and third (3) models assume that any species that arrived on the site may be able to colonise the area, including the late successional species that usually appear later in the process. Because of the single and multiple pathway debate, Horn (1974) argued that it has been impossible to develop a universal model for succession because the environment is not constant and is not the same universally. Therefore, it is better to study separately the factors that determine or influence the trends of succession in each context (Horn, 1974).

Among the models of succession, there is initial floristic composition, a theory developed by Egler to study old field succession (Connell & Slatyer, 1977; Halpern, 1989). The term old field can be defined as an area of abandoned agricultural land that was cropped or pastured to various degrees and abandoned for various degrees and times (Egler, 1954). Egler (1954) explains old field vegetation development using this theory which states that before abandonment, the land receives many seeds which are broken up, scattered and buried below the surface by ploughing and distributed by pasturing practises. After abandonment a progressive development follows with forbs and grasses dominating first and trees follow and dominate last (Egler, 1954).

1.2.4 Succession in South Africa

Examples of succession studies in South Africa are varied in terms of their location, biome and driver of the original loss of the original natural vegetation. Avis and Lubke (1996) revealed an increase in plant species diversity and community complexity as succession progressed on coastal foredunes in the Eastern Cape. They revealed the importance of dune pioneers in succession because they initiate foredune development by reducing sand movement and capturing salt spray. This led to the conclusion that foredunes play a vital role in succession as they reduce sand movement thereby creating a suitable habitat for mesic species to invade (Avis & Lubke, 1996). Several studies in northern Kwazulu-Natal examined forest revegetation and succession following the cessation of dune mining for heavy metals and rehabilitation through planting *Vachellia karroo* (Boyes *et al*., 2011; van Aarde *et al*., 1996). However, succession appeared to be arrested at many sites due to the impacts of domestic and wild herbivores constraining recruitment of woody species (Boyes *et al*., 2011). Other restoration studies in South Africa have examined plant community succession after clearing of invasive alien species as part of the Woking for Water programme (e.g. Galatowitsch & Richardson, 2005; Reinecke *et al*., 2008), with variable results depending on the nature of the original community and the extent of reinvasion from seed banks of the invasive species. Only one study has considered succession on abandoned crop lands, that being Shackleton *et al*.'s (2013) examination of forest revegetation on abandoned crop fields in the Transkei. It revealed that abandoned fields in this area revegetate through time along a clear trajectory of increasing similarity to uncleared forests in terms of species composition. In addition, species richness, diversity and woody cover increased with time, along with some changes in soil nutrients.

1.2.5 Succession and non-timber forest products

In the absence of frequent disturbance or some arresting process, much succession leads to an increase in species richness and diversity. This potentially increases ecosystem services such as biodiversity, regulating services and provision of natural products or resources. According to Gellrich *et al*. (2007), abandonment of land and subsequent forest re-growth has positive environmental consequences such as carbon sequestration, stabilisation of soils and a temporary increase in biodiversity. Returning species on old fields offer a different suite of benefits to local households than was provided when they were cropped (i.e. food), and this new suite is likely to change as forest succession continues. Key amongst this will be a variety of non-timber forests products (NTFPs). In Willowvale, some respondents viewed increase in forests as a positive change because it was beneficial to them as it increased the availability of NTFPs (Shackleton *et al*., 2013).

1.3 NON-TIMBER FOREST PRODUCTS

In the past twenty years, non-timber forest products have gained significant attention because of their importance to rural livelihoods and forest conservation (Shackleton *et al.*, 2011). Additionally, NTFPs have gained international acclaim for their conservation potential because NTFP collection and use is potentially more ecologically sustainable than timber harvesting (Mukul *et al*., 2015; Shackleton 2007a). Forests and forest products play a major role in sustaining rural communities that are dependent on forests by providing them with many NTFPs that fulfil daily needs such as food, medicine, shelter and energy (Mukul *et al*., 2015). Non-timber forest products are biological products from the wild harvested by rural people for direct consumption or income generation on a small scale (Shackleton & Shackleton, 2004). Examples of NTFPs include building materials, wild fruits, medicinal plants, plants fibres for craft and roofing, edible insects, mushrooms and honey, firewood and resins and saps for incense or brewing alcoholic beverages. Furthermore, NTFPs can be sold for financial gain to pay for other needs such as education or for financial security.

According to Shackleton and Shackleton (2004) NTFPs sustain livelihoods as a daily net or a safety net. Non-timber forest products as daily nets entail providing daily needs such as energy, medicine, food and shelter whereas, as safety nets, they provide security in times of hardships brought on by sudden changes in the economic or social setting. They play different roles to different communities, depending on the products available and the socio-economic circumstances of the community. Shackleton (2015) grouped the benefits of NTFPs into six categories, namely: daily household provisioning, cash income generation, cash saving, safety nets, supporting and regulating services as well as cultural services.

1.3.1 Daily household provisioning

Direct household provisioning, also referred to as the daily net, is when households use NTFPs to meet their daily needs (Shackleton & Shackleton 2004). Many rural communities are dependent on NTFPs for their everyday needs; this includes food, medicine, shelter and energy. Paumgarten and Shackleton (2009) found that households from two South African villages use NTFPs for construction, food, shelter, medicinal purposes, energy and fencing, tools, cultural and decorative items. Shackleton (2015) stated that millions of people from rural areas and a significant number of urban people use NTFPs every day to fulfil some or all of their food, shelter, energy and medicinal needs. Cocks *et al*. (2008) reported that all sampled households in six villages in the Eastern Cape used NTFPs that they harvested or bought from local traders to cater for domestic needs. Species like *Olea europaea* and *Ptaeroxylon obliquum* were used for maintenance of kraals and woodpiles. According to Sunderlin *et al*. (2005) the majority of NTFPs are directly consumed by collectors and their families. Shackleton and Pandey (2013) summarised across a number of empirical studies around the world that the contribution of NTFPs usually ranges between 10 and 60% of the total household income. The global comparative study by Angelsen et al. (2014) reported that the mean contribution of NTFPs to household income was 28%.

The contribution of NTFPs to livelihoods varies between type of NTFP used and between households (Shackleton, 2015). In rural areas lacking electricity, firewood is the primary energy source, and according to Shackleton *et al*. (2007a) over 80% of rural households in South Africa still use firewood. Shackleton *et al*. (2007b) reported that all households sampled used firewood with the mean annual demand about 4 000 kg in both locations studied. Forests are the primary source for self-medication for rural people as there is a range of medicinal plants that they can use. This is driven by culture, and limited physical or financial access to modern medicine. For example over 85% of the rural population of Ethiopia use medicinal plants as their main source of healthcare (Shackleton *et al*., 2011). According to Mander (1998) 27 million people use or buy traditional medicine collected from forests by herbalists and small-scale traders in South Africa.

1.3.2 Cash saving

By using NTFPs for food, medicine, building material and energy, households have the opportunity to save money they would normally use for these if they did not make use of NTFPs. Saving money through use of NTFPs allows households to have money for other services that can be obtained only by cash, such as school fees and agricultural inputs or the money can be saved for future emergencies such as medical expenses (Shackleton, 2015). Shackleton *et al*. (2007a) noted that not only does use of NTFPs save money for rural households but also for the government as it lightens the amount of money that the government has to spend in these communities providing basic or emergency services.

1.3.3 Cash generation

Some households sells NTFPs to earn cash income rather than for subsistence use (Shackleton, 2015). This cash income is then used for other needs or services that can only be obtained using money. Paumgarten and Shackleton (2009) reported that households take part in the trade of NTFPs to earn money for food, as a primary source of income, and to have income for basic needs. Trade of natural products offers opportunities for people to make ends meet through self-employment as well as act as a livelihood and coping strategy (Paumgarten & Shackleton, 2009; Shackleton *et al*., 2007a). The extent of cash income generation through NTFPs is growing (Paumgarten & Shackleton, 2009). For instance, in 2002, the number of marula beer sellers grew ten times relative to the year 2000 (Shackleton & Shackleton 2004). Mahapatra *et al*. (2005) reported that in Orissa, India, 95% of the households sampled received at least some cash income from harvesting and selling NTFPs. Income earned from selling palm brushes in Willowvale was regarded as the second most important source of income by traders (Mjoli & Shackleton, 2015). NTFPs can be sold in their raw form, for example the *Scleorocarya birrea* fruits sold by rural collectors in the Limpopo Province, South Africa, or in a processed or value-added form, for example, the hand brooms made from *Athrixia phyllicoides* sold in Bushbuckridge, South Africa (Shackleton *et al.*, 2011; Shackleton, 2015). According to Shackleton *et al.* (2001) women in 17% of the households in KwaJobe, KwaZulu Natal, South Africa, sold reed mats earning from R300 - R2 500 yearly.

1.3.4 Safety nets

Non-timber forest products provide a safety net for households under stress or during times of hardship. Paumgarten and Shackleton (2011) stated that NTFP use as a safety net entails increased use and trading of NTFPs. They act as fall-back options, coping mechanisms and insurance in times of misfortunes such as loss of crops or livestock due to floods, drought or diseases, and death of a breadwinner (Shackleton & Pandey 2013; Shackleton, 2015). In South and southern Africa HIV/AIDS is widespread resulting in death of breadwinners and people having to stop activities that generate money to look after sick loved ones, the safety net component of NTFPs is very crucial (Shackleton *et al*., 2007a). When households face such hardships and are vulnerable to extreme poverty, they turn to NTFPs to mitigate shocks. According to Shackleton *et al*. (2007a) this can take three forms, (1) using products that are not usually used by the household, (2) increased use of certain NTFPs and (3) temporary trade of NTFPs for financial income. Not only the affected household but close relatives as well may turn to NTFP harvesting in times of shock for trade and offer cash or social support, such as labour, to the affected household (Shackleton, 2015). In a study done in two villages in South Africa, 70% of households used NTFPs as a coping strategy in the previous two years (Paumgarten & Shackleton 2011). According to Paumgarten and Shackleton (2011) use of NTFPs as a safety net is an insurance option more to poor households as compared to wealthy households.

1.3.5 Cultural services

Forest products are an important part of people’s daily lives; they are also embedded in their culture (Shackleton, 2015). Because of their cultural significance, they are used for certain traditions and cultural rituals. Culture is place specific, therefore different NTFPs hold different cultural significance and are used for different cultural reasons. For example, cedar branches in Canada were used by the Sts’ailes people to make cultural products such as baskets, traditional clothes and mats, for ceremonial rites such as purification and blessing of ceremonies and spiritual practices where they use the branch to brush the body and purify the spirit (Kim *et al*., 2012). Some medicinal plants are used for cultural rather than conventional medicinal purposes. Cocks and Wiersum (2003) recorded that out of 103 plant species used by rural households in the Eastern Cape, almost one-third were used for cultural purposes and almost three-quarters of the households used wild plant species for cultural rituals.

1.3.6 Supporting and regulating services

Shackleton (2015) mentioned that regulatory and supporting services by NTFPs are a rare theme in the NTFP literature. Some NTFP species provide favourable conditions for other species that are important to sustain livelihoods. For example, *Sclerocarya birrea* as mentioned by Shackleton (2015), as providing shade that promotes favourable conditions for crop growth as well as acting as a source of food to many invertebrates which in turn are a source of food for local people. Some NTFP tree species with large canopies provides shade in people’s yards. Another example provided by Shackleton (2015) is that of dense reeds that play a part in water purification and stream regulation, as well as shaping the morphology and hydrology of streams. Additionally, they are habitat to organisms that may be of use to local people, such as rodents and birds.

1.4 PROBLEM STATEMENT AND OBJECTIVES

Non-timber forest products are widely used all over the world. However, this is dependent on the availability of NTFPs and the local socio-economic context. This study examined how NTFPs colonise abandoned fields during forest succession, potentially increasing their contribution to rural livelihoods in the face of deagrarianisation. It has been noted that forests play a vital role in rural livelihoods. Not only do they provide timber but non-timber forest products as well. Since the recognition of their potential value and role in the 1980s, NTFPs have been researched in many disciplines such as livelihood studies, conservation, economics and forestry (Shackleton *et al*., 2011). In this study, NTFPs were studied as part of forests and livelihoods as well as conservation.

There has been a marked decline in engagement of agriculture by rural people in the Wild Coast region (Shackleton *et al*., 2013). This leads to abandoned land that provides opportunity for revegetation and with this some species that are useful to the local people may colonise the land, this process is known as succession. Literature on succession dates back to 1916 to Clements's work, one of the forefathers of succession studies. The debate surrounding how the process takes place has occurred for many years with the climax stage being questioned by various authors. However, the majority of this work has been conducted in the temperate forests of the northern hemisphere, with only limited work in Africa, especially in South Africa. Because there are many studies reporting deagrarianisation, questions regarding what happens to these abandoned fields arise. Shackleton *et al*. (2013) reported widespread deagrarianisation in Willowvale and that woody plants were colonising old fields with increasing similarity to the species composition of intact forest with time since abandonment.

This study examined the vegetation that comes back after abandonment with particular emphasis on NTFPs. This was done by looking at successional stages, which has not been done before. Considering that there is very little work on succession in South Africa and no work on the implications of forest succession for NTFPs internationally, this study aimed to bridge a research gap on succession in South Africa and NTFPs in the successional process. This included unpacking how old field succession may affect livelihoods, considering that it offers different kinds of products to cultivation, the type of NTFP's found in the different stages of succession, how useful they are to the local people, and which stages (whether early or late stages) of succession provide more NTFPs. According to Ashton *et al*. (2014) several studies have reported that NTFPs can be more abundant in second growth forests as compared to late successional forest. However, that study was conducted in South Asian tropical forests and that may not be the case for South African temperate forests.

The aim of this study was to examine how forest succession affects the composition and abundance of NTFPs. Three objectives were considered:

- To identify when the delineated arable lands stopped being cultivated and assess the subsequent rate and nature of succession.
- Assess the impact of succession on the richness, composition and abundance of NTFPs.
- To investigate how people view the revegetation and how they make use of the NTFPs that come with the revegetation.

1.5 STUDY AREA

The study was conducted in Willowvale/Gatyana areas towards the coast from Willowvale town (32°15'46.33" S, 28°28'50.15" E) (Fig 1.2). The area is characterised by dispersed rural homesteads with large plots of land, a lack of infrastructure, poor transport systems, and limited local markets (Shackleton *et al.*, 2013; Shackleton & Luckert, 2015). The dispersed homesteads include home gardens, traditional huts for cooking and a livestock enclosure. The majority of the people who live in Willowvale are isiXhosa speaking. Administratively, Willowvale is located in Mbhashe local municipality in the Eastern Cape, South Africa (IDP, 2015-16). The Eastern Cape is the poorest and the second largest province in South Africa (Ruiters, 2011). Willowvale lies along the southern portion of the coastal region of the Transkei, frequently termed the Wild Coast (Shackleton & Hebinck, 2018). The Transkei region is a former homeland of the apartheid era accommodating the black South Africans who were evicted from farms and cities by the apartheid government. This is one of the poorest, least developed and most remote areas of the country (De Klerk, 2004 in Shackleton *et al*., 2013). The area was chosen because of the prevalence of abandoned agricultural fields, increasing forests and woodlands regenerating on old fields and the use of NTFP's by the local people reported in previous studies conducted in the area (Shackleton *et al*., 2013).

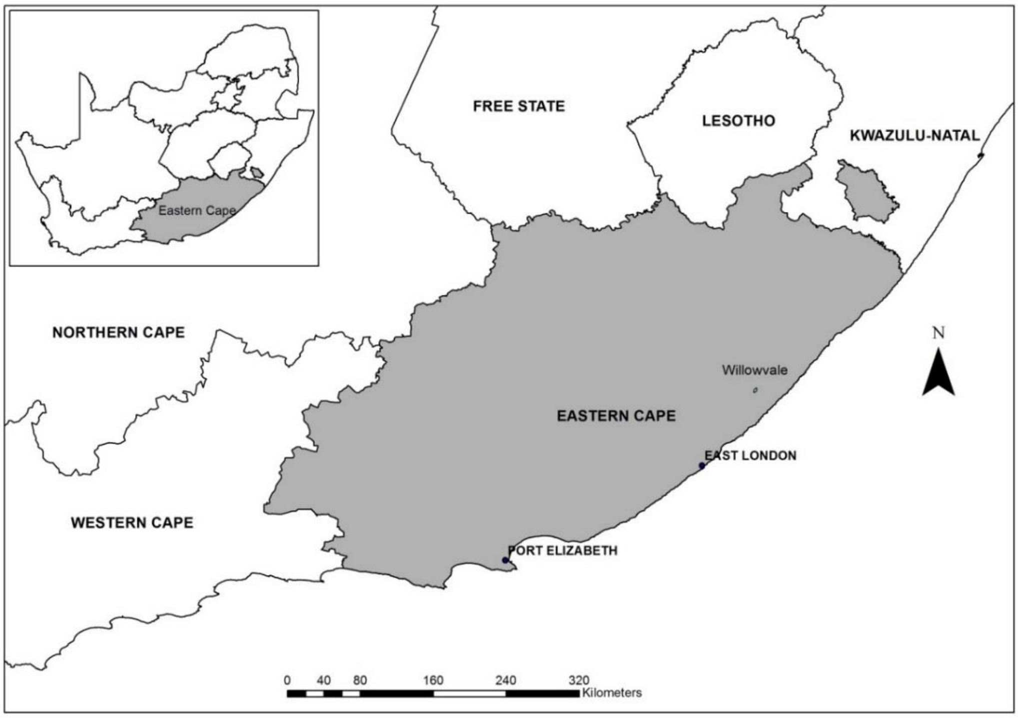


Figure 1.2: Location of Willowvale in the Eastern Cape, South Africa

1.5.1 Socio-economic characteristics

In Willowvale, homesteads have a dispersed settlement pattern with residential and agricultural plots allocated by traditional authorities (Mjoli & Shackleton, 2015; Shackleton & Hebinck, 2018). Land is common property with open access for livestock grazing and natural resource collection (Mjoli & Shackleton, 2015). Willowvale has a total population of 2 522, with a density of 205 people per km^2 (Stats SA, 2011). An important feature of the Eastern Cape pointed out by Ruiters (2011) is depopulation. According to Ruiters (2011) the role of the Eastern Cape in South Africa has been to supply labour, especially to the gold mines of then Witwatersrand. There are 802 households, of which 59% are female headed. According to Porter and Phillips-Howard (1997) this is because it is mostly male migrants who leave their homes for work in the cities or mines. Within the population 26.5% aged 20 years and above have received higher education and 27% aged 20 years and above have matriculated (Stats SA, 2011). Willowvale has a high unemployment rate (estimated at 42%), high levels of poverty, and low education levels (Chalmers & Fabricius, 2007; Stats SA, 2011).

1.5.2 Bio-physical characteristics

The area is dominated by rolling hills and valleys (Mucina & Rutherford, 2006 in Mjoli & Shackleton, 2015). It is situated at an altitude of 658 m above sea level and receives approximately 974 mm of rainfall per year with March as the peak rainfall period (Climate-data.org, 2016). It has a warm and mild climate with February being the hottest month at an average temperature of 20.5°C and July being the coldest month at an average of 13.3°C (Climate-data.org, 2016). The area falls under the Maputaland-Pondoland-Albany biodiversity hotspot which is unique for its high level of biodiversity and systems that sustain millions of people (CEPF, 2010). This hotspot supports a wide variety of vegetation, making it the second richest floral region in Africa with an estimated 8 100 plant species, of which approximately 1 900 species are endemic to the region (CEPF, 2010). According to Shackleton *et al*. (2013) the natural vegetation in the area of Willowvale is a mixture of forest, thornveld, dune thicket and grassland patches. Forests in the area are naturally fragmented and found in lower lying terrain (Shackleton *et al*., 2013). Forest patches are found on the moist deeper soils in valleys whereas the grassland occurs in the high ridges; the woodland however occurs in the transition zone between the two vegetation types (Chalmers & Fabricius, 2007).

1.6 OUTLINE OF THE THESIS

This thesis is divided into four chapters, each dealing with a specific aspect of the overall study.

Chapter 1: General introduction

This chapter reviews the literature surrounding the themes and subjects explored in this thesis to provide some background. These are deagrarianisation, succession and non-timber forest products. This chapter also details the need for this project, presents the objectives of the project and provides information about the study area.

Chapter 1: General Introduction

Chapter 2: Revegetation results chapter

This section reports on the results from GIS and field assessments conducted on aerial photographs and revegetated fields of different ages, respectively. This details the different ages of the fields, the change in the quantity of vegetation over time and unpacks the ecological information such as the plant species found in the area, their richness and the different life forms.

Chapter 3: Non-timber forest products results chapter

This chapter details the community's identification of NTFP and non-useful species found on revegetated old fields on the Wild Coast. The results also report the uses of the different NTFPs and provide a ranking on their importance to local households.

Chapter 4: Synthesis chapter

This chapter brings the two concepts (succession and NTFPs) together to show how succession impacts NTFP availability and the possible implications this may have for rural livelihoods in the area.

CHAPTER 2

FOREST SUCCESSION ON ABANDONED AGRICULTURAL FIELDS ON THE WILD COAST, SOUTH AFRICA

2.1 INTRODUCTION

The way in which people use the environment to meet their daily needs can in some instances, have detrimental effects such as over-exploitation of natural resources and deforestation. This, according to Kamwi *et al.* (2015), is the reason why understanding the complex interconnections between changing landscapes, land use and livelihoods is important. Livelihoods entail the way which people make a living through capabilities, assets and activities (Chambers & Conway, 1992). There are several assets that people draw upon to sustain and construct their livelihoods, however, for rural livelihoods, many of these assets and activities are tied to the natural environment **(**Kamwi *et al.,* 2015). Among these, agriculture has always formed a huge part of rural economics. However, recently this appears to be questionable, especially with respect to rural livelihoods in the context of deagrarianisation. Deagrarianisation is a worldwide challenge influencing many livelihoods, especially in developing countries, and South Africa is no exception (Hebinck *et al*., 2018; Ncube *et al*., 2014; Twyman *et al*., 2004).

2.1.1 Deagrarianisation in the Eastern Cape, South Africa

According to Manona (1999) most people in the Eastern Cape shifted from agrarian activities as means of livelihood. Hebinck and Van Averbeke (2007) attributed this to a number of reasons such as rural-urban migration, lack of interest in farming and other domestic tasks taking priority over agricultural tasks. For instance, the proportion of people who left the Eastern Cape between 1992 and 2001 was 0.7% annually which increased to about 1% for the period 2001 and 2006 (Edwards, 2011). This rate of out-migration was influenced by the underdevelopment of the province, driving people to find jobs elsewhere in the country to escape poverty (Edwards, 2011). Among the reasons for deagrarianisation in the former homelands is the increasing dependence on government social grants (Nel & Davies, 1999; Shackleton *et al*., 2013). Additionally, Shackleton *et al*. (2013) reported that loss of cattle was one of the main reasons people in Willowvale stopped in farming because they had no other means to plough. The decline in cattle numbers was attributed to the cessation of the government animal health and dipping program in the late 1990s. Migration to urban areas, lack of capital, equipment and interest in farming, expensive farming inputs and raiding of crops by livestock are some of the factors credited by respondents as the drivers of cropland abandonment on the Wild Coast, South Africa. Agriculture is declining in the rural Eastern Cape because of migration to big towns and cities such as East London and Johannesburg in search of employment and better standards of living (Bank & Minkley, 2005). The termination of restrictions on the movement of black people to towns allowed people to move freely from rural areas and go to any place they believe would give them a better life (Shackleton *et al*., 2013). With the eradication of pass laws, people of Guquka and Koloni (villages in the Eastern Cape) ceased the temporal migration influenced by employment and started to pursue a permanent urban life (Smith & Hebinck, 2007). This is signified by the decline in populations in the two villages after the first democratic elections (Smith & Hebinck, 2007) and still ongoing (Hebinck et al., 2018). In 1991, Koloni had a population of 514 while Guquka had a population of 650, and in 2004 Koloni had a population of 224 and Guquka had 187 people (Smith & Hebinck, 2007). This movement of people from rural Eastern Cape led to able-bodied people leaving rural areas and leaving behind the elderly and the youth who are either unable or have no inclination to partake in agriculture. For example, Porter and Phillips-Howard (1997) reported that the agrarian patterns of the former Transkei started to change when men left the rural areas to go to work in mines and the weight of agricultural work was left in the hands of the women. The movement of men from rural areas to go work in the mines was so high that between 1970 and 1980, about 500 000 migrants from Transkei worked in the then Orange Free State and Transvaal mines (Ngonini, 2007).

The declining levels of agriculture can also be attributed to food chains that import and sell cheap food to rural dwellers. Porter and Phillips-Howard (1997) reported that about 70% of food required by rural people is imported. Although land based activities such as livestock farming, wild resource harvesting and cropping contribute to rural livelihoods, the contribution of smallholder agriculture is declining (Lahiff & Cousins, 2005). Lahiff and Cousins (2005) attribute this to a lack of resources, especially land, state support and the difficulty smallholder farmers face in accessing markets. Due to the political past of the country that led to land dispossession and black people losing ownership of arable land, few households in Transkei can sustain their livelihoods through their own production. Therefore, they buy staple foods such as maize and wheat from commercial outlets (Porter & Phillips-Howard, 1997). Lahiff and Cousins (2005) state that the post-democratic transition land reform program has been unable to transform the pattern of land ownership in a manner that significantly improves rural livelihoods. Shackleton *et al*. (2001) agree that insufficient land ownership hampers land-based livelihoods to some extent.

One of the major consequences of deagrarianisation is the large proportion of idle agricultural land (Khanal & Watanabe, 2006). According to Cramer *et al*. (2008), in some regions this land will have characteristics that allow plant communities to assemble unaided. In South Africa, proof of this can be seen in Willowvale where Shackleton *et al*. (2013) reported a decline in agricultural fields and an increase in forests, woodlands and abandoned fields suggesting forest establishment on abandoned farm lands.

2.1.2 Succession on abandoned agricultural fields

One of the results of deagrarianisation has been the revegetation occurring on abandoned lands. Abandoned fields act as new and clear environments for plants to colonise leading to new plant assemblages. Revegetation on abandoned agricultural lands has become an increasingly common phenomenon globally. In Switzerland wooded areas increased by 17 000 hectares (14%) over a 12-year period in the 1980s and 1990s (Gellrich *et al*., 2007). Globally, the area of abandoned agricultural land increased by over 150 million hectares between the 1940s and 1990 (Cramer *et al.*, 2008). According to Gellrich *et al*. (2007), this is pronounced in areas with high farm abandonment rates and increasing populations. Revegetation on old lands can follow a sequential process referred to as succession and each stage of the sequence offering different ecological consequences.

2.1.3 Change in vegetation attributes in relation to succession on old fields

As succession progresses, litter quality, soil nutrient content and availability are expected to change with the process of species replacement (Ganade & Brown, 2002). Sometimes succession occurring on abandoned agricultural land begins on soils that have poor nutrients and low organic matter due to cultivation and cropping (Zak *et al*., 1990). According Benayas *et al*. (2007) when secondary succession progresses after land abandonment, soil evolution and plant colonisation include reduction in soil erosion and sediment export leading to soil fertility regeneration. For example, in Minnesota, nitrogen levels in the soil were twice as high in forests as compared to recently abandoned agricultural fields (Inouye *et al*., 1987). Shackleton *et al*. (2013) reported an increase in soil carbon as age of abandoned fields increased. To completely understand how plant litter and soil nutrients may influence succession, one needs to be aware of the extent to which they affect species colonisation of different successional stages (Ganade & Brown, 2002). Ganade and Brown (2002) showed that plant litter positively affected all species in old fields, which indicates that it is important for seed establishment in old fields.

Benayas *et al.* (2007) found that field abandonment led to increased plant biodiversity. There is a frequent correlation between time of abandonment and species richness (Benayas *et al*., 2007; Shackleton *et al*., 2013). This is supported by Bonet (2004) who revealed that species richness on loam soils showed a quick increase with old field age, and by Zhang (2005) who suggested that species diversity and species richness increased as succession progressed, whereas species evenness decreased. El-Sheikh (2005) reported that species richness and diversity increased during the first two years after abandonment and would decrease in the later successional stages.

Sarmiento (2003) reported that succession on old fields in the high tropical Andes appeared as a continuous change in the abundance of species rather than as a sequences of well-defined successional stages. This study revealed an increase in species richness during the first four years of succession. This is supported by the results of Bonet (2004) which showed that maximum species richness occurred during the relatively early stages of succession. According to Sarmiento (2003) species richness doubles during the first four years of succession with an average of about 10 to 20 species per plot, after which species richness stabilises.

2.1.4 Forest succession on abandoned lands on the Wild Coast

Studies on the South African Wild Coast reveal an increase in forest area. Chalmers and Fabricius (2007) reported an overall increase of 49% (568 hectares) of woody and forest patches in Nqabara, Wild Coast, between 1974 and 2001. Local experts attributed this to abandonment of cultivation and increase in abandoned fields, among other things. Results from this study also revealed that fields that were cultivated in 1974 had been invaded by forests. Working in the same area, De Klerk (2007) also reported an increase in woody cover from 56% in 1961 to 82% in 2001, alongside a long-term trend of declining livestock numbers. These findings are mirrored by those of Shackleton *et al.* (2013) who reported a 14.9% increase in woodland and 5% increase in forests between 1961 and 2009 in Willowvale, Wild Coast. This study also reported a large decrease in field cover and increase in abandoned field cover. Both these studies are reporting a common trend where field abandonment leads to revegetation and forest formation, thereby, forest succession on old fields.

2.2 OBJECTIVES AND KEY QUESTIONS

Based on the literature that has been reviewed above, the objectives and key questions of this chapter were as follows:

1. To identify when the delineated arable lands stopped being cultivated and assess the woody cover change
    - How long did it take before woody plants started to invade abandoned land?
    - How did woody cover change through time?
2. To reveal the nature of old field succession in terms of plant species richness, composition and abundance
    - How does succession affect species richness?
    - How does succession affect the composition of plant species in old fields?
    - What are the environmental factors that influenced succession on old fields?

2.3 METHODS

2.3.1 Data collection

Data collection was through a variety of vegetation assessment methods. Geographical Information System (GIS) was the first phase of data collection whereby aerial photographs of Willowvale were analysed to determine field age and track vegetation change through time. The second phase was field assessment to assess the change in various vegetation attributes in old fields of different ages since abandonment. A series of aerial photographs in approximately ten year time steps were analysed to assess vegetation change through time (Stickler & Shackleton, 2015). According to Nakashizuka *et al*. (1995) aerial photographs are a long-standing tool used for analysing vegetation. Disturbance regimes and dynamic features of the forest can be reflected by the forest's canopy structure (Nakashizuka *et al*., 1995). This is what made aerial photographs a suitable method to track vegetation changes for this study. Images obtained and used by Shackleton *et al*. (2013) to assess changes in land use and cover in Willowvale were used. The images that were available for the location were from the years 1942, 1961, 1972, 1985, 1995 and 2009. The first step was determining when the field was abandoned to find out its age. The fields identified on the aerial photographs later served as the fields where the field data was collected to answer the rest of the questions for the study. The second step was to determine the percentage of woody cover. This provided a clear picture of when the field ceased to be cultivated and helped in determining the successional stages of the sampled area.

2.3.1.1 Field age determination

To determine how old each abandoned field was, aerial photos were used to track each field through time (Table 2.1). This was done to estimate the period of abandonment, the age of the fields and when woody vegetation first started to invade the abandoned land (Bonet, 2004). On the earliest aerial photos, which were from 1942, cultivated fields were identified and delineated. All the fields that were identified were then tracked through time. This was done by looking at the same field in the following photographs of approximately decadal time steps and identifying if and when cropping stopped and woody vegetation started to invade. This was then repeated for each time step of aerial photos. The correction marks (√) in Table 2.1 indicate that the field was still an agricultural fields and the cross marks (x) indicate that the field was no longer cultivated then that year subtracted from 2016 (when data were collected) was taken as the age of the old field.

Table 2.1: Method used to determine the age of old field based on when cultivation stopped (x= cultivation, √= cessation of cultivation)

Field no.	1942	1961	1972	1985	1995	2009	Approximate age (years)
1	√	x	x	x	x	x	55
2	√	√	√	x	x	x	31
3	√	√	√	√	x	x	21

2.3.1.2 Assessing woody cover change through time

To assess changes in woody cover, aerial photographs from 1961, 1972, 1985, 1995 and 2009 were compared (Shackleton *et al*., 2013). For each aerial photo the percentage woody plant cover for each abandoned field identified was visually estimated. A 1x1 cm^2 grid was used, which corresponded to approximately 130 m^2 on the ground (Figure 2.1).

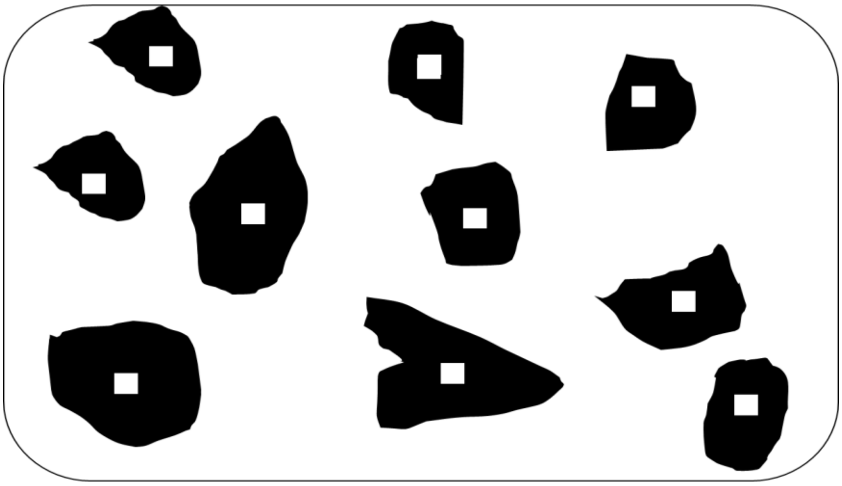


Figure 2.2: Method used to assess woody cover change through time in the old fields on aerial photographs using 1x1 cm^2 blocks at the centre of each field

2.3.1.3 Field data collection

Abandoned fields of different ages identified on the aerial photographs were sampled to determine plant species richness, composition and abundance. After analysing the aerial photographs to determine the age of the revegetated field, different abandoned fields of different ages were selected for sampling. Approximately 10 fields were selected per aerial photograph representing approximately a decade since abandonment. In total, 43 old fields and seven intact forests were assessed. A global positioning system (GPS) device was carried in the field to locate the selected points (Stickler & Shackleton, 2015). Plots of 10 x 20 m were laid out in the centre of each old field and a species list was recorded. The individual plants in each plot were identified and those unknown were collected, pressed and sent to the Selmar Schonland Herbarium for identification. Species richness was calculated as the number of species recorded in each plot (Sarmiento *et al*., 2003). A Braun-Blanquet scale was used to estimate cover abundance of each species. This method was also used by Avis and Lubke (1996) to assess plant abundance in a coastal dune vegetation succession. In each 200 m^2 plot, four 5 x 5 m quadrats were used to visually estimate the percentage cover of rocks, bare ground, litter and herbaceous cover. Abiotic components were measured using various methods as shown in Table 2.2. Soil samples were collected from each quadrat at the depth of 10 cm, mixed, and sent to a commercial laboratory to be analysed for texture (silt, clay and sand) and soil nutrients (Calcium (Ca), Potassium (K), Carbon (C), Magnesium (Mg), Sodium (Na), Ammonium nitrate (NH_4NO_3) and Phosphorus (P)) (Sarmiento *et al*., 2003; Shackleton *et al*., 2013).

Table 2.2: Methods used to measure the environmental variables in the old fields

Abiotic variables	**Methods**
Slope position	Five point scale
Slope angle	Abney level
Altitude	GPS
Disturbance	Notes

2.3.2. Data analysis

Data analysis was performed using various software for different analysis. Microsoft Excel was used to analyse and present all the data for descriptive statistics. STATISTICA was used to test for statistical relationships. For multivariate analysis, PRIMER was used.

The relationship between woody cover and old field age was tested using a liner regression in STATISTICA. This was done to see woody cover changes as forest succession continued. The same was done to test for the relationship between species richness and age of old fields. To assess the composition of species in the old fields, a similarity of percentage (SIMPER) was performed on PRIMER. This not only revealed the species composition of similar plots but also how much each species contributed to the overall similarity of the group. An analysis of similarities (ANOSIM) was used to test for differences in species composition between ages of old fields and between the old fields and forests. A hierarchical cluster analysis was used to group plots of similar species composition. A similarity profile analysis (SIMPROF) test represented plots of similar composition at $p<0.05$. Multi-dimensional scaling (MDS), was used to assess how the plots were grouped and the environmental variables that separated them.

A BEST analysis was used to assess which of the environmental factors best described the vegetation data and the species composition in the delineated lands. The (BEST) analysis was used at different correlation levels. An ANOSIM was performed to test for differences in the plots using the best environmental correlates at the highest correlation level.

2.4 RESULTS

2.4.1 Woody cover change through time

The GIS analysis showed that the landscapes had changed markedly over the past 60 years (Figure 2.2). The oldest and the youngest group of the sampled old fields were abandoned approximately 55 and 7 years ago, respectively. After abandonment, there was little vegetation cover but it increased gradually with time. Although there were some variations, data from the aerial photographs showed a clear increase in woody cover over a period of 55 years ($r = 0.43$; $r^2 = 0.18$; $p<0.05$). The relationship did not change when the forest (control) plots were included in the analysis ($r^2 = 0.57$; $p<0.05$). However, even after 55 years, the woody cover in the old fields was still considerably lower than in intact forests. Woody cover was approximately 2% in the youngest fields, with an age of approximately seven years and went up to 50% at the oldest fields with an approximate age of 55 years (Figure 2.2). The coefficient for age in years was 0.77 indicating that for every additional decade, woody cover can be expected to increase by an average of 0.77% per annum.

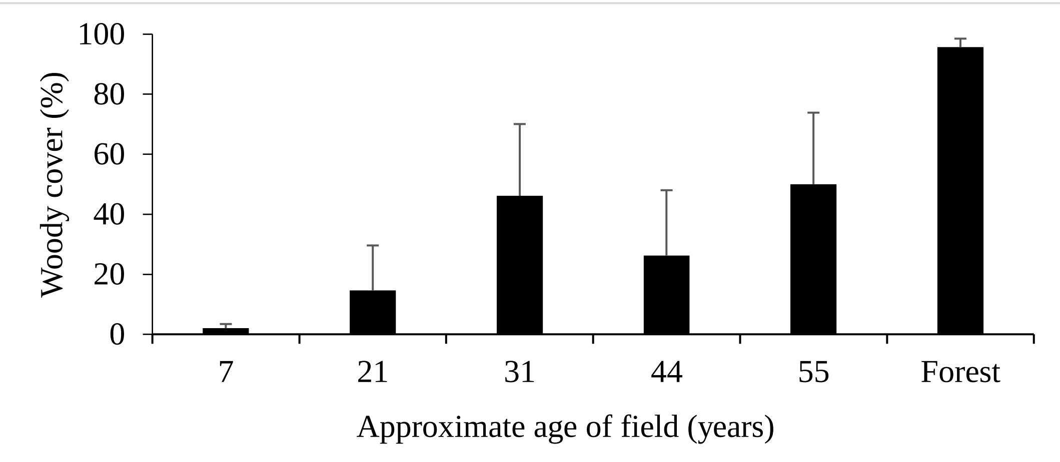


Figure 2.2: Mean woody cover change in the old fields of different ages

2.4.2 Change in plant species richness over time

Plant species richness increased with the approximate age of field (Figure 2.3). However, the fields that were abandoned in the 1970s with an approximate age of 44 years had marginally lower species richness than the decade before it. This could because these fields had been heavily burnt at the time of the field assessment. The plant species richness of old fields after 30 years, was similar to that of intact forests at 22±6.02 species. The regression coefficient revealed that for every additional decade, species richness increased by three species. The regression results showed a low but significant correlation between species richness and age of old fields (r^2 = 0.12; $p<0.05$). These results also showed that about 12% of the variance in species richness was explained by age. When the control plots (forests) were included in the analysis, there was no significant relationship between species richness and age (r^2 = 0.04; $p>0.05$).

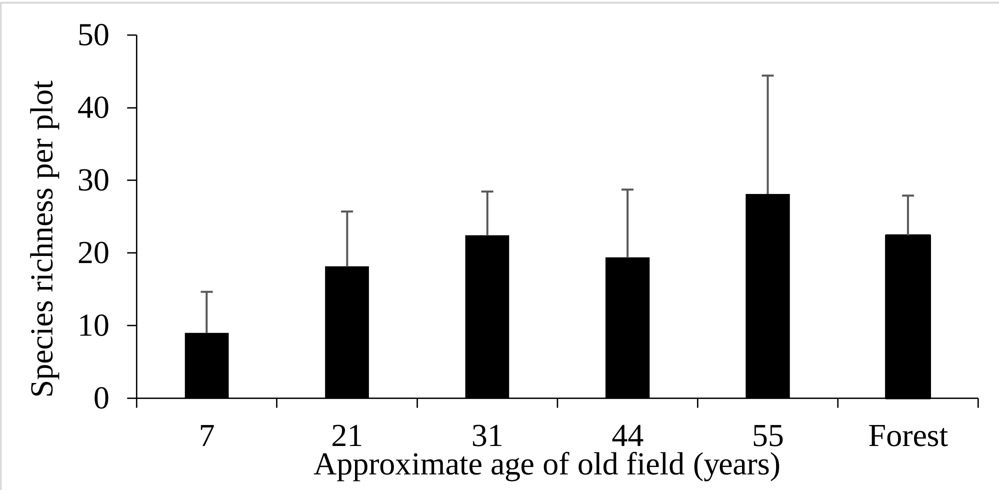


Figure 2.3: Change in plant species richness with the age of old field

Out of a total of 177 plant species, 75 (42%) were shrubs, such as *Coddia rudis* and *Searsia glauc*a, 72 (40%) were herbaceous including many perennials and annuals, only two were grasses and 30 (17%) species were trees such as *Brachylaena discolor* and *Cussonia spicata*. When species richness was disaggregated into growth forms, herbaceous plants were abundant in the early stages of succession whereas shrubs were limited (Figure 2.4). The number of shrubs was highest in the later stages. The richness of trees, though low, also increased with age of old field.

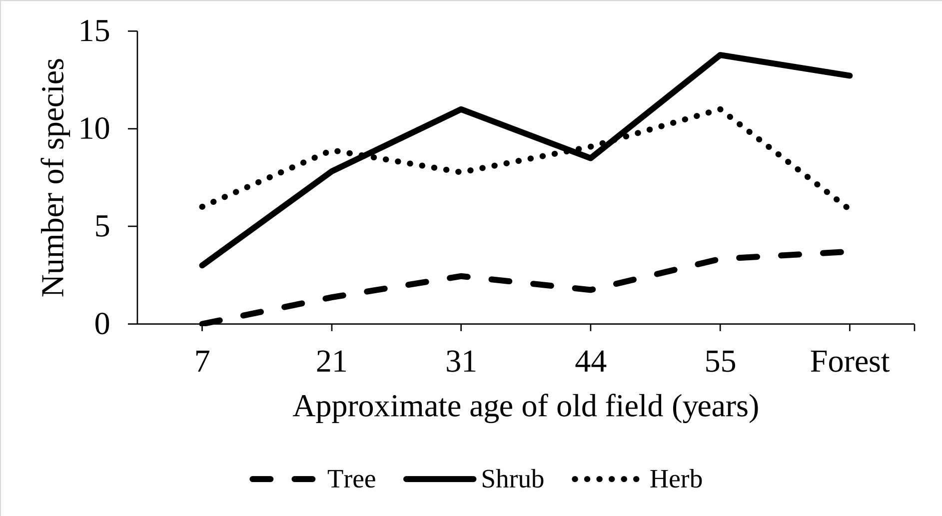


Figure 2.4: Change in species richness of different plant growth forms with the age of old field

2.4.3 Species composition per decade after abandonment

The SIMPER results in Table 2.3 show all the species found in the groups of fields of different ages and forest plots and how much they contribute to the groups. The groups were made up of plots of similar age. The results show *Vachellia karroo* as the species that contributed the most within the groups (from 1960 to 1990) when grouped by decade. However, in the 2000s and forest plots, the common species were *Hyparrhenia hirta* and *Dalbergia obovata*, respectively. The group of plots in the 2000s had the highest average similarity between group members based on the Bray-Curtis similarity measure of about 45%. Results from a SIMPER where plot type (old land/forest) was used as a factor, the top five species for old lands were *Vachellia karroo*, *Lantana camara*, *Centella asiatica*, *Hyparrhenia hirta* and *Diospyros lycioides* and the most dominant species in forests were *Dalbergia obovata*, *Monanthotaxis caffra*, *Buxus natalensis*, *Senegalia caffra* and *Canthium inerme.*

Table 2.3: Similarities measurement between plots of the same decade and how much species contribute to the groups

Common plant species	**1960s n =9**	**1970s n =12**	**1980s n =9**	**1990s n =11**	**2000s n =2**	**Forests n =7**
WOODY PLANTS (%)						

Vachellia karroo	15.2	22.1	20.7	23.5	-	-
Lantana camara	14.1	8.2	19.5	9.6	-	-
Diospyros lycioides	5.2	3.1	4.7	6.1	-	3.7
Lippia javanica	4.9	4.4	1.7	2.9	-	-
Coddia rudis	4.6	1.8	2.5	3.5	-	-
Maesa alnifolia	3.5	-	3.9	-	-	-
Zanthoxylum capense	3.3	-	2.9	2.0		1.5
Searsia glauca	2.4	1.5	6.8	-	-	-
Gymnosporia harveyana	1.7	1.3	-	-	-	-
Senecio pterophorus	0.9	-	1.8	-	-	-
Searsia crenata	0.9	-	-	-	-	3.1
Lippia sp.	0.7	-	-	-	-	-
Rubus rigidus	-	-	2.7	-	-	-
Dalbergia obovata	-	-	2.1	-	-	20.3
Monanthotaxis caffra	-	-	-	-	-	15.4
Buxus natalensis	-	-	-	-	-	13.1
Vachellia caffra	-	-	-	-	-	4.9
Canthium inerme	-	-	-	-	-	3.7
Trimeria grandifolia	-	-	-	-	-	3.6
Vepris lanceolata	-	-	-	-	-	3.5
Searsia chirindensis	-	-	-	-	-	2.3
Hyperacanthus amoenus	-	-	-	-	-	2.0
Millettia grandis	-	-	-	-	-	1.8
Dovyalis rhamnoides	-	-	-	-	-	1.5
NON-WOODY PLANTS (%)						
Centella asiatica	9.3	13.8	6.4	15.0	13.2	2.1
Hyparrhenia hirta	7.9	13.4	5.6	7.6	51.1	-
Fern	5.9	2.9	5.5	3.5	13.2	-
Taraxicum sp.	3.0	2.6	-	1.8	-	-
Dyschoriste setigera	1.8	-	-	-	-	-
Helichrysum anomalum	1.6	-	-	1.9	13.2	-
Gerbera ambigua	1.4	-	-	-	-	-

Merxmuellera disticha	1.0	-	-	-	-	-
Falkia repens	0.8	2.5	-	-	-	-
Athrixia phylicoides	0.8	-	-	-	-	-
Hibiscus trionum	-	4.4	-	3.8	-	-
Helichrysum odoratissimum	-	3.6	-	3.1	-	-
Cotula heterocarpa	-	2.8	1.7	3.2	-	-
Helichrysum cymosum	-	2.6		3.1	-	-
Cynoglossum hispidum	-	-	1.7	-	-	1.7
Rhoicissus sp.	-	-	-	-	-	3.1
Asplenium rutifolium	-	-	-	-	-	1.6
Asparagus sp.	-	-	-	-	-	1.5

An ANOSIM was used to test for differences in species composition between ages of old fields and forests. Forests were significantly different in species composition to all old lands at $p< 0.05$, but only ages 1970, 1980 ($p= 0.03$) and 1980, 2009 ($p= 0.02$) were significantly different to each other in the ages of old lands. Since age was not a good correlate within old fields, community analyses were performed to better analyse difference in community composition.

2.4.4 Community classification

The results of a hierarchical cluster analysis delineated all 50 plots into clusters of similar species composition. A SIMPROF test represents plots of similar composition at $p<0.05$ with a dotted line (Figure 2.5). This grouping separated six out of seven forest plots from old fields, which using a multi-dimensional scaling (MDS), were clearly separated by age at correlation. This was, however barring one forest plot which was grouped with old fields. The cluster classification further grouped the old lands into four significantly different communities (Figure 2.5). The clusters (communities) were also used as a factor in a SIMPER to show the different species contributing the most to each community. A BEST analysis highlighted the environmental or site variables that best explained the species composition in the community clusters.

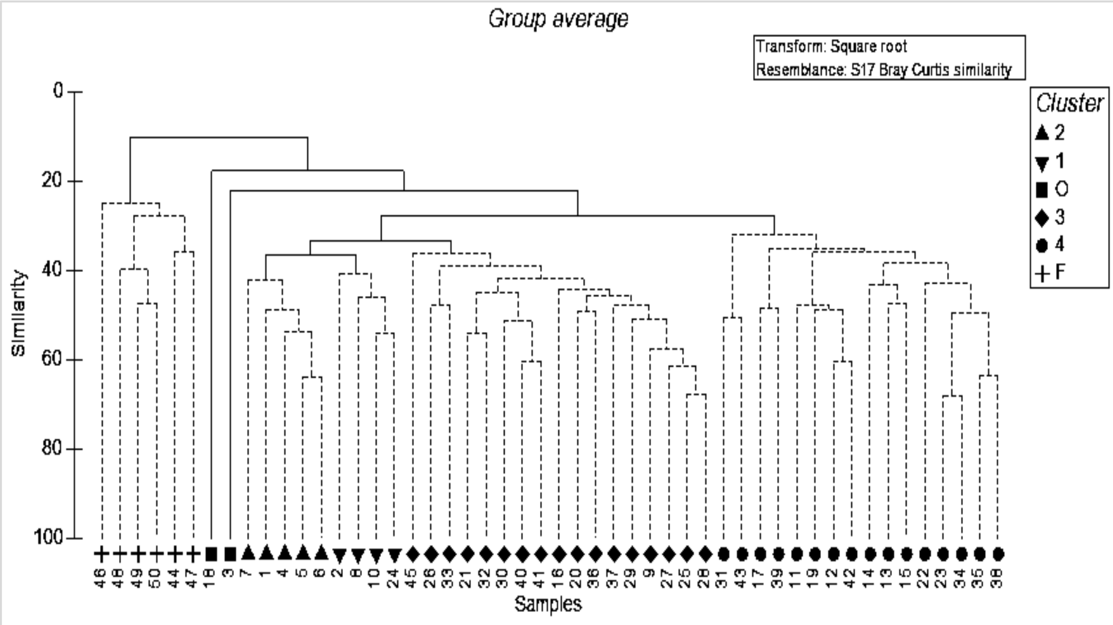


Figure 2.5: Communities as grouped by hierarchical cluster analysis (n=50)

2.4.5 Species composition in old field communities

Results from a SIMPER using clusters as a factor, showed the species that are dominant in the old field communities (Table 2.4). Table 2.4 represents the top five species that contributed the most to the average similarity percentage within the groups, how much they contribute and the similarity in species composition within the plots of the same group. Community 1 is characterised by herbaceous species and only a few shrub species. Community 2 had the highest average similarity between group members with a Bray-Curtis similarity measure of 48%. Although community 2 had a mixture of both shrubs and herbaceous species, shrubs dominated with the top five most contributing species to the group being shrubs. Communities 3 and 4 showed similar characteristics with communities 2 and 1, respectively. The most common shrubs in the old field communities were *Vachellia karroo, Lantana camara, Coddia rudis* and *Diospyros lycioides*. The most common herbaceous species were *Hyparrhenia hirta, Centella asiatica Helichrysum odoratissimum, Falkia repens* and *Hibiscus trionum*.

Table 2.4: Top five species that contributed the most to the average similarity percentage within the groups, how much they contribute and the similarity in species composition within the plots of the same group.

Community	Similarity (%)	Common plant species
Outliers (n=2)	10.8	*Vachellia karroo* (24.3%), *Centella asiatica* (24.3%), *Diospyros lycioides* (17.2%), *Helichrysum nudifolium* (17.16%), *Taraxicum* sp (17.2%)
1 (n=4)	44.6	*V. karroo* (26.1%), *Hyparrhenia hirta* (18.2%) *C. asiatica* (11.7%), *Helichrysum odoratissimum* (7.7%), *Falkia repens* (5.1%), *Taraxicum* sp, *Merxmuellera disticha*, *Helichrysum anomalum*, *Lantana Camara*, *Cotula heterocarpa*, *Gerbera ambigua*, *Spermacoce natalensis*
2 (n=5)	48.6	*V. karroo* (10.5%), *L. Camara* (9.5%), *Coddia rudis* (7.9%), *D. lycioides* (7.0%), *C. asiatica* (5.8%), *Senegalia caffra*, *Lippia javanica*, *H. odoratissimum*, *Searsia glauca*, *H. anomalum*, *Grewia occidentalis*, Fern, *Taraxicum* sp, *M. disticha*, *Dyschoriste setigera*, *Zanthoxylum capense*, *F. repens*, *Melhania didyma*, *H. nudifolium*, *Aristea* sp
3 (n=17)	43.0	*L. Camara* (23.4%), *V. karroo* (16.0%), *D. lycioides* (7.1%), *H. hirta* (6.5%), *C. rudis* (5.7%), *C. asiatica*, *Lippia javanica*, *S. glauca*, *Z. capense*, Fern, *Maesa alnifolia*, *Cynoglossum hispidum*, *Hibiscus trionum*, *Dalbergia obovata*, *Gymnosporia harveyana*, *Senecio pterophorus*, *Rubus rigidus*
4 (n=16)	37.4	*V. karroo* (20.2%), *Centella asiatica* (17.2%), *H. hirta* (16.2%), *H. trionum* (8.70%), *L. camara* (7.6%), *C. heterocarpa*, Fern, *Helichrysum cymosum*, *H. odoratissimum*, *D. lycioides*, *G. harveyana*, *L. javanica*, *Taraxicum* sp

2.4.6 Environmental and site correlates

The BEST analysis highlighted five factors at 0.59 correlation that influenced species composition in all the plots (Table 2.5), namely altitude, phosphorus (P), ammonium nitrate (NH_4O_3), fire and field age. Other variables that influenced species composition in all the plots but at a lower correlation (0.57) were calcium (Ca) and potassium (K). When the BEST analysis was performed on old fields only (without forest plots), the main correlates were altitude, fire, P, NH_4O_3 and K at a correlation level of 0.40. Other correlates that had an influence on species composition of old lands were Ca, age and pH at a 0.39 correlation. Fire was not a strong factor as it was just noted at the time of data collection if the site had obvious signs of recent fires. The majority of the variables influencing species composition with or without forests were soil components, leading to the conclusion that soil factors are what mostly influence the species composition.

Table 2.5: Mean ±SD of the environmental variables with the highest correlation level of 0.59 from the BEST analysis

Community	**Altitude (m)**	**Calcium (cmol/kg)**	**Phosphorous (mg/kg)**	**Ammonium nitrate (%)**	**Potassium (mg/kg)**	**pH (mol/l)**	**Field age (years)**
1	183± 50.5	3.1±0.7	12.8±4.1	0.2±0.4	142.8±84.5	5.5±0.2	38.3±11.5
2	284±8.9	5.6±2.6	11.0±6.8	0.3±0.1	359.0±126	5.7±0.3	36.6±17.3
3	120±64.4	3.1±1.4	23.2±9.4	0.2±0.1	199.4±77	5.0±0.4	39.4±23
4	138±80.1	3.1±1.6	18.1±6.7	0.3±0.1	176.9±98.1	5.3±0.4	36.3±16.2
Forest	188±167	11.7±14.6	33.8±12	0.6±0.2	252.5±159.4	5.2±0.6	166
Outliers	278±53.03	4.1±2.5	9±4.24	0.21±0.12	106±50.9	5.3±0.3	38±24

The soils of both old lands and forests were mildly acidic with an average pH of 5.3±0.3. Community 2 had the highest altitude as well as high calcium and potassium levels relative to all the other communities. These results also revealed that forests were richer in all soil nutrients when compared to old field communities. Communities 2 and 4 had the highest levels of ammonium nitrate among the old fields. An ANOSIM was performed on the variables altitude, field age, P, K, pH, NH_4O_3 and Ca against the communities to test the significant difference of all these factors between the communities at $p< 0.05$. The ANOSIM revealed a significant difference in altitude between community 2 and all the other communities. There was also a significant difference in age between forests and all the communities. Table 3.6 below summarises the communities that are significantly different in terms of the variables.

Table 2.6: Significantly different communities in respect to the BEST variables

Altitude	**Calcium**	**Phosphorous**	**pH**	**Ammonium nitrate**	**Potassium**	**Field age**
2&1 2&3 2&4 2&F 2&O O&3 O&4	2&3 2&4 3&F 4&F	1&F 2&F 4&F	2&3 2&F	1&F 3&F 4&F	2&1 2&3 2&4	F&1 F&2 F&3 F&4 F&O

*O-outliers *F-forests

2.5 DISCUSSION

2.5.1 Conversion of agricultural fields to forests on the Wild Coast, South Africa

Tracking the nature and rate of succession of the area through aerial photographs revealed a linear relationship where although woody cover had fluctuations, it increased with time since cessation of cultivation. These results were similar to that of Stickler and Shackleton (2015) where although inconsistent, there was a general increase of woody cover from 1956 to 1998 in commonages around Bathurst in the Eastern Cape, South Africa. In this study, field age is time since abandonment, and abandonment follows Bonet (2004) who stated that abandonment is termination of agricultural activities such as ploughing and sowing even though grazing may still occur on those fields. Woody cover was low at the youngest stages and started to rise significantly at approximately 21 years after abandonment. This pattern is similar to that of El-Sheikh (2005) whereby woody species become dominant after 25 years of abandonment in Egypt. Succession appeared as an accumulation of woody cover with time. This was similar to Bonet (2004) who reported an increase in species richness of woody species with age from early to late old fields.

The significant relationship between woody cover and old field age shows an increase in forest growing on land previously used as fields, with time. This is supported by Chalmers and Fabricius (2007) and Shackleton *et al.* (2013) who both reported an increase in forests in the area over the past few decades. Chalmers and Fabricius (2007) reported a significant increase of forests between 1974 and 2001 in Nqabara, Willowvale on South Africa’s Wild Coast. This is a result of woody plants colonising land previously used for cropping resulting in transformation of old fields to forests. This is corroborated by Shackleton *et al.* (2013) who reported an absolute 5.4% increase in abandoned fields between 1961 and 2009. Also, Shackleton *et al.* (2013) reported forests and woodlands have increased by 5% and 14.9%, respectively, in Willowvale, South Africa, over the past 50 years.

This increase in woody vegetation on old fields can be attributed to the cessation of agricultural cultivation. Many households on the Wild Coast are abandoning farming on agricultural fields away from their homesteads leading to an abundance of abandoned fields. Various studies who reported high levels of deagrarianisation in the Eastern Cape cited rural-urban migration as the one of the causes (Bank & Minkley, 2005; Hebinck & Van Averbeke, 2007; Porter & Phillips-Howard, 1997). According to Shackleton *et al.* (2013) the people of Willowvale ascribed lack of cattle for ploughing as one of the major causes for ceasing farming. They also listed livestock raiding the crops and that farming is not worth the effort. Other drivers, mentioned by local respondents, of revegetation on the Wild Coast included increased rain, decline in use of forested area, change in land use practises, increase in alien species which are not used much as local people prefer indigenous species (Chalmers & Fabricius, 2007; Shackleton *et al.*, 2013).

2.5.2 Species richness and growth form sequence

Plant species richness on old fields increased with age of old fields in the same way as stated by Inouye *et al.* (1987) and Zhang (2005), whereby species richness increased significantly with successional development. However, there was one group of older fields (abandoned approximately 44 years ago) expected to have more species than the younger decade before them (abandoned 31 years ago), in order to follow this pattern but which had a lower species richness. Also, the decade after (which is fields abandoned 55 years ago) had higher species richness suggesting species richness was increasing with age but there were occasional disturbances that resulted in that one particular decade disrupting the overall trend. This could be attributed to the site variables that might have caused a lower species richness during field assessment and the data collected showed that majority of these fields had signs of recent, heavy disturbances by fire. Alternatively, species richness may not have a linear relationship with abandonment age (Bonet, 2004) meaning although it is increasing, there are some variations due to disturbances or episodic recruitment of some species.

In contrast, this pattern was contrary to some studies that suggest species richness increases rapidly in the first few years of succession then either decreases with time or stabilises (El-Sheik, 2005; Sarminento *et al*., 2003). The plant species richness took three decades to be comparable to that of primary forests. According to Guariguata and Ostertag (2001) this is because woody plant richness increases rapidly in the early stages of secondary succession leading to a secondary forests quickly reaching values similar to that of primary forests.

The species richness revealed a life form succession pathway where herbaceous plants were dominant in the younger old fields but shrub species abundance rose steadily with age of old fields and became dominant in the older fields. This is mirrored by Sarmiento *et al*. (2003) where a predictable sequence of life forms is observed, whereby herbaceous species are dominant in the early stages and progressively replaced by shrubs. Examples of the herbaceous plants dominating the early stages include *Centella asiatica*, *Hyparrhenia hirta* and *Helichrysum anomalum* while the woody species (both trees and shrubs) dominating the older stages include *Lippia javanica*, and *Zanthoxylum capense*.

2.5.3 Composition of plant species in fields of different ages

Although species richness of secondary succession may be quick to mirror that of primary forests, community composition takes longer. According to Guariguata and Ostertag (2001) this depends on the intensity of past land use and environmental conditions. The species composition on old fields was very distinct when compared to that of forests. When examining the dominant species between old fields and primary forest, there were some common species, including: *Dalbergia obovata*, *Searsia crenata*, *Zanthoxylum capense*, *Diospyros lycioides*, *Centella asiatica* and *Cynoglossum hispidum*. This shows that even though it might take some time, the secondary forests growing on abandoned land are likely to return to species composition similar to that of primary forests. *Hyparrhenia hirta* (a grass) appeared to be the pioneer species at the youngest fields (the first decade after abandonment) and then replaced by *Vachellia karroo* the decade after and for the rest of the successional development. Age did not produce a clear pathway among old fields, although it separated old fields from forest sites. Because age was not a strong factor to determine species composition in old fields, species composition in the different communities was assessed and is discussed below.

2.5.4 Community structure and species composition in revegetating old fields

The vegetation on old fields was grouped into distinct communities separated by mainly by soil properties and altitude. The difference between communities was whether non-woody or woody species dominated. The communities dominated by herbaceous plants were comprised of perennial herbs and the communities dominated by woody species were comprised of shrub species. The communities comprised of herbaceous plants are similar to the early stages (0-2 years after abandonment) described by El-Sheik (2005) for succession on abandoned fields after shifting cultivation in Egypt. While the communities where shrubs are dominating are similar to the scrubland stages (20-30 years after abandonment) of succession described by Zhang (2005) for succession in abandoned croplands in China. These communities revealed a succession pathway where perennial herbaceous plants are progressively replaced by shrub species. This closely coincides with Sarmiento *et al*. (2003) on the vegetation patterns of the high tropical Andes and El-Sheik (2005) on old field succession after shifting cultivation in Egypt.. Altitude was the one of the main factors that influenced species number and composition in this study. Aide *et al*. (1996) had similar results where altitude had a strong effect on the species composition in Luquillo, Puerto Rico. According Gibson and Hulbert (1987) plant communities found in soils that were located at a high altitude, like community 2 in this study, support high species richness as compared to plant communities found in soils that are located at low altitudes.

2.6 CONCLUSION

Deagrarianisation is a key cause of revegetation and formation of forest on abandoned lands. Some studies in the area suggest diversification of livelihoods and people stopping field farming and transitionning to home gardens (Chalmers & Fabricius, 2007; Shackleton & Luckert, 2015). Forest succession on old fields on the Transkei Wild Coast appears to be positively corrrelated within increases in plant species richnes. Although, there are some alien plants, the majority of the species are idengenous species. Age of old fields, although not a strong factor, has a positive relationship with vegetation attributes such as woody cover and species richnness. This study has shown the importance of understanding the interconnectedness of land use changes, livelihoods and changing landscapes. There is a definite need for more studies on succession in South Africa and Africa as a whole as most studies on plant succession are from the northern hemisphere.

CHAPTER 3

USE OF NTFPs THAT COME WITH THE SUCCESSION ON ABANDONED AGRICULTURAL FIELDS IN WILLOWVALE

3.1 INTRODUCTION

Many rural households depend on natural resources for a range of basic living requirements (Angelsen *et al*., 2014; Mmopelwa *et al*., 2009; Shackleton *et al*., 2001). Among these are non-timber forest products, which typically play a number of crucial roles in rural household subsistence and economies (Delang, 2006; Shackleton, 2015). Non-timber forest products can be defined as biological materials (excluding industrial timber) harvested from natural ecosystems for a range of benefits, including household subsistence, income generation, and social, cultural and religious values (Wickens, 1991 in Neumann & Hirsch, 2000). These include resources such as honey, wild food plants, fuelwood, raw materials for craft, herbal medicines, grasses and the like (Delang, 2006).

The value ladder presented by Shackleton (2015) indicates that the primary and usually most important role of NTFPs is for household subsistence (Shackleton *et al.*, 2007a; Angelsen *et al*., 2014). The second one being for cash saving, whereby NTFPs are usually free goods which mean that poor households can save their scarce cash resources for other livelihood needs through the use of NTFPs (Shackleton *et al.*, 2007a). The third rung of the value ladder deals with NTFPs providing opportunities for cash generation through their harvest and sale on local or larger scale markets (Belcher & Schreckenberg, 2007; Weyer *et al*., 2018). The next rung presents the importance of NTFPs as safety-nets during periods of shock and misfortune, providing households with free consumptive goods or a means to earn an income through NTFP trade as they attempt to weather the shock (Weyer et al. 2018; Wunder et al., 2014). The next, little explored tier, relates to the ecological role of NTFPs in community ecology whereby some support or provide services to other species and processes important to rural livelihoods (Shackleton 2015). Last is the importance of some NTFPs in local cultures, traditions and worldviews (Dold & Cocks, 2002; Kim *et al*., 2012), a role which is almost impossible to value in financial terms.

Being a very biodiverse and multi-ethnic country, studies in South Africa show that across the country thousands of plant species are used as NTFPs and hundreds by individual communities. There is a rich literature reporting on the subsistence values (Baiyegunhi & Oppong, 2016; Cocks & Dold, 2004; Mugido & Shackleton in press; Shackleton & Shackleton, 2004; Twine et al., 2003), indicating that NTFPs contribute from just a few percent of annual household income or over 20 %. There is also extensive work on trade in

NTFPs on local and export markets (Shackleton *et al*., 2008; Venter *et al*., 2013; Wynberg & van Niekerk, 2014). The recent national survey by Mugido & Shackleton (2017a) found that 6.4 % of rural households trade in at least one NTFP. The work on NTFPs as safety-nets is extensive in South Africa (Mugido & Shackleton, 2017b; Paumgarten, 2005; Paumgarten & Shackleton, 2011; Weyer *et al*., 2018) and shows that use of NTFPs is an important and widespread coping response to misfortune, especially for the rural poor, but not limited to them. And the extensive work on the use and sale of traditional medicines, even amongst educated and urban populations, demonstrates the significant cultural values that many people place on them (Botha *et al.*, 2004; Dold & Cocks, 2002), as well as other NTFPs such as traditional brushes (Cocks & Dold, 2004) or specific species necessary for certain ceremonies (Cocks & Wiersum, 2003).

Although there is widespread knowledge and appreciation of these different roles and values of NTFPs in rural livelihoods, and some urban livelihoods, in South Africa and internationally, Mugido and Shackleton (in press) argued that there is little work on how local context influences the nature and extent of NTFP use. For example, it is probable that more biodiverse locations may result in a wider diversity of species used as NTFPs than in less biodiverse environments (Dovie, 2007; Salick *et al*., 1999). Another example might be that more productive environments (such as wetlands (Gosling *et al*., 2017; Mmopelwa *et al*., 2009)), will provide greater quantities of NTFPs for human use than less productive environments (Mugido & Shackleton, in press). Degraded landscapes might provide lower species richness and even quantities, but potentially higher monetary values because of induced scarcity of some NTFPs in such landscapes. These examples compare on setting to another, therefore, a spatial contrast. However, NTFP supply, diversity, uses and values may also vary in a specific place over time, in other words, a temporal contrast.

Most work on temporal changes in NTFP supply have been framed around the consequences of a real or potential decline in NTFPs, typically through one or a combination of land transformation, overuse, human population growth or adverse effects of fire or invasive alien species. For example, Jimoh et al. (2013) examined the relative population status of five NTFPs species in lowland forests in Nigeria, displaying the impacts of timber logging and habitat degradation on the population structure and density of the species. Whereas, Krishnamurthy *et al*. (2013) found that it was the actions of the harvesters that threatened cycad populations in the Western Ghats of southwest India. In contrast, there are relatively few studies that have considered how changes in land use practices have the potential to increase the supply of some NTFP species, or that the diversity and composition of NTFPs will vary with time. In the context of my study, this relates to the potential changes in NTFP diversity and abundance in relation to forest succession after the cessation of cultivation of subsistence fields. As described in the previous chapter, such abandoned fields undergo a range of changes with duration since abandonment, including in plant species life forms, richness and composition. Many previous studies have also documented changes associated with plant successional transitions (see Chapter 1). However, none has examined how the successional changes influence the supply and use of a diversity of NTFPs by rural communities. Consequently, this chapter reports on a study to determine what plant species are used as NTFPs by the communities at Willowvale, and does the type of NTFPs available change with forest succession.

3.2 METHODS

To carry out the work needed to meet this objective, focus group discussions with the local people were held. Focus groups are a type of group interview that exploit communication and generate data from discussion taking place between research participants (Kitzinger, 1995). Focus groups are able to capture the feelings that interviews fail to capture. Also, they provide powerful insights, comfortable environments for participants to thoughtfully answer, discuss and learn, as well as collect people's attitudes and opinions regarding a certain subject. Importantly, they are also much more flexible than questionnaires because experienced facilitators can guide the discussion to follow up on interesting leads and to dig deeper around areas of specific interests or sentiments not previously considered.

Seven focus groups with a minimum of six and a maximum of 10 people were held. Each focus group was carried out in a location near to every group of fields that had been ecologically assessed (see Chapter 3). The headman from different regions of Willowvale were key personnel in bringing the group participants together. Emphasis was placed on encouraging a diversity of participants across age, gender and livelihood experiences within each focus group. The focus groups were held at either a church hall or a headman's house, whichever had electricity and was easiest to access. Each was conducted in the local language, *isiXhosa*, and generally lasted two to three hours. Refreshments were served.

At the start of the focus group, after introductions, the purpose of the research was explained, and participants were afforded opportunities to ask questions of the researcher as a means of promoting their understanding of the project. It was also emphasised that all opinions were valid, that there were no wrong or right answers, and that rather it was a learning process through knowledge sharing within the group. Participants were also reassured that their comments and contributions would not be recorded by name.

Thereafter, pictures of all the plant species recorded during the ecological assessment (Chapter 3) were used for the focus group slideshow and were projected into a wall (Figure 3.1). A laptop and a projector was used to present a slideshow of the pictures (Figure 3.2), which would then kick start a conversation of what the plant was, its local name, if it had any uses, and if so, what it was used for (Table 3.1).

Figure 3.1: An example of the pictures used for the slide show in the focus groups

Figure 3.2: Community members looking at the slide show during the focus groups

After plant identification, there would be a discussion around the use and how important it is in everyday life or cultural importance and after consensus, they would give it an importance rating (Table 3.2). The focus groups were held in a discussion manner because sometimes, one plant meant different things to different people.

Table 3.1: Information recorded during the focus groups

Local name	**Use**	**Use type**	**Scientific name**
Mlungu mabele	Toothache	medicinal	*Zanthoxylon capense*

Table 3.2: Rating scale used to grade importance of each species to the local people

1	**2**	**3**	**4**	**5**
Not important at all	Slightly important	Somewhat important	Very important	Extremely important

3.3 RESULTS

A total of 177 species were recorded from 50 plots that were sampled during the ecological data collection. Of these, 70 species (39.6%) were identified by the focus group participants as non-timber forest products (NTFPs). The participants grouped the NTFPs into six categories namely: food, building, medicinal, craft, cultural and energy. The group with the greatest number of species was for building purposes (timber for houses, fencing, building kraals and fibre for roofing) as well as medicinal plants, followed by species that have traditional or cultural significance and species that serve as food for the local people (Figure 3.3). The smallest group was for crafting such as making walking sticks and brooms and those used as firewood. The useful species were mainly shrub species except medicinal and craft species where herbaceous and tree species dominated, respectively (Figure 3.3). This suggested that the later stages of succession provided more NTFPs than the early stages.

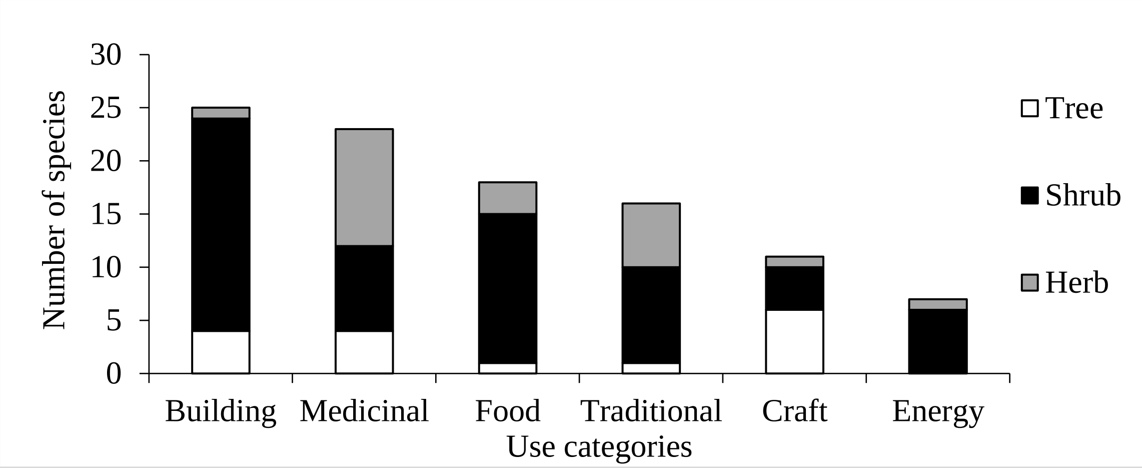


Figure 3.3: The number of NTFP species in each use category (n=70 species)

3.3.1 Species with multiple uses

Out of the 177 species recorded in the plots in the abandoned fields, 70 had at least one use to the local people and 107 had no use. Of the 70 species, 64% had one use, 31% had two uses and 4% had three uses. The species that had three uses were *Ptaeroxylon obliquum*, *Diospyros lycioides* and *Vachellia karroo*. *Ptaeroxylon obliquum* was used for building, firewood and traditional ceremonies. *Diospyros lycioides* was used for building, as firewood when dry and its fruits were sometimes eaten, especially by children. *Vachellia karroo* was used for firewood, human and livestock medicine and the sap was food to some people (especially children and herders).

3.3.2 Non-timber forest products as forest succession progresses

The number of NTFP species increased marginally with the age of the abandoned field (Table 3.3). The oldest fields, which were approximately 55 years, had an average of 17 NTFP species in the 200 m^2 sample plot, while the youngest fields with an approximate age of seven years had an average of seven NTFP species per plot. However, non-NTFP species also increased with age of the old field, and at a rate higher than that of the NTFP species. Consequently, the proportion of NTFPs within the species assemblage, decreased with increasing old field age. In the youngest fields (approximately 7 years old) 84% of all the plant species recorded were NTFPs. In contrast, in the oldest fields, with an approximate age of 55, only 63% of the plant species recorded were identified as NTFPs by the group discussion participants, which was a relatively similar to the proportion recorded in the primary forests.

Table 3.3: Non-timber forest products with age of field in comparison to total species

Age of old field	Average no. of species	Average no. of NTFPs	% of NTFPs
7	9.0	7.0	84.6
21	18.2	14.0	80.0
31	22.4	16.4	78.1
44	19.4	14.5	78.0
55	28.1	17.8	68.3
Forest	22.4	15.6	71.1

Although the later stages of succession sites more NTFPs than the early stages, this was not the case for all NTFP use categories. People used different amounts and kinds of NTFPs from different stages of succession. For example, most herbaceous species identified as NTFPs were listed in the medicinal category. Consequently, the early successional stages had more medicinal species than the later ones, as the abundance and diversity of herbaceous species declined with increasing woody plant cover. Species used for building and food (especially fruits) peaked when fields become dominated by woody plants. Building species were more abundant in the shrub or young stages of the succession. NTFPs used for craft were most abundant in the mature stage. This is because people mostly crafted walking and fighting sticks which requires woody plants.

3.3.3 Non-timber forest products used for building purposes

The species mentioned for building purposes were important to the local people because they used them for fencing their yards, gardens and kraals (livestock enclosures) as well as roofing and building mud and stick houses (Table 3.4). They used branches, leaves and wood to fence home gardens. The participants mentioned that thorny trees were especially suited for fencing gardens as a means of trying to prevent livestock from raiding their vegetables and crops.

Another important role these plants played was roofing, especially for mud huts. Almost every household in the area had a traditional hut which is usually used as a kitchen, with the roofs made of poles from trees collected in the wild as well as thatching grass. Sometimes, even the body of the hut was made from sticks with mud packed in between. All the NTFPs used for building were made up of woody species except for *Hyparrhenia hirta*, commonly known as thatching grass, which was used for the roofs of mud huts.

Table 3.4: Non-timber forest products used for building purposes (listed from high to low importance)

Scientific name	**Local name**	**Use**	**Scale of importance**	**Life form**
Apodytes dimidiata	Mdakane	Poles, kraal	5	Tree/Shrub
Anastrabe integerrima	Umnquma swili	Kraal and fire place building, poles used for fencing	5	Shrub
Brachylaena discolor	Isiduli	Yard fencing, poles	5	Tree
Cestrum laevigatum	Uminki	building, garden fencing	5	Shrub
Coddia rudis	Intsinde	Fencing, kraal and firewood place	5	Shrub
Diospyros lycioides	Umbhongisa	Fencing, kraal	5	Shrub
Grewia occidentalis	Umnqabaza	Roofing, kraal, yard	5	Shrub
Hyparrhenia hirta	Umthala/ Umqungu	Thatch grass for houses/roofing	5	Herb
Millettia grandis	Umsimbithi	Poles	5	Tree
Ptaeroxylon obliquum	Umthathi	Building	5	Tree
Scutia myrtina	Isiphingo	Garden fencing, hedge	5	Shrub
Senegalia caffra	Ubobo	Yard fencing	4	Tree
Buxus natalensis	Isixweza	Branches for kraal fencing	4	Tree/shrub
Canthium inerme	Ubuchopho bekati	Fencing	4	Tree
Clerodendrum glabrum	Qangazani	Kraal fencing	4	Tree
Duvernoia adhatodoides	Uhlwehlwe	Kraal and garden fencing	4	Shrub
Ekebergia capensis	Umgwenye	Poles	4	Tree
Hyperacanthus amoenus	Uthongothi	Garden and yard fencing	4	Tree
Vepris lanceolata	Umzane	Poles	4	Tree
Dovyalis rhamnoides	Umqaqoba	Garden fencing	3	Shrub

Chaetachme aristata	Uthongothi 2	Garden and yard fencing	3	Shrub
Searsia chirendensis	Intlolokashane 3	Garden fencing, hedge	3	Tree
Searsia crenata	Intlolokashane 2	Yard fencing	3	Shrub
Searsia glauca	Intlolokashane 1	Yard fencing	3	Shrub
Putterlickia pyracantha	Umhlangwe	Garden fencing	2	Shrub

3.3.4 Non-timber forest products used for medicinal purposes

Twenty-three species were identified as medicinally useful, which included treating both human and livestock illnesses. People used these medicinal plants for various ailments from skin and gynaecological to gastric and cold related conditions (Table 3.5). Medicinal plants that treated skin related illnesses included *Mystroxylon aethiopicum* used to for whitening the skin; *Hibiscus trionum* used for treating wounds; *Spermacoce natalensis* used for pimples and *Acokanthera oblongifolia* used for treating a snakebite. Medicinal plants listed for treating gynaecological problems were *Laportea peduncularis* and *Bersama swinnyi*. Among the medicinal plants listed for treating gastric related illnesses were *Lippia javanica*, used for stomach pains, taken before meals to protect against poison and as a worm medicine for children and *Senecio deltoideus,* which was used for bile and as a vomit inducer. Among cold related illnesses was asthma which can be treated by *Helichrysum* species and fever which can be treated by several species including *Plectranthus ciliatus*, *Leonotis leonurus* and *Stachys aethiopica*, to mention a few. Among the above-mentioned uses, local people mostly used medicinal plants for fever and stomach related illnesses.

Table 3.5: Non-timber forest products used as medicine (listed from high to low importance)

Scientific name	**Local name**	**Use**	**Rating**	**Life form**
Vachellia karroo	Umnga	Stop diarrhoea, branches can be used as a splint for fractured limbs in cattle	5	Shrub/tree
Acokanthera oblongifolia	Intlungu-nyembe/buhlungu benyoka	Medicine for snake bite/wound	5	Shrub
Bersama swinnyi	Isindiyandiya	Medicine for gynaecological problems	5	Shrub
Cussonia spicata	Umsenge	Indigestion medicine	5	Tree
Fern	Ubuhlungu benyoka	Decoration plant, snake bite ointment, traditional	5	Herb

		herbalist use it for vomiting		
Helichrysum anomalum	Impepho 1	Vomit inducer, steaming medicine, acts as incense, mosquitos, asthma medicine	5	Herb
Helichrysum cymosum	Impepho 3	Vomit inducer, steaming medicine, acts as incense, mosquitos, asthma medicine, hatching nest for chicken	5	Herb
Helichrysum nudifolium	Isicwe	Initiation for men medicine	5	Herb
Helichrysum odoratissimum	Impepho 2	Vomit inducer, steaming medicine, acts as incense, mosquitos, asthma medicine, hatching nest for chicken	5	Herb
Hibiscus trionum	Umguzane	Wound medicine for people and livestock, pimples	5	Herb
Hippobromus pauciflorus	Ulwathile	Cow medicine, remedy to stop dogs from vomiting	5	Shrub
Laportea peduncularis	Inkunzi yezembe/mbabazane	Drop medicine	5	Herb
Lippia javanica	Isihlungu	Goat medicine, stomach medicine, eat before meal to protect against poison, worm medicine for children, pain medicine	5	Shrub
Mystroxylon aethiopicum	Unome/mbomvane/ umnqayi	Whitening skin, puts down goats, medicine for flue and stomach ache	5	Tree
Plectranthus ciliatus	Rhalajojo	Excretion inducer, fever medicine for children, gargling medicine for sore throat	5	Herb
Senecio deltoideus	Skhupha nyongo/ undenze	Vomit inducer, Bile medicine	5	Herb
Stachys aethiopica	Isihawuhawu	Flu medicine	5	Herb
Stangeria eriopus	Imfingwane	Antiemetic	5	Shrub
Zanthoxylum capense	Mlungu mabele	Antiemetic and toothache medicine	5	Tree
Combretum caffrum	Umdubi	Prevent dogs from eating eggs, treats dog	4	Tree

		sicknesses		
Gerbera ambigua	Saphephe	Cough mixture	4	Herb
Leonotis leonurus	Fincafincane	Fever medicine	4	Shrub
Spermacoce natalensis	Nomaqhinana	Pimple medicine	4	Herb

3.3.5 Non-timber forest products that serve as food

Eighteen species were listed has being eaten, either fruits or wild vegetables. Fifteen were trees and three were herbaceous plants (Table 3.6). Fruits were the main edible products collected from the wild. Other edible products that people reported to collect from the wild were wild herbs and vegetables (locally known as *imifino*) and sap. There were three species that used as herbs and vegetables namely: *Rhoicissus tomentosa*, *Centella asiatica* and *Lantana camara*. The rating increased for edible species that have more than one use. For example, even though some plants had edible fruit, they also had another use such as for making bread or using the leaves as a wild vegetable.

Table 3.6: Non-timber forest products that serve as food (listed from high to low importance)

Scientific name	**Local name**	**Use**	**Rating**	**Life form**
Vachellia karroo	Umnga	The sap is food to some people	5	Shrub/tree
Centella asiatica	Nongotyozana	Imifino, chewing	5	Herb
Diospyros lycioides	Umbhongisa	Fruit	5	Shrub
Grewia occidentalis	Umnqabaza	Fruit	5	Shrub
Lantana camara	Utywala bentaka	Imifino/Vegetable, fruit	5	Shrub
Psidium guajava	Gwava	Fruit	5	Shrub
Phoenix reclinata	Usundu	Fruit, used to make bread	5	Tree
Rhoicissus tomentosa	Saqoni	Fruit, imifino/vegetable, chewing	5	Creeper
Rubus rigidus	Amaqunube	Fruit, dessert	5	Creeper
Scutia myrtina	Isiphingo	Fruit	5	Shrub
Agelanthus kraussianus	Umthi wenyosi	Bee trap	4	Shrub
Ekebergia capensis	Umgwenye	Fruits	4	Tree
Gerbera ambigua	Saphephe	Has a milky sap that some people eat	4	Herb
Dovyalis rhamnoides	Umqaqoba	Fruit	3	Shrub

Searsia chirendensis	Intlolokashane 3	Fruit	3	Tree
Searsia crenata	Intlolokashane 2	Fruit	3	Shrub
Searsia glauca	Intlolokashane 1	Fruit	3	Shrub
Rhoicissus sp.	Mnxeba we Saqoni	Fruit	2	Herb

3.3.6 Non-timber forest products used for traditional purposes

There were 15 species recorded to have traditional uses or significance (Table 3.7). Uses varied from using the plant during a traditional ceremony to calling upon the ancestors and protection from witchcraft. Using a five-point Likert scale with one being not important at all and five being extremely important, the majority of the species in this category were rated as extremely important. The species rated as not important at all were species that have uses regarded as bad/ dark magic. The lowest ranked species were *Solanum aculeastrum* used for destroying houses and *Pelargonium* sp. which was believed to cause laziness.

Table 3.7: Non-timber forest products used for traditional purposes (listed from high to low importance)

Scientific name	Local name	Use	Rating	Life form
Acokanthera oblongifolia	Intlungu-nyembe/buhlungu benyoka	Hung up during thunderstorms	5	Shrub
Asparagus sp.	Ntsaka-ntsakane	Love and business potion	5	Herb
Carissa haematocarpa	Isibetha nkunzi	Ancestor apeasing during traditional ceremonies	5	Shrub
Helichrysum anomalum	Impepho 1	Spiritual burning for calling the ancestors	5	Herb
Helichrysum cymosum	Impepho 3	Spiritual burning for calling the ancestors	5	Herb
Helichrysum odoratissimum	Impepho 2	Spiritual burning for calling the ancestors	5	Herb
Helinus integrifolius	Ubulawu	Traditional doctors herb for dream interpretation	5	Herb
Hypoxis hemerocallidea	Inongwe	Bad luck medicine	5	Herb
Monanthotaxis caffra	Udwabe	Plate/tray for meat after a slaughter	5	Shrub
Ptaeroxylon obliquum	Umthathi	Used during traditional ceremonies	5	Tree
Solanum mauritianum	Ikhakhakhakha	Protects the home and its valuables during thunderstorms.	5	Shrub
Combretum caffrum	Umdubi	Causes thieves to vomit what they stole	4	Tree

Maesa alnifolia	Cawuza	Protection from lightning	4	Shrub
Tarchonanthus camphoratus	Mhlangwe	After funeral flower, put on graves/casket	4	Shrub
Pelargonium sp.	Jika nelanga	Lazyness causing plant	1	Herb
Solanum aculeastrum	Umthuma	Witchcraft potion, causes houses to collapse	1	Shrub

3.3.7 Non-timber forest products used for craft

There were several products that participants said were made from NTFPs, from walking sticks, fighting sticks and brooms to baskets and tools. These products were usually sold to neighbours, used during traditional ceremonies and celebrations as well as donated as gifts during celebration ceremonies. The species used for craft were mainly woody species, with only one out of 10 species was a non-woody species (Table 3.8). *Merxmuellera disticha* was a grass that the local people used to make brooms. The majority of the species used to craft were rated as extremely important (5), except for two species which were rated very important. The two species with a lower ranking were *Celtis africana* and *Vepris lanceolata* which were used for making fighting sticks and walking sticks, respectively. These species ranked lower than the others because they were not the only species that could be used to make fighting and walking sticks.

Table 3.8: Non-timber forest products used for craft (listed from high to low importance)

Scientific name	**Local name**	**Use**	**Rating**	**Life form**
Apodytes dimidiata	Mdakane	Sticks	5	Tree
Brachylaena discolour	Isiduli	Walking sticks	5	Tree
Dalbergia obovate	Uzungu	Baskets and ropes	5	Shrub
Merxmuellera disticha	Isilevu	Used to make brooms	5	Herb
Millettia grandis	Umsimbithi	Walking stick, church stick	5	Tree
Monanthotaxis caffra	Udwabe	Plate/tray for meat after a slaughter	5	Tree
Mystroxylon aethiopicum	Umnqayi	Craft for spoons and walking sticks	5	Tree/shrub
Phoenix reclinata	Usundu	Brooms	5	Tree
Zanthoxylum capense	Mlungu mabele	Tools	5	Tree
Celtis africana	Umvumvu	Fighting stick	4	Tree
Vepris lanceolata	Umzane	walking stick	4	Tree

3.3.8 Non-timber forest products with energy uses

Not many species were listed for fuelwood purposes. This was explained as being a result of people nowadays using electricity for cooking, along with paraffin or gas. Firewood was used mainly during traditional ceremonies because there was a lot of cooking to do. Firewood was also used to save electricity and as a fall back when people run out of electricity. Additionally, several respondents noted that cutting of fuelwood is not encouraged because it damages plants that have other uses, such as for medicines or for building. There were seven species recorded as firewood of which six were woody species and one was a herbaceous plant (Table 3.9). All the woody species were rated as extremely important and the herbaceous plant (*Senecio inaequidens*) rated somewhat important as it was used as kindling to start a fire, rather than for actually cooking on it.

Table 3.9: Non-timber forest products with energy uses (listed from high to low importance)

Scientific name	**Local name**	**Use**	**Rating**	**Life form**
Vachellia karroo	Umnga	Firewood	5	Shrub/tree
Anastrabe integerrima	Umnquma swili	Firewood when dry	5	Shrub
Cestrum laevigatum	Uminki	Firewood	5	Shrub/tree
Dalbergia obovata	Uzungu	Firewood	5	Shrub
Diospyros lycioides	Umbhongisa	Firewood when dry	5	Shrub
Ptaeroxylon obliquum	Umthathi	Firewood	5	Tree
Senecio inaequidens	Inkanga	Firewood	3	Herb

<u>3.4 DISCUSSION</u>

This study has corroborated several others from the region and South Africa showing that rural communities know and use a wide diversity of plant species for a range of household and cultural needs. Seventy species were identified by the focus group participants as having one or more uses to local people. At the plot scale, between 68% and 85% of the species found in a 200 m^2 sample plot were documented as NTFPs. This proportion declined with increasing species richness of a plot. Comparisons to other literature are not easy because most studies on how many NTFP species are used do it via free-listing whilst my study used only those species found within the sample plots, which were old fields. Sites that would never have been cultivated (such as on steep slopes, rocky areas, shallow soils, distant from the homestead, temporarily inundated areas, etc.) therefore were not part of this survey, and consequently the total number of species, and the number of NTFPs will be a lot lower than what may have been found via free-listing of all landscapes. Even the exclusion of active fields resulted in lower counts of useful species, especially for wild, edible leafy vegetables (*imifino*). Most imifino species in South Africa are 'weeds' in disturbed sites, and consequently many species thrive in active fields and are harvested from there for home consumption. Thus, there are many more imifino species in the Willowvale area (Bvenura & Afolayan, 2014; Ncube *et al.*, 2016) that were not revealed during my study which focussed on old fields. Nonetheless, considering all the use types, the percentage values are not very dissimilar from the observation by Geldenhuys (1999) that approximately 77% of sub-canopy forest tree and shrub species and 94% of forest tree species have some traditional or commercial use. Dovie (2007) examined patterns of useful and non-useful woody species around ten rural South African villages in the savanna and thicket biomes and reported that amongst the full inventory list of 191 woody species, that 71% had one or more uses; at the individual plot scale (1 000 m^2) it varied between 80% and 100% of species recorded were NTFPs.

A core finding was the pattern of change in the relative prevalence of NTFPs with forest succession. Generally, the total species richness per plot increased with forest succession, as did the richness of NTFPs. However, proportionally, the prevalence of NTFP species per plot declined from a high in the youngest old fields (85%) to approximately 70 % in the oldest fields and intact forests. Thus, there was an increasing prevalence of non-useful species with increasing age of old fields. This suggests that a mix or a mosaic of different aged patches would be the best to optimise the availability of NTFP species, i.e. increasing habitat diversity will benefit the species diversity of NTFPs. For example, Shackleton *et al*. (2013), working in the same area, reported that people view old fields as important sites for the collection of NTFPs, not only for the range of species found in them, but also because they were relatively accessible as the woody vegetation was not too dense.

The advantages of having a diversity of different aged patches is further advanced when the different use categories and life forms are examined. With respect to life forms, herbaceous species were most prevalent in the recently abandoned fields, and declined as the shrub and tree cover increased. Shrub richness was highest in old fields of intermediate age, and tree richness in the oldest abandoned fields. Consequently, residents seeking particular herbaceous medicinal species would have the greatest success in relatively young sites, whereas those seeking building timber species would probably make greater use of very old field sites or intact forests. Local people will have the local ecological knowledge built up over time of where to find particular species based on past experiences and observations (Berkes *et al*., 2000), as well as their understandings of the patterns in relation to habitat, soil type, aspect and slope position, proximity to water and similar determinants of species distributions. However, the increasing abandonment of agriculture adds another determinant of species distributions in the local environments. However, this determinant is not static, but changes with time, as do the effects of fire, also likely to be affected by successional changes, especially the ratio of herbaceous to tree biomass and corresponding fuel loads. This means that knowledge of where particular species may be found, and in what abundance will need to be adaptive to the changing circumstances (Berkes *et al*., 2000).

The two most species rich use categories were building timber and medicinal plants. This is also shows the setting of the area which is very rural, with almost every household having some traditional huts (which are built using poles, trees and clay as well as grasses for roofing) and livestock. Therefore, woody species are also used for fencing to protect crop fields and gardens, as well as building kraals in which the livestock sleep in during the night. Although medicine was one of the major uses of NTFPs, this does not suggest that people did not have access to modern healthcare such as clinics and hospitals but rather they use traditional healers for particular needs in parallel to modern health care facilities. According to Dold and Cocks (2012) this is because many Xhosa people ascribe any sickness to the spiritual world and the presence of bad spirits rather than physical health symptoms.

The use of NTFP species for energy was lower than expected. This may be a reflection of either the old fields not yet supporting favoured firewood species or the recent introduction of electricity into the area and its increasing adoption for cooking. This is in contrast to the

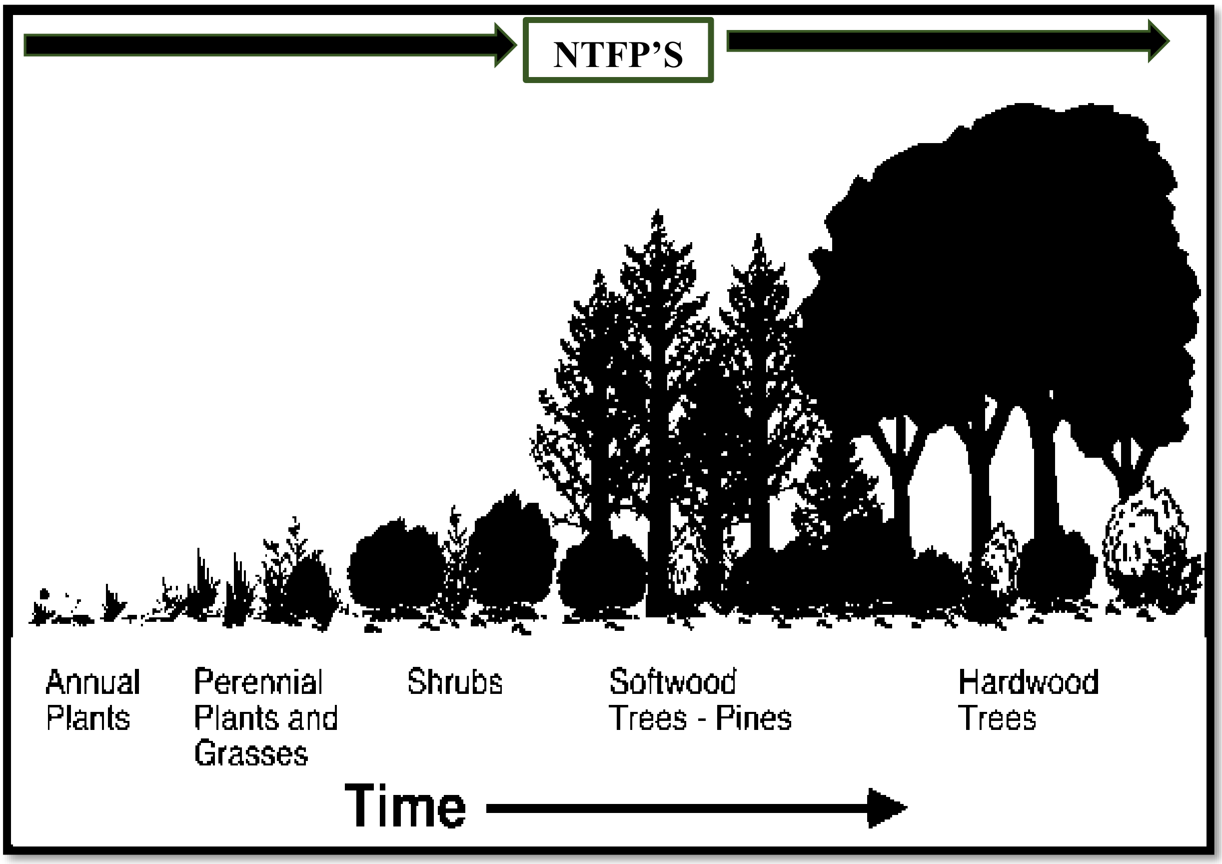
Ciskei, where firewood was the second highest used after medicinal plants (Cocks & Wiersum, 2003). Additionally, just to the north of the study site, Shackleton *et al*. (2007b) reported that households used an average of 4 to 4.5 tons of firewood per household per year, and that firewood contributed the greatest proportion to the monetary value of NTFPs used. In Willowvale is appears that firewood is important for some households who use it regularly, but for others it is becoming something they use mainly during traditional ceremonies and as a fall back when they run out of electricity. This is an example of how NTFPs serve a safety net function in rural households. This is similar to a study conducted by Shackleton *et al*. (2007b) in Cwebe and Ntubeni on the Wild Coast whereby household participated in trade of firewood only when it was necessary.

3.5 CONCLUSION

To conclude, the secondary forests provide different services than when the fields were ploughed and planted with crops. However, with the revegetation after cessation of cultivation there is now a greater variety of plant species that people can harvest to sustain their daily needs. The majority of the useful species were woody species, leading to the conclusion that shrublands and mature forests provide more NTFPs including plant species used for utilitarian and cultural significance.

CHAPTER 4

THE SUCCESSION OF NON-TIMBER FOREST PRODUCTS



Sourced from Pidwirny (2006) and edited by Njwaxu Afika

4.1 INTRODUCTION

It has been well established that non-timber forest products (NTFPs) make significant contributions to livelihoods especially in developing countries. According to Steel *et al.* (2015) studies around the world presenting the value and significance of NTFPs are abundant, especially in developing countries. However, the value and amount of NTFPs is place and context specific, based on the biophysical and socio-economic characteristics of the area where the studies are conducted. The increasing reliance on the formal economy and associated deagrarianisation has seen a change in rural livelihood strategies which includes a dependence on natural resources such as NTFPs. Klimanek (2013) associates deagrarianisation with the progressive development of a society and the proportion of the people who still take part in agricultural activities. In the case of Willowvale, South Africa, development includes increasing cash availability through urban links and social and old age grants, among other things as one of the factors that display the socio-economic shift in the area. As far as the proportion of people engaging in agricultural activities, there are multiple factors influencing deagrarianisation including lack of cattle, lack of enthusiasm for field agriculture and rural-urban migration (see chapter 1).

Succession serves as an important concept to study changes that may affect the functionality of natural ecosystems such as increased anthropogenic disturbances and climate change which lead to land use and land cover changes. Therefore, this chapter brings together three inter-connected concepts, i.e. deagrarianisation, succession and NTFPs, that largely influence rural livelihoods. This research was intended to examine how forest succession affects the composition, diversity and abundance of NTFPs on the Wild Coast, South Africa. This aim was addressed by two results chapters (chapters 2 and 3). Given the data presented in chapter 2 and 3, this chapter seeks to bring together the core findings in relation to the aim and objectives (see chapter 1) of this study. This will be done by synthesising the core findings of the study, a brief discussion of the implications of these results and provision of relevant recommendations and conclusions. The research objectives associated with the aim were:

1. To identify when the delineated arable lands stopped being cultivated and assess the subsequent rate and nature of succession.
2. To assess the impact of succession on the richness, composition and abundance of NTFPs.

3. To investigate how people make use of the NTFPs that come with the succession.

4.2 SUMMARY OF CORE RESULTS ACCORDING TO THE OBJECTIVES

The results of the study described in this thesis is a body of work that demonstrates how ecological processes can influence rural livelihoods. The two objectives noted above are a response to the lack of studies on succession in South Africa and its implications on NTFPs globally. This study provides an addition to the studies from Europe and America as well as providing an African perspective. This thesis presented findings on succession occurring on abandoned agricultural fields, the NTFPs that come with the revegetation and the use of these NTFPs by the people of Willowvale. Building on the work presented by Shackleton *et al.* (2013) on deagrarianisation in Willowvale, this study discussed the ecological regrowth of plants occurring on lands previously used for cropping. This work is complemented by that of El-Sheik (2005) showing old field succession in Egypt. This study has shown that the people in Willowvale depend on various plants for many daily needs such as shelter, food and medicine, which is in harmony with several studies (Mjoli & Shackleton, 2015; Shackleton *et al*., 2007b) conducted in the area.

In terms of the first objective which looked at when cultivation stopped and natural vegetation started to invade these old field site to determine the nature and rate of succession by tracking woody cover through time, the findings of this study revealed the different ages from seven years old to 55 years old. The aerial photographic analysis of the area revealed an increase in woody cover in the old fields of Willowvale with time. These findings are broadly in line with those of Chalmers and Fabricius (2007) who assessed forest expansion in a different area of Willowvale albeit not specifically on old fields. This was the first step in achieving the aim of my study.

Because these were results from aerial photographs, some ground truthing was done to complement them. This was done through field assessment conducted in the same area showing species richness with a similar pattern as the woody cover change through time. The majority of the species were shrubs and herbs, with shrubs less abundant in the younger fields, peaking as the fields start to move towards a climax state. Tracking of species composition through time revealed a grass, *Hyparrhenia hirta*, as the dominant species in the early stages, *Vachellia karroo* in the older fields (mature stages) and *Dalbergia obovata* in the primary forests.

Out of the total species (species richness) 40% were identified as NTFPs, with the majority of these used for building purposes (roofing, yard and kraal fencing) and a minority used for energy purposes. The majority of NTFPs were shrubs (woody species). The number of NTFPs increased with age of the old field. Although, the proportion of NTFP species was more than that of non-useful species, it decreased with time and age of the old field, while that of non-useful species increased with time. Although, more NTFPs were found in the mature successional stages (mainly woody species), the early stages provided more medicinal plants. The different NTFP uses appeared to be spread out through the different stages of succession.

4.3 THE IMPACT OF FOREST SUCCESSION ON NTFPS IN WILLOWVALE

Economic development leads to an increase in numbers of non-farm jobs leading to some famers to disengage from farming, thereby inducing revegetation of forests in fields previously used for cultivation and cropping. This in a nutshell, is what has happened in Willowvale. However in Willowvale, the economic development and improvement in socio-economic conditions of citizens is largely influenced by the country’s recent political changes. People in the former homelands have always made use of the natural environment to survive because of several factors that led to them living in poverty conditions especially the racially discriminated dispensation which restricted opportunities and movement. However, after 1994, the new dispensation prevailed and people could move freely to cities and social grants also assisted in their living conditions. The improvement in infrastructure led to people being able to buy food from supermarkets, making field cultivation (which was usually used for staple foods e.g. maize, pumpkins and wild vegetables) not a necessity. According to Shackleton and Luckert (2015) people did not completely stop agricultural activities but stopped field cultivation and shifted towards home gardens. It is understandable why people would be discouraged by field cultivation given the fact that these fields were at a distance from homesteads. The citizens of Willowvale listed farming as something not worth doing and rural-urban migration, among other things, as reasons for them to stop field cultivation (Shackleton *et al.*, 2013). Abandonment of field agriculture led an increase in idle agricultural land and later revegetated old fields.

These revegetated old fields acted as new grounds for people of Willowvale to access and collect NTFPs (Shackleton *et al*., 2013). Which then begged the question, how did succession affect NTFPs, which previous literature has already revealed the people of Willowvale make use of, leading to the assumption that succession occurring on these old fields had the potential of affecting NTFP composition and abundance, thereby affecting the livelihoods of Willowvale households.

The majority of the species in the communities and fields of different ages were NTFP species. One might even hypothesise or expect that an increase in species richness would automatically result in an increase in the proportion of NTFPs in the abandoned fields. However, this study revealed that an increase in species richness resulted in an increase in the proportion of non-useful species. For the purpose of this study, useful species (NTFPs) are species collected from primary and secondary forests that the local people deemed useful or can benefit from in one or more ways meaning the rest of the plants found within the plots were non-useful plants.

According to De Zoysa *et al*., 1999 in Ashton *et al*. (2014) NTFPs in South Asian, secondary growth forest can be more prolific and diverse than NTFPs in primary forests. Non-timber forest products make up a big part of livelihoods in the rural South Africa (chapter 4). Rural and forest adjacent communities all over the world have been dependent on forest products for millennia. This, of course, depends on availability and abundance and what people need them for as different communities are dependent on NTFPs for different reasons. Harvesting of NTFPs puts pressure on some plant species and ecosystems and can be detrimental without proper management practises in place (Ticktin, 2004). There is often concern around the ecological implications of NTFP harvesting and whether plant populations can be replenished in time to meet the NTFP demand. According to Ashton *et al*. (2014) few studies have critically examined whether and to what point demand can be met by natural products. This study revealed that in Willowvale, the majority of the useful species were mainly woody species (shrubs) and woody vegetation was increasing with time. Therefore, NTFPs collected from secondary forests were an addition to the existing NTFPs collected from primary forest thereby providing an influx of NTFPs for the people of Willowvale to use.

4.4 SIGNIFICANCE OF THE STUDY

4.4.1 Implications for rural livelihoods in Willowvale

People from Willowvale have the option of planting some of these NTFPs in their homestead or home gardens but collecting NTFPs with cultural or medicinal significance entails a trip to the forest. This is because the trip to the forest is part of the healing and the cultural experience. According to Dold and Cocks (2012) healing of *Xhosa* people usually entails treating more than physical but the spiritual well-being as well. This is because in *Xhosa* areas illness is usually believed to be more than a physical thing, but includes the involvement of supernatural entities.

While people use some NTFPs for daily needs such as food, energy and shelter, all of these have alternatives that could be bought or sold, therefore they have some sort of quantifiable value. However, there are some natural products with uses that hold a special, non-quantifiable meaning that are part of the values of the people and cannot be replaced by any socio-economic development. This can be understood through the concept of biocultural diversity whereby cultures and traditions are maintained by nature and in turn nature is conserved by certain cultural practises. Biocultural diversity represents the relationship between people and nature, the importance of biodiversity to communities and the role played by human diversity in biodiversity conservation (Cocks, 2006). This further shows that NTFPs are more than a livelihood strategy but part of generational traditions and identity.

People stopped field cultivation for various reasons but one of these is seeing it as an unnecessary process not worth the trouble as crops harvested from fields can be store bought. The revegetation of forests offers more than just food products, it also offers more products that have uses that cannot be obtained anywhere else but from the wild. These uses include protection from lightning, calling upon the ancestors, good luck charms and protection from witchcraft and bad luck. Non-timber forest products also have the safety net and cash saving function which allows people to save money for other things that can only be obtained by cash and offer insurance or a fall back plan. Some uses overlap, for example the use of firewood for cooking during traditional ceremonies and big celebrations. This has cultural significance because it is tradition for some rituals to cook freshly slaughtered meat with firewood rather than modern stoves and it has the cash saving function because it saves electricity as large quantities of food and traditional beer are prepared using firewood during such rituals (Cocks & Wiersum, 2003; Dold & Cocks, 2012).

4.4.2 Contributions to existing knowledge

This study provides a better understanding of the vegetation ecology of the Wild Coast. It contributes to the limited body of knowledge on succession in South Africa and adds a southern hemisphere perspective to the already existing and abundant literature on succession in the northern continents. It also provides new insights regarding the unexamined impact of succession on NTFPs which has not been reported in previous literature. It further provides a South African perspective on old field succession. According to Stickler and Shackleton (2015) it is crucial to understand the rates and causes of land use change to identify solutions, especially in sensitive landscapes and ecosystems, as well as in places undergoing rapid political, socioeconomic or ecological changes. Opportunities for future research include the comparison of NTFPs found in old fields and active fields, and similar work carried out in a different biome and location with different socio-economic factors.

4.5 SHORTCOMINGS, RECOMMENDATIONS AND CONCLUSION

The disturbances measured during field assessment could have been measured and recorded more thoroughly than being recorded as a presence or absence factor. This could have provided more insight on the secondary succession of Willowvale forests. Studying one landscape (old fields) was crucial to address questions asked in the beginning of this study; future studies could include other landscapes. A comparison to active fields (as opposed to abandoned fields) could have been done if there was more time. A comparison study could be constructive for future research whereby a comparison is done on NTFPs found on abandoned and active agricultural fields. For future studies, NTFP can include non-plants i.e. bushmeat, as it could be interesting to see how succession, affected fauna in the area such as insects and bushmeat. Some traditional medicine is made from animal products (Dold & Cocks, 2012) therefore, because the records for this study only had plant products, limiting/ preventing people from mentioning some animal NTFPs they use.

The one thing that my study has shown is that succession is not a one-way process. There are multiple dynamics involved that influence the perceived linear, consistent accumulation of vegetation resulting in either a drop or increase in plant species richness. These include a range of ecological and anthropogenic factors such as climate, disturbances (harvesting, fire and grazing), spontaneous plant invasion or colonisation. Although, an increase in species richness resulted in an increase in the proportion of non-useful species, the core finding is that succession led to an increase in the number and diversity of NTFPs for the people of Willowvale. There were already places where people in the area collected NTFPs before the revegetation, for example primary forests. The secondary forests just added to the already existing locations. The fields of different ages provide people with a wide variety NTFPs. With woody species providing more uses to the local people, secondary forests reduce some pressure on primary forests thereby limiting overharvesting.

Appendix 1: List of NTFPs and the use categories they belong to

Species name	craft	medicinal	traditional	food	building	energy	Number of uses
Senegalia caffra					√		1
Vachellia karroo		√		√		√	3
Acokanthera oblongifolia		√	√				2
Agelanthus kraussianus				√			1
Anastrabe integerrima					√	√	2
Apodytes dimidiata	√				√		2
Asparagus sp			√				1
Bersama swinnyi		√					1
Brachylaena discolor	√				√		2
Buxus natalensis					√		1
Canthium inerme					√		1
Carissa haematocarpa			√				1
Celtis africana	√						1
Centella asiatica				√			1
Cestrum laevigatum					√	√	2
Chaetachme aristata					√		1
Clerodendrum glabrum					√		1
Coddia rudis					√		1
Combretum caffrum		√	√				2
Cussonia Spicata		√					1
Dalbergia obovata	√					√	2
Diospyros lycioides				√	√	√	3
Dovyalis rhamnoides				√	√		2
Duvernoia adhatodoides					√		1
Ekebergia capensis				√	√		2
Fern		√					1
Gerbera ambigua		√		√			2
Grewia occidentalis				√	√		2
Helichrysum anomalum		√	√				2
Helichrysum odoratissimum		√	√				2
Helichrysum cymosum		√	√				2
Helichrysum nudifolium		√					1
Helinus integrifolius			√				1
Hibiscus trionum		√					1
Hippobromus pauciflorus		√					1
Hyparrhenia hirta					√		1

Hyperacanthus amoenus					√		1
Hypoxis Hemerocallidea			√				1
Lantana camara				√			1
Laportea peduncularis		√					1
Leonotis leonurus		√					1
Lippia javanica		√					1
Maesa alnifolia			√				1
Merxmuellera disticha	√						1
Millettia grandis	√				√		2
Monanthotaxis caffra	√						1
Mystroxylon aethiopicum		√					1
Pelargonium sp			√				1
Phoenix reclinata	√			√			2
Plectranthus ciliatus		√					1
Psidium guajava				√			1
Ptaeroxylon obliquum			√		√	√	3
Putterlickia pyracantha					√		1
Rhoicissus sp				√			1
Rhoicissus tomentosa				√			1
Rubus rigidus				√			1
Scutia myrtina				√	√		2
Searsia chirendensis				√	√		2
Searsia glauca				√	√		2
Searsia crenata				√	√		2
Senecio deltoideus		√					1
Senecio inaequidens						√	1
Solanum aculeastrum			√				1
Solanum mauritianum			√				1
Spermacoce natalensis		√					1
Stachys aethiopica		√					1
Stangeria eriopus		√					1
Tarchonanthus camphoratus			√				1
Vepris lanceolata	√				√		2
Zanthoxylum capense	√	√					2

Appendix 2: List of all the species in the assessed plots including non-useful species

Species name	
Abutilon sonneratianum	*Cynoglossum hispidum*
Acalypha sp	*Dais cotinifolia*
Acokanthera oblongifolia	*Dalbergia obovata*
Agelanthus kraussianus	*Dalechampia capensis*
Anastrabe integerrima	*Dioscorea dregeana*
Apodytes dimidiata	*Diospyros dichrophylla*
Argyrolobium sp	*Diospyros lycioides*
Aristea sp	*Diospyros scabra*
Asparagus falcatus	*Diospyros scabrida*
Asparagus sp	*Dovyalis rhamnoides*
Asparagus virgatus	*Duvernoia adhatodoides*
Asplenium rutifolium	*Ekebergia capensis*
Asteraceae	*Eriosema acuminate*
Athrixia phylicoides	*Eriosema squarrosum*
Berkheya sp	*Euclea crispa*
Bersama swinnyi	*Euclea natalensis*
Brachylaena discolor	*Fabaceae*
Brachylaena ilicifolia	*Falkia repens*
Burchellia bubaline	*Felicia filifolia*
Buxus natalensis	Fern
Calpurnia aurea	*Ficus* sp
Canthium inerme	*Gazania krebsiana*
Carissa haematocarpa	*Gerbera ambigua*
Celtis africana	*Grewia lasiocarpa*
Centella asiatica	*Grewia occidentalis*
Cestrum laevigatum	*Gymnosporia harveyana*
Dyschoriste setigera	*Gymnosporia nemorosa*
Chaetachme aristata	*Harpephyllum caffrum*
Chlorophytum comosum	*Helichrysum anomalum*
Cineraria sp	*Helichrysum cymosum*
Cissampelos torulosa	*Helichrysum nudifolium*
Clausena anisate	*Helichrysum odoratissimum*
Clematis brachiate	*Helinus integrifolius*
Clerodendrum glabrum	*Hesperantha* sp
Clutia dregeana	*Hibiscus pedunculatus*
Coccinea sp	*Hibiscus* sp
Coddia rudis	*Hibiscus trionum*
Combretum bracteosum	*Hippobromus pauciflorus*
Combretum caffrum	*Hyparrhenia hirta*
Commelina africana	*Hyperacanthus amoenus*
Commelina sp	*Hypoestes* sp
Conyza scabrida	*Hypoxis Hemerocallidea*
Cotula heterocarpa	*Isoglossa* sp
Crinkley fury	*Jasminum multipartitum*
Cucurbitaceae c.f Coccinea	*Lantana camara*
Cussonia Spicata	*Laportea grossa*

Laportea peduncularis	*Senecio deltoideus*
Leonotis leonurus	*Senecio inaequidens*
Lichtensteinia interrupta	*Senecio pterophorus*
Lippia javanica	*Senecio retrorsus*
Lippia sp	*Senecio speciosus*
Lobelia flaccida	*Senegalia caffra*
Maesa alnifolia	*Sida dregei*
Maytenus heterophylla	*Sida rhombifolia*
Maytenus oleoides	*Sida ternate*
Melhania didyma	*Solanum aculeastrum*
Merxmuellera disticha	*Solanum linnaeanum*
Milletia grandis	*Solanum mauritianum*
Monanthotaxis caffra	*Spermacoce natalensis*
Monopsis unidentata	*Stachys aethiopica*
Mystroxylon aethiopicum	*Stangeria eriopus*
Ochna arborea	*Syncolostemon densiflorus*
Osyridicarpos schimperianus	*Syncolostemon* sp
Oxyanthus speciosus	*Taraxicum* sp
Pavetta lanceolata	*Tarchonanthus camphoratus*
Pelargonium sp	*Teclea natalensis*
Persicaria sp	*Tecomaria capnesis*
Phoenix reclinata	*Tephrosia capensis*
Phyllanthus incurvus	*Teucrium trifidum*
Phyllanthus niruri	*Trema orientalis*
Plectranthus ciliatus	*Tricalysia lanceolata*
Plectranthus ecklonii	*Trimeria grandifolia*
Polygala amatymbica	*Triumfetta sp*
Prostanthera sp	Unknown 1
Protorhus longifolia	*Vachellia karroo*
Psidium guajava	*Vangueria infausta*
Psychotria capensis	*Vepris lanceolata*
Ptaeroxylon obliquum	*Vernonia angustifolia*
Putterlickia pyracantha	*Vernonia capensis*
Raphionacme	*Hilliardiella aristata*
Rhamnus prinoides	*Yellow Lobelia*
Rhoicissus sp	*Yellow orchid*
Rhoicissus tomentosa	*Zanthoxylum capense*
Rhynchosia sp	*Ziziphus mucronata*
Rubus flagellaris	
Rubus rigidus	
Ruellia cordata	
Schotia latifolia	
Merwilla plumbea	
Scutia myrtina	
Searsia chirindensis	
Searsia crenata	
Searsia glauca	

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