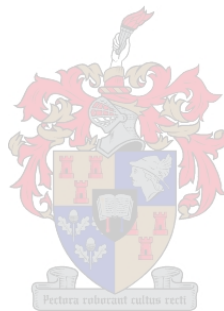


“BEEWARE” OF THE WASP: THE ROLE OF LANGUAGE IN STUDYING AND MANAGING THE EUROPEAN PAPER WASP

by

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of Arts and Social Sciences at Stellenbosch University*



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DECLARATION

By submitting this thesis electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the sole author thereof (save to the extent explicitly otherwise stated), that reproduction and publication thereof by Stellenbosch University will not infringe any third party rights and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

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ABSTRACT

Over the past decade or two, scientists have recognised the importance of the role the general public may play in scientific research to address scientific challenges. This thesis deals with communication concerning the European paper wasp, *Polistes Dominula*, as facilitated by the South African National Biodiversity Institute (SANBI), to a predominately Xhosa-speaking public. In addition, the thesis focuses on invasive alien species (IAS) management and the positive impact that public engagement may have on the process of this management, as SANBI has a desire to eradicate the European paper wasp, *Polistes Dominula*, and public participation is considered imperative to achieve this goal. The incorporation of the public into the realm of science requires a mode of communication of that science to various publics. Prior to effective communication, however, the communicating institution needs to understand each public's level of understanding, knowledge of and perceptions of the European paper wasp. This information is necessary to develop appropriate communication tools for each public.

The main data method used in this research was personal, one-on-one interviews, guided by a structured interview schedule. The interviews were conducted with members of the Coasta Land community, in Kayamandi .The respondents were heads of households, or a suitable replacement above the age of 18. The study reveals that language is a barrier in researching, and therefore understanding, a public's perceptions, understanding and knowledge of the European paper wasp. In particular, many English scientific terms are not found in the South African indigenous languages. This poses not only an obstacle to research, but renders likely a communication breakdown between science communicators and the public.

This thesis recommends that, in order to achieve successful IAS management, creative methods of communication have to be developed in order to reach Xhosa-speaking communities such as the one studied. Furthermore, along with linguistics and scientists, a process of science-terminology development needs to be embarked upon to overcome the language barrier in science communication.

OPSOMMING

Oor die afgelope dekade of twee, het wetenskaplikes die belangrike rol wat die algemene publiek in wetenskaplike navorsing kan speel om wetenskaplike uitdagings aan te spreek, erken. Hierdie tesis handel oor die kommunikasie met betrekking tot die Europese papierwespe, *Polistes Dominula*, soos gefasiliteer deur die Suid-Afrikaanse Nasionale Biodiversiteitsinstituut (SANBI), aan 'n oorwegend Xhosa-sprekende publiek. Daarbenewens, fokus die tesis op indringerspesie-bestuur en die positiewe impak wat openbare deelname kan hê op die proses van hierdie bestuur aangesien SANBI 'n begeerte het om die Europese papierwespe, *Polistes Dominula*, uit te roei, waarvan openbare deelname noodsaaklik is om hierdie doel te bereik. Die insluiting van die publiek in die wetenskaplike terrein vereis 'n vorm van kommunikasie van daardie wetenskap aan verskeie publieke. Voor effektiewe kommunikasie kan geskied, moet die instelling wat kommunikeer egter elke publiek se vlak van begrip, kennis van, en persepsies van die Europese papierwespe, verstaan. Hierdie inligting is nodig om toepaslike kommunikasie-instrumente vir elke publiek te ontwikkel.

Die hoof data-insamelingsmetode wat in hierdie navorsingsprojek gebruik is, was persoonlike, een-tot-een onderhoude, wat gelei is deur 'n gestruktureerde onderhoudskedule. Onderhoude is gevoer met lede van die Coasta Land gemeenskap in Kyamandi. Respondente was howe van huishoudings, óf 'n geskikte plaasvervanger bo die ouderdom van 18. Die studie toon dat taal 'n hindernis is in die navorsing, en dus begrip van die publiek se persepsies, begrip en kennis van die Europese papierwespe. Baie Engelse wetenskaplike termes word veral nie in Suid-Afrikaanse inheemse tale gevind nie. Dit dien nie slegs as 'n struikelblok tot navorsing nie, maar dra ook waarskynlik by tot 'n kommunikasie ineenstorting tussen wetenskap-kommunikeerders en die publiek.

Hierdie tesis beveel aan dat, ten einde suksesvolle indringerspesie-bestuur te bereik, moet kreatiewe metodes van kommunikasie ontwikkel word om Xhosa-sprekende gemeenskappe, soos die een wat bestudeer is, te bereik. Boonop, moet 'n proses van wetenskap-terminologie-ontwikkeling aangepak word saam met taalkunde en wetenskaplikes om die taalgrens in wetenskap kommunikasie te oorskry.

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ACRONYMS AND ABBREVIATIONS

DESC	Departmental Ethics Screening Committee
FET	Further education and training
GET	General education and training
IAS	Invasive alien species
ISP	Invasive Species Programme
NRMP	Natural Resources Management Programme
PUS	Public understanding of science
SANBI	South African National Biodiversity Institute
SU	Stellenbosch University
UNESCO	United Nations Educational, Scientific and Cultural Organisation
WRC	Wasp Research Consortium

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CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION

The European paper wasp *Polistes dominula* (Christ) (Hymenoptera: Vespidae: Polistinae) is an invasive alien wasp that is causing damage to South Africa's indigenous ecosystems. It is documented that this wasp has managed to establish itself as "a prolific invader across the globe and has been recorded and studied on all continents, with the exception of continents with extremely low temperatures" (Benadé, 2015:1). Countries of invasion include, Argentina, Australia and Canada (Benadé, Veldtman, Samways & Roets, 2014:1). Biological invasions by IAS often incur high costs, both economically and ecologically, and invasive organisms are now regarded as one of the greatest threats to global biodiversity (Benardé, 2015:11). The broad spread of IAS today is a result of increased mobility through trading of goods and services, travel and tourism (Mcneely *et al.*, 2001; Mooney & Cleland, 2001, as cited in Benardé 2015:1).

Its presence also has a negative economic impact, and poses a public health threat in South Africa. Within the Western Cape Province of South Africa, the noteworthy negative economic impact has become increasing evident as problematic organisms on some Stellenbosch farms. On those farms, the wasps build their nests on vines and supporting structures in vineyards resulting in financial losses for the farmers who have to spend money on insecticides and human labour to eradicate the nests (Benadé, 2015:19). The presence of the nests and wasps on vines has led to reduced grape and/or wine production in some Stellenbosch farms, as grapes are not being harvested (Stellenbosch wine farmers, pers. comm., as cited in Benadé, 2015:19). The European paper wasp often builds its nest on buildings and man-made structures, increasing the probability of these fairly aggressive wasps coming into contact with human beings (Benadé, 2015:19). This poses a public threat as its sting is regarded as one of the most painful of all insect stings (National Environmental Management: Biodiversity Act, 2004:7). The wasp can detect human movement from a mile. One can be easily stung while changing an outside light bulb, while painting or removing window shutters (Jacobs, 2016:1).

1.2 PROBLEM STATEMENT

The European paper wasp was first documented in Cape Town in 2008. Since then, a number of areas in the Western Cape have been invaded by this IAS, and, as detailed above, it has caused much damage to people's homes and to restaurants that are situated on farms (Benadé *et al.*, 2014:1).

Fortunately, the parameters of its invasion are still very limited; it has not spread to other parts of South Africa, and is therefore still at a controllable stage (Veldtman *et al.*, 2012:1). From its detection until 2014, no research was conducted on the IAS in South Africa, hence SANBI, with its partners – including Stellenbosch University (SU) and the City of Cape Town – formed the Wasp Research Consortium (WRC) to study this species, with the objective of finding a way to eradicate it (Veldtman *et al.*, 2012:1). During the course of the WRC's research, it has become evident that there is a need to look beyond natural ecosystems and consider societal aspects concerning the wasp, such as how the public relates to the species. Citizen science, that is, public participation in organised research efforts (Dickinson & Bonney, 2015), is the link that has been missing in the development of a model that can assist in the eradication of the species.

The public's reporting of *P. dominula* nest sightings, for example, is key in planning eradication efforts effectively. Before an eradication model can be developed, there has to be a clearer understanding of public perceptions, attitudes and knowledge regarding the European paper wasp (e.g., can they identify the wasp, and are they aware of the safety measures required when dealing with the wasp?). In addition, there also has to be a clear understanding of the factors that may facilitate or limit public participation in addressing this IAS not only as a biodiversity threat, but also as an economic and public-health issue. Therefore, my project will focus on the communication of information on IAS, in particular the European paper wasp, to the public, so as to determine the role thereof, but also of other potential factors, in shaping public perceptions and actions *vis-à-vis* the wasp. The broader objective is to understand factors that influence public perception and action in relation to biodiversity issues, and to inform the development of appropriate methods of communication that would effectively reach a socio-economically diverse public. It is therefore hoped that the results of the study will be used to develop a model that will increase public participation in the process of eradicating the European paper wasp in the South African context. At the time of this study, articles in local newspapers, radio interviews and pamphlets had been used by SANBI to communicate the European paper wasp within the Stellenbosch municipal district and the City of Cape Town district.

1.3 RESEARCH QUESTIONS

In an attempt to achieve the objectives of this study, the following research questions were initially developed to guide the research:

- Does cultural distance between science and the public affect public knowledge, perceptions and attitudes in terms of the European paper wasp?
- What are the public's perceptions (positive or negative) regarding the eradication of the European paper wasp, and which factors influence these perceptions?
- Among the major means of communication that have thus far been used to bring about public action aimed at eradicating the European paper wasp, which have been the most effective?

However, while in the field and due to unforeseen challenges (discussed in Chapter 3), the research questions were changed to the following:

- What is the level of awareness of the European paper wasp, amongst residents of a primarily African, low-income community?
- Does language have an effect on the understanding of that public's perceptions, attitudes and knowledge of the European paper wasp?
- What are that public's perceptions (positive or negative) regarding the eradication of the European paper wasp, and which factors influence these perceptions?
- What is that public's opinion on the SANBI pamphlet on the European paper wasp?
- What are the population demographics of the study population?
- What is the level of scientific literacy amongst the study population?
- Does the study population have any knowledge of the European paper wasp?
- What is the study population's perceptions of the communication of the European paper wasp to the public?
- Is the communication of formal scientific knowledge of the wasp incoherent with the public's life experiences of the wasp?

1.4 BACKGROUND TO THE INVASIVE SPECIES PROGRAMME AND THE INVASIVE WASP PROJECT

“The South African National Biodiversity Institute (SANBI) has a legal mandate to promote the conservation of South Africa’s exceptional biodiversity, to monitor and report on invasive alien species (IAS) and run programmes to eradicate invasive species” (NEM:BA, 2004:18). The Invasive Species Programme (ISP) was established by SANBI with the mission of contributing to the protection of ecological infrastructure and ecosystems services from the threat of IAS. To deliver on this mandate, The Natural Resources Management Programmes (NRMP) of the Department of Environmental Affairs appointed SANBI as an implementing agent to direct, in collaboration with appropriate stakeholders, a number of activities targeting invasive alien species. SANBI was also appointed to manage IAS and gather data.

In the years 2015/2016, the programme employed approximately 80 contractors for eradication and containment of operations on target taxa species (Annual Plan of Operations, 2016:1). Furthermore, awareness raising efforts in support of ISP will be carried out within the context of the broader communications framework of NRMP. To succeed in this, SANBI will undertake to integrate existing and new data on biological invasions into its existing biodiversity-information-management systems, so that these are accessible to all stakeholders.

The objectives of the ISP programme are:

- Co-ordinated detection and surveillance
- Rapid identification and verification
- Risk assessment
- Operations to manage populations of IAS requiring compulsory control
- Research in support of objectives 1–4
- Facilitate information management systems that allow for readily accessible and accurate exchange of information
- Raise awareness of the negative effects of IAS
- Effective and compliant management of financial and human resources
- Monitor and evaluate the effectiveness of the programme
- Co-ordinate a Marine Invasive Species Programme

In 2012, the Invasive Wasp Project (IWP) was founded, under the ISP programme.

1.4.1 THE INVASIVE WASP PROJECT (PHASE 1)

The primary focus of Phase 1 of the IWP is research. The investigation and study is centred on the invasive and potentially dangerous wasps to the public in South Africa: *Vespula germanica* (German wasp) and *Polistes dominula* (European paper wasp). This first phase started in 2012 and continued until 2015 (Annual Plan of Operations, 2015/2016:2).

The following student research projects were carried out: Two MSc-student research projects, one of which focused on farmers' experiences with *V. germanica* (Haupt, 2015). This was the first study with a public-interaction aspect, and its findings revealed that *V. germanica* is a problematic IAS to the farming community. The removal of nests and use of insecticides is costly for the farmers. The second MSc project centred on monitoring the activity of *P. dominula* and its congener¹, *Polistes marginalis*. The purpose of the study was to determine when *P. dominula* and *P. marginalis* undergo diapause² and when the diapause ends (Bernadé, 2015). A PhD project was also carried out, and it focused on a geometric morphometric analysis of *V. germanica*'s front wings to identify variation in the wings. The results will assist in understanding why *V. germanica* has not spread as widely in South Africa over the past 40 years compared to other countries in the Southern Hemisphere. Lastly, a Post-Doc project, in collaboration with the DST-NRF Centre of Excellence for Invasion Biology (C•I•B) was also done (Poole & Veltdman, 2014:1). The project focused on the effect of various factors such as environment and food availability, in the understanding of the invasiveness of various IAS from marine, terrestrial and fresh water systems. Through collaboration with the Invasive Wasp Project (IWP), invasive wasp species were included.

All of the research projects in Phase 1 were done to form a basis in beginning to understand the invasion by both *V. germanica* and *P. dominula*. My project forms part of Phase 1, as its focus is research rather than implementation; and my research focuses on the latter wasp.

¹ Congener is defined as an organism belonging to the same taxonomic genus (family) as another organism.

² Diapause is defined as a physiological state of dormancy involving a delay in development in response to, or initiated by, regularly and recurring periods of adverse environmental conditions.

1.4.2 INVASIVE WASP PROJECT (PHASE 2)

The second phase of the IWP project is aimed at building on the work conducted in Phase 1. Phase 2 started in January 2016 and is expected to be completed in 2017. The focus of Phase 2 is on control experiments and public awareness. The research conducted by the students in Phase 1 revealed that the control as well as the eradication of the species is not a simple task. It was concluded that the point of departure would be to begin with an eradication attempt at a specific location, as well as several control studies (Veltdman, van Zyl & Daly, 2016:1). Secondly, from the studies conducted in Phase 1, it was clear that there is a need for greater public awareness of both wasp species (Veltdman, van Zyl & Daly, 2016:3). In 2014, a display of the European paper wasp was presented at the Iziko Museum in Cape Town. An opportunity arose to augment the display with a television station that would show several short wasp and control film clips on loop. However, the idea is still in its infancy stage (Veltdman, van Zyl & Daly, 2016:1).

Both SANBI and the City of Cape Town have come to recognise the need for a systematic approach to increase public awareness of the wasp. They therefore formed a partnership to develop such an approach, as well as to train control technicians to exterminate nests. The partnership developed into a consortium – the Wasp Research Consortium (WRC) – that included other stakeholders, such as Stellenbosch University (SU) and the C•I•B. My thesis responds to this consortium's interest in increasing public awareness of the two species during Phase 2 (Veltdman, van Zyl & Daly, 2016:3), by (i) determining the level of public awareness and knowledge of the European paper wasp, as well as the perceptions that the public have of the wasp; and (ii) evaluating the awareness-raising material that has already been distributed in the study area, particularly a pamphlet. A primarily sociological approach was followed, drawing from sub-fields such as the sociology of science and sociology of scientific knowledge. Furthermore, my study is an interdisciplinary study, crossing the boundaries between sociology and ecology. The study has practical implications (Bryman, 2012:7), as the underlying rationale for the study was to provide assistance and guidance to SANBI in developing an effective communication tool that can increase the public's awareness of the IAS. It links to another initiative in Phase 2, which is focused on educating the public in the importance of noticing invasive insects and reporting them (Veltdman, van Zyl & Daly, 2016:3).

This thesis will present, from a sociological perspective, the methodological challenges posed by language when measuring perceptions, knowledge and understanding concerning a primarily scientific topic, in this case an invasive alien wasp. Furthermore, how this challenge affects the

likelihood of achieving the end goal of increasing public awareness of the European paper wasp, through science communication methods, will be examined. Lastly, I will consider IAS from a social constructionist approach, reflecting critically on the construction of IAS as problematic, and needing to be eradicated urgently.

In Phase 1 of the IWP, an eradication programme was implemented by the City of Cape Town. The City of Cape Town also collaborates with Stellenbosch Municipality's Eco-Centre to eradicate wasps, as well as to create awareness by means of SANBI-published articles in newspapers, radio interviews, and posters and pamphlets distributed to the public. In the process of this programme, they realised that they needed to understand public perceptions and understanding first, before continuing on the programme, hence their decision to support my MA research that would allow them to create an improved eradication programme in Phase 2 of the IWP.

1.5 CHAPTER OUTLINE

This research will be presented in five chapters. Following the introduction, the second chapter consists of a review of scholarly literature related to sociology of science, IAS, public understanding of science and science communication. The third chapter outlines the methodological approach, methods and techniques adopted to answer the research questions of this study. Chapter 4 reports on the results of the study, which are interpreted and discussed in relation to the literature reviewed in Chapter 3. The final chapter, Chapter 5, draws conclusions on the basis of these findings and provides recommendations for future research on this topic, as well as for improvement of science communication on the European paper wasp.

CHAPTER 2: LITERATURE REVIEW

2.1 SOCIOLOGY OF SCIENCE

The topic of my study is primarily located within the fields of public understanding of science (PUS) and science communication. As it will be explained further in detail in Section 2.2, I will be viewing the broader topic of IAS from a sociological perspective, specifically as offered by the field of sociology of science. Therefore, it is relevant to briefly view literature on the sociology of science and its links with PUS and science communication. However, sociology of science is not the main theoretical framework of my study, but rather a broader lens through which I view the theories of PUS and science communication.

During the 1960s, sociology of science was recognised as a new research speciality in sociology. This field broke new ground and attracted attention from fields other than sociology (Davids, 2012:61). But this was not always the case, as a few challenges prevented this research speciality from being accepted by many sociologists who did not understand how science is a social problem, and there are still some who fail to see its relevance in sociology (Davids, 2012:61).

Science befits to be studied in sociology, because in modern, western society it is considered by many a social problem, or, if not a social problem in itself, a significant cause of many social problems. As Mulkay (1979:67) argues, when something is defined a social problem, it automatically becomes a proper object of study. This resulted in an interest by sociologists, and other scholars in the social sciences, to understand the social aspects of science (Davids, 2012:5). My study attempts to understand the social aspect of science; to be specific, the social aspects of the European paper wasp.

The founding theoretical base of sociology of science was the Mertonian theory on the sociology of science. His theory is based on the idea that social institutions of science can be studied as any other social institution (Barnes, Bloor & Henry, 1996:21). As an institutionalised activity, science has goals and proceeds through the various social processes to realise its goals. Sociology of science is interested in not only how scientific knowledge is generated in science institutions, but also how it is then transferred to the public, which is referred to as science communication (Barnes *et al.*, 1996: 23). My project is focusing on the social processes that are involved in carrying out the process of reaching this latter goal of science as an institution.

Sociologists of science tend to agree that there is a gap between scientists, science institutions and the public. For scientific institutions to reach their goals effectively, the social processes that are involved in producing the gap need to be understood. As a result of research aimed at this understanding, a sub-field has developed within sociology of science, known as the public understanding of science (Barnes *et al.*, 1996: 23). This sub-field is not only studied within sociology of science, but also more widely within the social sciences, as will be explained further in Section 2.4. This research field focuses on public perceptions regarding scientific information, with the assumption that, once public perceptions, knowledge and attitudes are understood, it will be easier to close the gap and communicate science in an effective way to the public.

Having made the connection between sociology of science, PUS and science communication, I will proceed to review literature that relates to the central concepts of my study, starting with a review of the literature that provides the context of the European paper wasp as a topic of study.

2.2 THE EUROPEAN PAPER WASP IN CONTEXT

The communication to the public of, and public perceptions and attitudes regarding, the environmental problems caused by the European paper wasp, *Polistes Dominula* (Christ, 1791), as IAS in South Africa, is the topic of my study. IAS “is a term used to describe introduced species with the ability to spread and increase to sufficient density to cause economic, social and/or environmental effects” (Beggs, Brockerhoff, Corley, Kenis, Masciocchi, Muller, Rome & Villemant, 2011:506). The European Paper wasp is considered an IAS as it is a introduced species that is causing negative economic, environmental, health and social impacts in South Africa. Therefore, it is important that I consider literature that will assist me to understand the IAS in the South African context, specifically the context of the area where I conducted the research.

P. dominula is a native of Europe, where it is widespread, but commonly found in southern Europe, which has a Mediterranean climate, and also in Belgium and southern Holland (Hathaway, 1981, as cited in Eardley, Koch & Wood, 2009:226). The first published observation of its presence in South Africa was made in the Western Cape Province in 2008, in the suburb of Kuilsrvier (Benadé *et al.*, 2014:220). The province is a winter-rainfall region, and therefore has a climatic similarity with parts of this species’ native habitat (Hathaway, 1981, as cited in Eardley *et al.*, 2009:226–227). In South Africa, *P. dominula* is currently classified as an IAS according to NEM:BA, because: it is a “species whose establishment and spread outside of its natural distribution range (a) threatens ecosystems, habitats or other species; and (b) may result in economic or environmental harm or

harm to human health". According to the definition by Richardson *et al.* (2000), an IAS is introduced and produces reproductive offspring in areas distant from sites of introduction. *P. dominulus* meets both definitions. It has also invaded other countries. For example, from when it was first recorded in North America during the late 1970s, it spread rapidly southwards, and replaced the native paper wasp within a few years (Cerva *et al.*, 2000; Buck *et al.*, 2004, as cited in Benadé *et al.*, 2014:220).

Invasive organisms such as the European paper wasp are considered by invasion biologists as a major threat to the indigenous biodiversity of a country. It is also suggested that *P. dominula* is likely to displace one of South Africa's indigenous paper wasps, *Polistes fuscatus*, in at least parts of its invasion range, due to the superior productivity and survivorship of *P. dominula* colonies (Liebert, Gamboa, Stamp, Curtis, Monet, Turillazzi & Starks, 2006:595). The European paper wasp also affects local biodiversity through direct predation or competition for food or space with the native wasp species (Beggs *et al.*, 2011:505). This IAS is also very well adapted to human habits and more tolerant to human presence than *P. fuscatus* (Curtis & Stamp, 2006, as cited in Beggs *et al.*, 2011:515). Major efforts have been made towards understanding the process that is driving the invasion by the wasp, as such an understanding is essential to develop management strategies that would limit its spread (Benadé *et al.*, 2014:1). The pathway of introduction is not clear, but Hulme *et al.* (2007, as cited in Galimore) conclude that "the main pathways or routes of insect invasions are as contaminants of commodity that was imported, and stowaways on transport vectors, while some arrive unaided through natural range expansions". Thus, these are possibly the most probable pathways of introduction of the *P. dominula* in South Africa.

In the last eight years, three recordings of the presence of the *P. dominula* in South Africa were published. In 2009, it was spotted in the Western Cape in the suburb of Kuilsriver. At the time, it was predicted that it would spread and become invasive in other regions of South Africa, as it is not confined only to the Mediterranean climatic zones. (Benadé *et al.*, 2014:2–3). Between 2010 and 2013, a number of specimens were collected in the Stellenbosch area, 13km east of Kuilsriver, and it is clear that this IAS is already well established in the area. New data have revealed that the European paper wasp is also present in Jonkershoek to the east, in Paarl to the north, and Somerset West/Strand to the south, of Stellenbosch.

It is believed that the Hottentots-Holland mountain range, running from Betty's bay northwards, has curbed the further spread of this species. In 2013, four European paper wasps were also collected in Grabouw and Knysa (Benadé *et al.*, 2014:2–3). This IAS is therefore spreading rapidly within Stellenbosch and its environs, and consequently, the need for assistance from the public in eradicating this species is growing.

According to Benadé *et al.* (2014), the paper wasp is a “fairly aggressive wasp” which builds nests on buildings and other man-made structures. Thus, it tends to come in close contact with humans. The impact the wasp has on humans is its painful sting, which can occasionally cause a life-threatening allergic reaction (Golden *et al.*, 2006, as cited in Beggs *et al.*, 2011:510). As a result of its sting, the wasp disrupts human activity, such as outdoor recreation and forestry operations, as it does not only build its nests in man-made structures, but also on trees. In the case of wasp nests in gardens, where they can be obscured by vegetation, stings tend to result from accidental nest disturbance (Beggs *et al.*, 2011:511).

This constitutes another reason to communicate information regarding the wasps to the public. Furthermore, in the Stellenbosch area, the European paper wasps build their nests on the vines and supporting structures in the vineyards, resulting in financial losses for the farmers. The wasp invasion also affects harvests, and farmers sustain great expenses on insecticides and manpower to remove the nests (Benadé *et al.*, 2014:2).

For invasion ecologists who have conducted the research on its effects, this IAS is clearly a problem that needs to be eradicated. One of the questions that my study will attempted to answer is, does the public construct the European paper wasp the same way as the ecologists, i.e. as problematic?

2.3 THE SOCIAL CONSTRUCTION OF INVASIVE ALIEN SPECIES AS “PROBLEMATIC” AND A “THREAT” TO THE ECOSYSTEM

Invasion biology is a branch of science that addresses the causes and consequences of introducing alien organisms to new environments, where some are able to persist and spread unaided, often with substantial negative consequences. The invasion of natural and modified ecosystems by alien species is a growing problem worldwide (van Wilgen, Davies & Richardson, 2014:1).

As this quotation reflects, invasion biologists consider IAS as problematic, and a threat to both natural and modified ecosystems. Larson (2008:16), however, provides an opposing view. He questions why IAS cannot be accepted as part of the natural biodiversity, especially since it is inconceivable that the biodiversity will be returned to its original state of perfection. IAS are viewed as one of the reasons why our biodiversity is changing, and not for the best.

But is this construction of IAS as a “threat” a result of shifted blame? According to Larson, the social construction of the IAS as problematic is misplaced. In as much as these species are causing

problems, humans are also doing so, by bringing about changes in the environment, such as building homes in woodland areas and subdividing forests.

A question then comes to mind: how is the discourse that IAS are a threat and problematic to the various ecosystems maintained? In an attempt to answer this question, as mentioned in Section 1.4.2, I will consider IAS from a social constructionist approach, reflecting critically on the construction of IAS as problematic, and needing to be eradicated urgently.

Social constructionism as a theoretical orientation has no single definition, because, it is broad, underpinning to a lesser or greater degree more recent social science approaches to the study of human beings as social animals (Burr, 2003:1). One may, however, view social constructionism as an approach that has its foundations in a number of key assumptions (Gergen, 1985, as cited in Burr, 2003:2), the first of which is a critical stance toward taken-for-granted knowledge. Social constructionism “insists that we take critical stance towards our taken-for-granted ways of understanding the world, including ourselves”. It invites us to be critical of the idea that our observations of the world unproblematically yield its nature to us. It challenges the view that conventional knowledge is based upon objective, unbiased observation of the world. Therefore, it stands in opposition to the positivism and empiricism that is associated with traditional science (Burr, 2003:3), such as invasion ecology. Social constructionism also cautions us to be ever-suspicious of our assumptions about how the world appears. A second key assumption is historical and cultural specificity, i.e. that the way we view and understand the world, its concepts and categories, are both historically and culturally specific. Therefore, we do not all view the world the same, as our understanding is shaped by our historical and cultural context (Burr, 2003:3).

Thirdly, social constructionism has its foundation in the key assumption that knowledge is sustained by social processes. The knowledge of the world and the understanding of the world is constructed among people through daily interactions. Through these interactions, our knowledge of the world becomes fabricated, therefore social interactions of all kinds, and particularly language, is of great interest to social constructionists (Burr, 2003:3–4). It also means that what we regard as truth, which varies historically and cross-culturally, may be thought of as our currently accepted ways of understanding the world. The final assumption is that knowledge and social action go together: the negotiated understandings of the world could take on a wide variety of different forms, thus producing numerous social constructions of the world. Each social construction brings with it a different kind of action from human beings.

Having understood social constructionism as a general approach, I will now proceed to focus on social constructionism in relation to natural science, by highlighting that, when

scientists agree on a claim, they literally make it true. The world corresponds to agreement, not the other way around. Similarly, when engineers create agreement on what the most efficient solution to a problem is, they literally make that solution the most efficient one (Sismondo, 2010:68).

In other words, as stated before, reality is something that is created through a social process, therefore rendering it a non-static factor. When applied to the European paper wasp, scientists studying it as an IAS have agreed that this species is a problem that needs to be eradicated. Considering the quote by van Wilgen *et al.* on IAS, which introduced this section, it is clear that a conclusion has been reached that IAS is growing problem, based on the scientific knowledge available. Therefore, a direct connection was made between knowledge and reality. Social constructionism, however, is opposed to the notion that our knowledge is a direct perception of reality. It is based on the belief that, as a culture or society, we construct our own version of reality amongst ourselves (Burr, 2003:6).

As a result of various social interactions among individual researchers studying the wasp and the institutions with which they are affiliated, this reality of the European paper wasp as a problematic species – as a threat to “indigenous” ecosystems – has become truth to them. The public, however, also constructs the wasp as problematic, but it is expected that their construction is based on non-scientific discourses, such as it being harmful, being a nuisance, negatively affecting their outdoor activities and an economic liability.

Larson (2008) speaks of two ways of viewing IAS: “we can view them as pernicious, they are taking over and driving out indigenous species. On the other hand, we can view them with acceptance, species come and go, some we will like some we will not like”. According to Larson (2008:16), “we (researchers and practitioners in the field of invasion biology) have chosen to go with the first explanation which poses IAS as a problem that we have to get rid of”. Larson (2008) then poses a question: who made us kings and queens of creation with the right to decide what is right and wrong? As a result of humans’ neglect of the planet, the world is currently facing major environmental challenges, ranging from global warming to habitat loss. In the context of these large-scale changes, IAS are a convenient focus for activity, as it is easier to face the smaller problem than to deal with the larger problem, which is the “diverse environmental problems we face as a result of how we (humans) have chosen to live on our home planet” (Larson, 2008:14).

To illustrate, when asked about his opinion of the effects of the introduced Sitka black-tailed deer on the ecosystem of Haida Gwaii, a person’s response was: “I look at the deer the same way as white man and what they’ve done to us” (Larson, 2008:14). Larson (2008) likens this response to the

limitation of how IAS are currently viewed by invasion biologists, i.e. as a problem in themselves rather than a symptom – a riffle within a torrent of global change brought about by our species” (Larson 2008:14). In the light of this global change, it is convenient to attribute the changes to the indigenous ecosystem and other environmental infrastructures to IAS. In light of this view of IAS as a “foe”, it is easier for invasion biologists to say that there is a level of control of IAS before they take over, than searching for ways of dealing with IAS – we can just simply reach down and uproot a plant or cull an unwanted mammal. This level of control can be likened to “xenophobia”, but Simberloff (2003) is very critical of this idea that invasion control is a form of xenophobia.

On the other hand, the way that IAS is conceptualised is very habitual, and the ideas are carried from one generation to the next. Larson (2008) suggests that we consider addressing the difficult questions, such as what our role and place is in nature that allows the spread of IAS. In the process of being obsessed with controlling and eradicating IAS, we have made them “the enemy to justify controlling them and subjugating them; they have been reduced to an ‘other’ rather than an element of biodiversity that we care about” (Larson, 2008:16). This statement resonates with Simberloff’s (2003) concern regarding the idea of “attacks” on IAS as xenophobic. As Sismondo mentions, in science, once there is a consciousness of something, it becomes reality. However, according to social constructionism, a critical stance toward such a taken-for-granted reality should be maintained, as this reality is historically and culturally specific, and has been constructed (and is sustained) by social practices that constitute science. Worldwide there is agreement amongst researchers and practitioners in the field of invasion biology that the European paper wasp is an IAS that needs to be eradicated. This agreement has developed through a number of social discourses within the scientific community, which has then created this reality.

The use of language is a form of action that highlights the socially constructed nature of the notion of IAS as problematic, and some social constructionists take this “performative” role of language as their focus of interest. In the case of my study, it is important to ask whether the language used to explain the effects of the European paper wasp – such as the sting, the resulting itch etc. – have an impact on how the public perceives the European paper wasp. For example, certain phrases and words are used to create a picture of a “war” taking place between the community of invasion biologists and IAS. This “war” is evident in the militaristic language used by biologists, such as “invasive”, and “eradication strategies”. The language further strengthens the construction that IAS are problematic, and that there is an immediate need for them to be eradicated (Larson, 2009:499). Thus the language in itself produces action. This resonates with Burr’s (2003) final assumption of social constructionism, i.e. that knowledge and social action go together. But Larson

(2009) states that we will never win this “war”, as we will never return the ecosystem to a pristine state – a view that is contrary to the one maintained by other biologists who believe that the “war against IAS” can be won.

Larson shows us that there is an alternative to the conventional understanding of IAS, i.e. viewing IAS with acceptance: species come and go; some we might like and others we might not. But as a result of a consensus among invasion biologists and some members of the public, IAS are viewed as problematic, and that remains a “truth” in their context. This then reveals that the construction of IAS as a problem and a threat to the indigenous ecosystem is a result of a social process, thus making this “truth” socially constructed. My thesis will attempt to explore if the residents of a low-income community in Stellenbosch also construct the European paper wasp in the same manner as the invasion biologists, i.e. a problem that needs to be eradicated. Or, are they inclined more towards Larson’s (2008) suggestion of accepting IAS, in this case the European paper wasp, as part of life.

2.4 PUBLIC UNDERSTANDING OF SCIENCE

My research objective places this study within the field of PUS which emerged during the early 1980s as an area of social research (Bauer, 2009:1). Bauer (2009) defines PUS research as

a field of activity and an area of [...] social research [...] Secondly, it refers to the social research that investigates, using empirical methods, what the public understanding of science might be and how this might vary across time and context. This includes the conceptual analysis of the term understanding [...] (2009:223).

The origins of PUS as a research field can be traced back as far as a decade ago, to a debate about the concepts of PUS versus scientific literacy. In brief, this debate asks the question of whether we may view the public as scientifically illiterate, or whether the public is more knowledgeable about the subject matter of interest. Furthermore, this debate revolves around whether it is a matter of scientific literacy or knowledge (Bauer, 2009:223– 224). As a result of this ongoing debate of PUS vs. scientific literacy, PUS’s “efforts were directed towards developing indicators of scientific attitude, perception, information and knowledge prevalent among the public” (South African National Research Foundation [NRF], 2004:2). In studies that were conducted during the early years of PUS development, these concepts were measured through surveys, whereby the public was divided into those who are scientifically literate and those who are not. The results of these early studies in this research area revealed that there was (i) a low level of scientific literacy amongst the public; and (ii)

no evidence that the changes in science teaching techniques, curriculum content and communication methods, or an increase in expenditure on science and technology, created a radical shift in the scientific literacy level. However, as experts from other fields such as law, linguistics, political science and sociology joined the debate, fresh perspectives were brought to the emerging field of PUS (Raza, Singh & Shukla, 2009:270). I will now proceed to view literature on PUS in the South African context.

2.4.1 PUBLIC UNDERSTANDING OF SCIENCE IN THE SOUTH AFRICAN CONTEXT

In the post-apartheid South African context, science communication and PUS have developed as separate disciplines, but in academic institutions PUS remains neglected as a field (du Plessis, 2012:163). Du Plessis (2012) depicts the development of PUS in South Africa, focusing on the historical context of the country. She argues that the history of the country during apartheid has greatly affected the development of the discipline and the scientific literacy levels of the public. Thus, in the South African context the measurement of PUS and scientific literacy has to be conducted within the context of the country's political history. In South Africa there have been a number of efforts aimed at increasing scholarly interest in science communication and PUS, such as the International Conference on Science and Society, organised by the NRF in 1998; the seventh Public Communication of Science and Technology International Conference on Science Communication held in Cape Town in 2002; the first African Science Communication International Conference in December 2006; and the second such conference which followed in 2009, with the aim to improve the level of PUS studies in the country. Despite these efforts, PUS remains undeveloped in the country (du Plessis, 2012:164).

A 2009 Human Science Research Council (HSRC) Report titled *Science and the publics: A review of the public understanding of science studies* presents an overview of South African PUS research. The report states that, "South Africa does not have a systematic, comprehensive and nuanced assessment of the public's relationship with science" (as cited in du Plessis, 2012:165). The report argues in favour of policies that are more knowledge-based than resource-based to harness the growth potential of the knowledge economy for socio-economic development. Against the background of the highly stratified nature of South African society, the report suggests a relationship of science with "public(s)" rather than the public. I am also interested in this relationship of science with "publics" in South Africa, or a particular "public", defined by a relatively low socio-economic status.

Also, there is a notion that a public's relationship with science is shaped by the culture with which that public is associated. Between 1991 and 2007, a few small-scale PUS surveys were conducted in South Africa, but these focused mainly on one topic and primarily involved "white" people as respondents. This led to the HSRC report reaching the following conclusions regarding existing scholarly work: i) science communication perceptions are still dominated by racial perceptions, and there is an absence of a fair representation of the country's racial demographics; ii) the public(s)' perceptions exist in theory only; iii) the public(s) is/are still viewed as deficit in scientific knowledge and the scientists are still following the globally contested deficit model of science communication; and iv) a recent development involves attempts to understand a bio-directional relationship between the public and science (du Plessis, 2012:165). This development includes issues related to understanding the communication of messages about science and technology, the dynamics of attitude and belief formation regarding science and technology and, importantly, access to information about science and technology. Other areas that need attention in the development of PUS in South Africa include policy that supports PUS not only on paper, but translated into projects and programmes; ii) the uncertainty that exists regarding the definition of science; and iii) the need for the development in South Africa of an understanding of issues related to science communication (du Plessis, 2012:165).

PUS still has to develop in South Africa, but one has to keep in mind that social and political transformation takes time. For a country that has a long history of political subjugation, social oppression and intellectual neglect, the process will take longer. Social and political transformation will have a direct impact on the development of PUS as a field in South Africa (du Plessis, 2012:166).

2.4.2 PUBLIC UNDERSTANDING OF SCIENCE AND CULTURAL DISTANCE

The field is also concerned with "empirically determining the cultural distance of a scientific explanation from the quotidian life of common citizens" (Raza *et al.*, 2009:272). Cultural distance is defined as the extent to which "a worldview, attitude, perception, or an idea, generated within one cultural context, travels on a time scale for its democratisation within the thought structure of the other cultural sub-group(s)" (Raza *et al.*, 2009:272). Cultural distance is increased by a number of factors, including those of a socio-cultural and socio-economic nature. Thus, PUS aims to address the challenge of traversing this distance when communicating science to a diverse public in a form that they can understand. With regard to attaining this aim in the field of PUS, two major but conflicting models can be identified: the dominant model and the deficit model.

According to the former, the knowledge that science produces is too complicated to be widely understood. Thus, mediators translate that knowledge into simplified accounts for general consumption. This model is linked to popularisation theory (Sismondo, 2010:170). However from the point of view of the scientists, simplification always represents distortion. Therefore popularisation is a necessary evil that cannot be done by scientists, as “the culture of science heavily discourages scientists from taking the role of mediators, and shapes how they mediate when they do” (Sismondo, 2010:170). Popularisation is considered as potentially polluting the sphere of pure research (Sismondo, 2010:170). Popularisation theory has been criticised for its assumption that scientific knowledge is not linked to any context, which underlies its argument that “popularisation pollutes scientific knowledge by simplifying or otherwise changing it to fit non-scientific contexts” (Sismondo, 2010:174).

On the other hand, the deficit model characterises the public as deficit in knowledge. This deficit allows non-scientific assumptions to become entrenched, thus making it difficult for the public to take up new and correct information (Sismondo, 2010:176). For the purpose of my study, I will be using the deficit model for reasons that will be discussed in more depth in the next section on science communication.

2.4.3 THE PUBLIC’S ACCEPTANCE OF SCIENCE COMMUNICATION

Once scientific information has been communicated to the public, the question always remains: How do they receive this information? According to Ziman (1991), four principles govern the way people receive (and use) scientific knowledge.

- 1) *Incoherence*: The information that the public gathers is not simply a filtered version of formal scientific knowledge. Rather, its meaning is actively constructed by the processes and circumstances in which it is communicated or received. When applied to my project, this principle raises the question of whether communication of formal scientific knowledge of the wasp is coherent with the public’s life experiences of the wasp.
- 2) *Inadequacy*: The use of formal scientific knowledge by the public depends on their need, at that moment, for receiving the information. Thus the level of response from the public varies according to need. In the case of my project, it is most likely that those who are affected by the wasp will respond far better to the information on the wasp than those least affected would, as contending with the wasp is an immediate need for them.

- 3) *Incredibility*: People do not passively accept the information given to them by scientific experts, but they evaluate it first. The credibility of the source of information depends strongly on how its interests in a particular context are perceived by the public. In the community I will be studying, it will be of great interest to investigate this issue of credibility. However due to time constraints, I decided not to pursue the theme of credibility. It is a very important topic and thus should be a topic for future research.
- 4) *Public conflicts* on social and environmental issues between scientific experts inevitably downgrade the privileged position of scientific knowledge. However, public and private discussions help people to confront all forms of scientific knowledge with what they are currently experiencing.

These four principles assist in understanding how the public assimilates the scientific information they receive. The assimilation of information also plays a role in the level of understanding they will have of the information they have received; thus, it is important for the field of PUS to acknowledge the role that the social context plays in how the public receives scientific information. Kurtz (1966:1) affirms this by stating:

Scientific knowledge is not received impersonally, as the product of disembodied expertise, but comes as part of life, among real people, with real problems, with real interests, in a real world. If the understanding of science does not help the citizens to make decisions and is not exhibited in their daily actions, then it is not an understanding.

2.4.4 SCIENTIFIC AND ENVIRONMENTAL LITERACY

Another aspect of PUS is scientific literacy, which Miller (1983) defines as consisting of three dimensions: i) an understanding of the norms and methods of science (i.e., the nature of science); ii) a basic understanding and use of scientific and technical terms (i.e., science content knowledge); and iii) an awareness and understanding of the impact of science and technology on society. According to Miller (1983), for a citizen to be considered scientifically literate he/she needs to have a basic vocabulary of scientific terms and constructs and a general understanding of the nature of scientific inquiry. For Durant (1993), scientific literacy “stands for what the general public ought to know about science”. This commonly implies an “appreciation of the nature, aims and general limitations of science, coupled with some understanding of the more important scientific ideas” (Jenkins, 1994:5345). For Shen (1975), scientific literacy is a construct that should be viewed as a series of separate measures, such as citizen roles, consumer roles, and general level of cultural understanding.

Considering the above definitions, in this study I conceptualise a scientific literate citizen as someone who has an understanding of science and an appreciation for science.

There are also a number of definitions and interpretations of scientific literacy which are influenced by factors such as which interest group's scientific literacy is focused upon (Laugksch, 2000:74). Laugksch (2000) describes four different interests groups. The first is the science-education community "which is concerned with the nature (i.e., purpose), performance, and reform of existing educational systems". The second group is comprised of social scientists and public-opinion researchers. This group is concerned with the extent of the public's support of and participation in science and technology. Also, it enquires into the public's perceptions and attitudes towards science and technology. I can place my project partly in this category, as I am measuring perceptions and attitudes regarding an IAS. The third interest group includes sociologists of science and science educators who are employing a sociological approach to scientific literacy. Their focus is on the construction of authority with respect to science, such as organisational forms of ownership and control of science. I also belong partly to this interest group, as I am also considering the authority of science to construct the European paper wasp as a problem. The final group is defined as the informal science-education community, the members of which in general write about science because they have an interest in it, and to help familiarise the public with scientific matters.

When attempting to define scientific literacy, a central term to take into account is understanding. Understanding is a broad term, ranging from an elementary idea of what something means (or how it works) to a deep, professional understanding of a concept or construct in the full context of a field. In my research project, the questions that will assist in examining scientific literacy amongst the public will be: *"Do they understand what the wasp is, and what it does that directly affects them?"*

As mentioned before, there are many different meanings and interpretations of scientific literacy. This has given rise to a view that "scientific literacy is an ill-defined and diffuse concept" (Bybee, 2008:12). Having acknowledged the difficulty in defining this construct, Bybee (2008) states that scientific literacy is essential for an individual to fully participate in society. It also empowers a citizen to make personal decisions and appropriately participate in the formulation of the public policies that impact his/her life. Bybee (2008) further argues that a scientifically literate individual does not only have an understanding of science, but this understanding leads to an attitude that contributes to action. When applied to the primary focus of this project, i.e. science communication on the wasp, the ideal outcome of such communication is an increase in the public's understanding of the wasp, and in turn, their ability to take action. It is important to acknowledge that, besides lack

of understanding, there are other factors that could affect the public's active response to science communication, such as access to resources and services, for example in the form of financial resources and social capital.

For the purpose of my project, I also reviewed literature on environmental literacy. My project concerns an ecological problem which is considered part of the broader field of environmental science, hence my need to develop an understanding of the field of environmental literacy. Environmental literacy is "an aspect of scientific literacy that extrapolates onto the knowledge of environmental science" (Khishfe, 2014:3068). This definition is applicable to my study, as one of the focus areas of my study is the public's knowledge on an issue within the environmental science of invasion ecology. UNESCO (1997) also defines environmental literacy, and does so as follows: "the basic functional education for all people, which provides them with the elementary knowledge, skills, and motives to cope with environmental needs and contribute to sustainable development". Miller (2010) defines environmental literacy as the ability to recognise that one's choices have a great impact on the environment, and to identify the most appropriate and sustainable solutions to a problem, while at the same time being environmentally friendly.

Similar to scientific literacy, environmental literacy is therefore a term that has many definitions and can be understood from various perspectives, and the notion that environmental literacy is essentially the result of education about environmental-science content is insufficient. However, the only way to achieve effective environmental science communication is to create a dialogue between science and society, and use this dialogue as a means to promote environmental literacy (Khishfe, 2014:3068). My study aims to understand the public's perspectives on and attitudes towards the European paper wasp, thereby opening the environmental-science dialogue and improving communication between society and the science of invasion biology.

In the South African context, the challenge faced in the development of environmental literacy is similar to that experienced in the development of scientific literacy- as discussed in section 2.4.1. Du Plessis (2012) attributes this challenge to the country's political history, in particular racial segregation, that had an impact on the educational system – that affected the learning of the citizens – by creating a nation consisting of multiple cultural differences, and therefore one that is simultaneously first world and third world. Post-apartheid, the government has been attempting to reconcile these two extremes and create a "rainbow nation". The National Department of Basic Education is continually adjusting the curricula to improve scientific literacy, on the basis of the assumption that a scientific citizen is moulded from a young age (Du Plessis, 2012). Webb (2009) suggests an integrated strategy to science and environmental education in schools which includes

reading, listening, writing and speaking. All these factors are important in developing scientific and environmental literacy. Webb (2009) also notes that the multiple languages in South Africa pose a challenge, because many children are taught environmental science in a language that is not their first language. It is also clear that scientific and environmental literacy studies in South Africa are biased against adults. There is a need for research in this field that involves the adult population of this country, hence my decision to investigate the levels of environmental literacy amongst the adult population.

For there to be understanding, some form of communication must take place. Within the discipline of PUS, science communication is the field that is concerned with the communication aspect of the public's understanding of science. A brief discussion on this field of science communication will now be presented.

2.5 SCIENCE COMMUNICATION

Science communication is a "process by which the culture and knowledge of science are absorbed into the culture of the wider community" (Bryant, 2002:3). Science communication can also be defined as "the use of appropriate skills, media, activities and dialogue to produce one or more of the following personal responses to science: awareness, enjoyment, interest, opinions and understanding of science" (Burns, O'Connor & Stocklmayer, 2003:190). Referred to as the AEIOU definition (the acronym of the personal responses), it clarifies the purpose and characteristics of science communication, providing a basis for evaluating the success of the communication (Burns, O'Connor & Stocklmayer, 2003:190).

In 1998, the United States' National Aeronautics and Space Administration (NASA) established a panel of science communicators, communication researchers, Pulitzer Prize-winning journalists, and scientists to assist in its efforts to communicate its research to the American public (Borchelt, 2001:196). During a panel discussion, three purposes of communicating science to the public were identified: i) "to inform consumers, patients, and citizens about scientific activities, products or conclusions that may be useful in improving the quality of life generally or in regard to specific problems, issues or events"; ii) "to provide information for citizens to enable them to understand, think about, and perhaps participate in the formulation of public policy on specific issues"; and iii) "to provide descriptions and explanations of scientific work to enhance the level of scientific or biomedical literacy in the recipient" (Borchelt, 2001:197). For my study, the first purpose is the most

relevant, as effectively communicating scientific information about the European paper wasp could improve the quality of the life of those affected by it.

The panel also proceeded to agree on the following six principles of scientific communication:

- 1) There is no such thing as “the general audience”. The public cannot be placed into a single group, because people use science and technology for different reasons, and the level of understanding differs amongst the public. Therefore, the “effectiveness of communication – the accurate receipt and use of information – can be improved substantially by carefully defining intended audiences and by tailoring the level of information provided to each audience” (Borchelt, 2001:203). This principle initially applied particularly well to my study, as originally designed (see Chapter 3), as it informed my initial intention to collect data from and compare two communities that differ quite widely in socio-economic terms, but are affected by the same problem.
- 2) The scientific community and managers of the science enterprise (including individual agencies, institutions and organisations) are faced with a challenge when they have to distinguish between understanding of science and appreciation of science (or of research institutions). This lack of understanding of the difference between the two goals then affects the communication process. In the case of my study, the public is aware of the wasp, but they do not have an understanding of it, which could explain a low response rate to the communication efforts by SANBI . Furthermore, there is a possibility that the public could appreciate science without an understanding of it. Therefore, appreciation does not equal understanding.
- 3) Science-and-technology communication should not be driven by the research enterprises’ desires about what the public should know, but rather by the desire to meet the audience’s needs and interests (Borchelt, 2001:203). My study is a response to the WRC’s needs, and by conducting my study, I will be able to determine what the public’s needs and interests are. On the basis of the results, the WRC will be able to communicate, in an appropriate manner, information that meets the needs of the public.
- 4) The active involvement of scientists and engineers (or rather, in the case of this study, environmental managers) is critical to the success of science communication. It clearly emerged from meetings that I had with some of the members of the WRC, that the more the scientists are involved in the communication process, the more effective science communication will be, because when scientists and managers interact with others, such as social scientists, they expand their knowledge on social issues and how to approach them. Hence, they prevent making the same mistakes when communicating scientific information to the public.

- 5) Science communicators who can foster mutual respect between scientists and public's external to the scientific sphere, are essential to effective public communication of science.
- 6) The proliferation of new media and the fragmentation of existing media are having a profound impact on how and with whom one communicates about science and technology. The shift from traditional forms of media communication to more digital ones has had a significant impact on science communication (Borchelt, 2001:204). The public no longer has an interest in long messages, and they are attracted by visuals. Therefore, this move to digital forms of communication forces science communicators to be more creative and communicate their message in the shortest way possible.

Although the European paper wasp has over the past few years spread around the Western Cape, the low response to SANBI's communication suggest that there is a lack of interest amongst members of the public on this issue. The research problem my study ultimately aims to address is a lack of action or participation by the public in relation to SANBI's efforts to eradicate that wasp. One possible reason for this impassiveness originates from the deficit model. As explained in section 3.1, the deficit model characterises the public as "deficient in awareness and understanding" and therefore "science is transmitted by experts" to them as audiences (Trench, 2008:4). The low response rate to SANBI's communication efforts could possibly be a result of the public's deficit in scientific environmental knowledge, especially about the European paper wasp.

I am aware that this model has been criticised. For example, the argument that so-called "irrational" fears of the lay public are a result of lack in understanding of scientific knowledge has been challenged by the contrary argument that people select risks to worry about according to the norms of their social milieu, rather than responding to supposedly more "objective" hazards (Hayes & Tariq, 2000:12). Secondly, researchers working within the deficit model have been criticised for their almost exclusive use of measures of scientific understanding via quantitative survey research design (Hayes & Tariq 2000:15). Lastly, the argument is made that proponents and opponents in scientific controversies are likely to select different domains of knowledge as being relevant or important. It is further argued that the "survey takes the respondent out of their social context and is intrinsically unable to examine or control analytically for the potentially variable, socially rooted meanings that key terms for social actors" (Hayes & Tariq 2000:15). As much as these criticisms are valid, in my view they do not sufficiently problematise the deficit model to justify abandoning it entirely. Once the target audience, which is seen as deficient in scientific knowledge has been identified. Communication methods have to be created to communicate the science to the public.

Therefore, I will be viewing literature on principles that could guide in developing successful science communication.

2.5.1 PRINCIPLES OF CREATING SUCCESSFUL SCIENCE COMMUNICATION

The creation of effective communication methods lies at the centre of science communication. In this section, I will be considering a few principles of successful science communication, which can be used as a guide when developing communication methods. Schweizer, Thompson, Teel and Bruyere (2009) provide ten key principles that could increase the effectiveness of the communication of science, specifically the science of climate change, to the public. Four of these ten principles are applicable to my study, because I will be describing the public's action regarding wasp eradication, which is similar to Schweizer *et al.* describing public response to climate change. The three principles are: i) know your audience and send a credible messenger; ii) know what claim or argument you are making and assess if it is appropriate for your audience; iii) connect your message with your audience's cultural values and beliefs. Connecting the message with the audience is very important, because when people can relate to something, they react more readily than when presented with abstract concepts; and the presentation of one's message should be made meaningful and appeal to the values of one's audience (Schweizer *et al.*, 2009:272).

In my study, these principles were used in conjunction with the evaluation of the SANBI communication plan. Considering the three methods (i.e., pamphlets, radio interviews and newspaper articles) that are currently being used to communicate the issue of the European paper wasp as an IAS, it is important for SANBI to keep these principles in mind, because they can be used as a guide to develop and analyse the effectiveness of these methods. Bultitude (2011) expands on these principles by providing five practical tips for creating successful science communication:

1) *Know your audience*

As mentioned earlier, the public is not homogenous, therefore "one size" does not "fit all".

2) *Think creatively*

Society is not static and trends are constantly changing, therefore science communicators need to be able to come up with methods of communication that are current and attractive to the audience.

3) *Learn from others' experience*

Inasmuch as it is important to take ownership of one's science communication activity, in most cases one would be able to find other science communicators that have dealt with one's topic and

delivered the message successfully. Learning from them will only increase the chances of one's project being successful.

4) *Evaluate your own activities*

It is important to always evaluate the communication process. This should include monitoring and impact.

5) *Enjoy yourself*

When the public experience the science communicators as enthusiastic, they are more likely to respond positively.

SANBI is currently using three communication methods: pamphlets, radio interviews and newspaper articles. My study uses the respondent's assessment of the pamphlet as a means of measuring perceptions of the European paper wasp.

2.6 CHALLENGES INVOLVED IN THE COMMUNICATION OF SCIENCE TO THE PUBLIC

Within the field of the PUS, various researchers have noted a disconnect between science and the public, and that this disconnect has a number of implications (Brossard, 2013:14096). While the public can potentially play an important role in the process of eradication and management of IAS, invasion biologists face challenges in relation to the communication of their science to the public that, according to Scheufele (2013:14047), are common among natural science researchers. The first of these challenges relates to the public's preparedness for new scientific information, as citizens do not seem to readily accept new scientific discoveries as truth. The European paper wasp was first documented in South Africa in 2008, and research on this species has been conducted in the past four years (Benadé *et al.*, 2014:220). As an IAS it is not new to South Africa, but scientific discoveries regarding the wasp and its effects are new. Secondly, the nature of science poses challenges, as much uncertainty exists around new scientific discoveries, which exacerbates the first challenge of the public's reticence to accept new scientific discoveries. Thirdly, crumbling science–public “infrastructures” are the result of the rapid decline in traditional communication methods, such as print media in favour of online forms of communication. Lastly, another challenge concerning science–public interfaces concerns the fact that scientists are trained in communicating their research to their peers rather than to those outside of the scientific sphere (Scheufele, 2013:14042–43). As Brossard states, “scientists do not have the ability to market their product well and to communicate to the public directly” (2013:14097).

The above mentioned challenges stem mostly from the incorrect assumption that science should be debated and discussed in isolation from personal beliefs and views (Scheufele, 2013:14044). What renders this assumption incorrect is a clear trend over the past few years that, to achieve its goals, science is increasingly in need of interaction with, and participation by, the public (Scheufele, 2013:14047). Thus, science can no longer be viewed in isolation from society, but needs to be integrated with society. This point is clearly illustrated in my study, as it is motivated by the realisation that it would be near impossible to eradicate the European paper wasp from South Africa without the insights of, and assistance from, the public, because the wasp nests are usually located on private property, and therefore institutions such as SANBI and the City Of Cape Town will only have knowledge of the nests if the residents report them.

The widening gap between science and the public is further exacerbated by a lack of understanding and awareness among the public as to what action has been taken and needs to be taken. Without an understanding of what needs to be done, individuals receiving information on environmental issues may feel frightened or simply overwhelmed by the information, which then prevents them from reacting. Until now SANBI has been communicating information about the wasp to the public through newspaper articles, radio interviews and pamphlets, but SANBI has not been receiving the desired response, i.e. an increase in the public's reporting of wasp observations. Therefore, my project will also attempt to assess the effectiveness of these communication methods. Another major challenge when communicating to the public is to ensure that the scientific information is "brought home" for them to understand. Unfortunately, in science there is a tendency in the development of communication methods to not use examples that are practical or relevant to the public's immediate surroundings, thereby "losing" the audience (Brossard, 2013:14098).

What is clear from the literature reviewed above is that the communication of science, including invasion biology, to the public currently poses a number of challenges. Another challenge facing science communication is the issue of language. Next I will be reviewing literature on science communication and indigenous languages.

2.7 SCIENCE COMMUNICATION AND INDIGENOUS LANGUAGES

South Africa is a country that has eleven official languages, therefore it is imperative to consider the relationship between science communication and indigenous languages. Information is better received when communicated in the indigenous language of a community (Nkomo, 2008:2). However, the dominance of English as the *lingua franca* of science and also as the international language of science communication is well documented (Ferguson, 2007:7). In Africa, during colonialism, indigenous languages were deficient in terms of writing compared to English. Indigenous languages were only transferred orally. As a result, English and other colonial languages which were available both in spoken as well as written form, had an advantage over indigenous languages. By the time that “African languages were put into writing by missionaries for the purposes of education and evangelisation, they were already trailing behind those of the colonisers” (Nkomo, 2008:1).

Post-independence, colonial languages continued to be used more than indigenous languages in teaching and official communication (Nkomo, 2008:2). Where science and technology is concerned, most of the knowledge is imported from the West. Due to this importation of knowledge attention has to be given to the translation process, if any that takes place when scientific names and technological concepts enter African societies. Are they successfully translated or they remain unchanged? This raises the issue of “terminology development”. This concept can be defined as “the process of naming concepts which includes collection, description and presentation of terms in a way that displays the relationships between concepts and the terms of the particular field” (Nkomo, 2008:4). Ultimately, the objective is to make sure that the African terminology that is created carries across the same meaning in the indigenous language as in the original language of the terminology.

This leads one to consider two methodological terms that concern the translation of survey questionnaires and interview schedules: lexical equivalence and conceptual equivalence. The former refers to asking the same question in a questionnaire or interview schedule in the same words as in the original language. The latter refers to the equivalence of meaning, i.e. is “the term transferred “from one culture to another unambiguously?” (Babbie & Mouton, 2001:238–239). In other words, the translation of scientific terms and concepts from one language to another must not only lead to terms that are equal in meaning and understanding, but must also not be ambiguous to the reader or the listener in the other language. In the case of my study, the translation process proved that some of the scientific terminologies used in the interview schedule are not found in the Xhosa language. This then created a language barrier because there were no terminologies to communicate with the respondents. This problem of language as a potential barrier in science communication does not only

apply to communication between scientists and the public, but also amongst scientists. A 2008 article in science and society, titled “Is there science beyond English”, stated that, for a scientist to obtain any international recognition, he/she must be able to master scientific English, because scientific English has become a communication tool in a less erudite world consisting of those who want to learn about and pass on knowledge.

The mere fact that scientific knowledge is not easily (if, indeed, at all) accessible in indigenous languages – through academic journals, newspapers or public campaigns – limits the spread of this knowledge. More scientists would benefit if their research could be made accessible in indigenous languages, as it could then reach a greater audience, thereby increasing exposure of their work (Meneghini & Packer, 2007:2–4). For the purpose of my study, am interested in the relationship between science and the public, and therefore the role this language barrier plays in understanding public perceptions of, and attitudes towards, biodiversity-conservation issues – in the case of this study, the European paper wasp. It is also highly likely that this this language barrier could affect my ability to research the public’s perceptions and attitudes towards the European paper wasp.

The Bilingual Exhibit Research Initiative (BERI) is an American study on the perceptions and experiences of Spanish-speaking visitors at bilingual science exhibitions across America. It revealed that the visitors appreciated the ability to access the information in their native language, as it improved the process of learning and understanding. The adult visitors felt that the understanding of the content allowed them to share the information with their young children who cannot read (BERI, 2012:7–90). These findings support the view that scientific information presented in one’s native language improves the process of engagement between science and the public. One of the major aims of the IWP is to improve engagement with the public, based on the assumption that, if the public is able to engage with the information communicated to them, then they will be able to become better citizen scientists. In my literature search, no study on indigenous languages and science communication in the South African context appeared. It is hoped for that my study will probe South African researchers to investigate on this issue of science communication and indigenous languages in South Africa.

2.8 INVASIVE SPECIES MANAGEMENT

The WRC's focus on public understanding of the European paper wasp forms part of their attempt to understand how to design a successful eradication programme. As part of the Consortium, I will therefore conduct a study that considers public perceptions of, and attitudes towards, the European paper wasp. It is hoped that this information will be useful to the Consortium in its design of an eradication programme, and to improve its communication methods. In most cases, IAS management is a response to an ecological, health or social threat presented by an IAS. In the case of the European paper wasp, its invasion poses an ecological threat by disrupting the ecosystem of the indigenous wasps.

The health threat is posed by the fact that the wasps sting and causes an allergic reaction, and socially the wasp is a nuisance to home owners. Bremner and Park(2007) state that a major contributor to the success of IAS-eradication programmes is public support, therefore "understanding the underlying attitudes of the public can help inform outreach education activities" (2007:306). Bremner and Park (2007) assessed the management of non-native species in Scotland, identifying the following factors that have contributed to the failure of IAS management programmes: (i) "lack of political and public awareness of the potential threats"; (ii) the "view that eradication is an impossible goal"; and (iii) a "lack of enthusiasm amongst conservationists for an activity that many people find distasteful" (Bremner & Park, 2007:307). These points are relevant to my study, as the low response rate to the SANBI communication methods seems to suggest a lack of awareness and understanding of the threats posed by the European paper wasp. The second factor is particularly relevant to my study, as a large number of people view the eradication of the wasp as near impossible, as thus far no country as manage to eradicate the European paper wasp (Benade, 2015).

A growing number of researchers are realising that, as much as it is a scientific issue, IAS management is a social issue involving political and other human factors. Thus, there is an increasing need for participatory decision making involving the public. Hence, a better understanding of the attitudes of the public towards IAS is required. Zavaleta, Hobbs and Mooney (2001, cited in García-Llorente *et al.*, 2008:2970) highlight the neglect of a social component in dealing with IAS, and suggest that, "due to the potential socioeconomic importance of IAS, both ecological and social factors should be considered". Consequently, "IAS can be viewed as a socioeconomic problem, one that requires solutions from economics and sociology" (García-Llorente *et al.*, 2008:2970). These sentiments provide a point of departure for my study, as I am researching an IAS from a social

sciences standpoint. The question arises as to why there has been a lack of focus on “the social” when dealing with IAS. García-Llorente *et al.* (2008) attribute the lack of attention to public attitudes towards IAS to the difficulties of measuring social impact that IAS has on the public. When the invasive wasp team developed the management plan for this species, no form of impact, in terms of success and effectiveness was considered, and neither was evaluation. To deal with this challenge, my study incorporated an evaluation, albeit brief and not detailed, of the impact of the distributed pamphlet concerning the European paper wasp.

According to Larson, Phillips-Mao, Quiram, Sharpe, Stark, Sugita and Weiler (2011), the incorporation of a social objective in IAS management will result in the sustainability of such management. Larson *et al.* (2011) provide a model for sustainable IAS management that consists of three pillars: environmental, social and economic. The social pillar consists of five measures of progress, namely (i) involvement of multiple stakeholders in the management-planning process; (ii) communicating progress; (iii) involving community members in the implementation of the project; (iv) developing education and outreach programmes; and (v) increasing coordination among agencies and knowledge networks at all levels. When one examines the proposed wasp project both Phase 1 and 2 as discussed in Chapter 1, to be undertaken by the WRC, it seems that some of these measures are being implemented, but the question concerning the effectiveness of the entire programme still needs to be addressed. The model for sustainable IAS management further suggests a ripple effect from one pillar to the next: ecological considerations define possible economic considerations which, in turn, define the social considerations which determine what actually gets done (Larson *et al.*, 2011:18).

There has been a tendency to rapidly implement IAS management programmes which, according to Mackenzie and Larson (2010), is ineffective because of three reasons: (i) the short timeline of these programmes does not allow for development of interpersonal trust relationships among all stakeholders; (ii) when a new species is discovered, available scientific knowledge on that species is often limited, which is the case with the European paper wasp: since its discovery, not much research has been conducted on it (Benadé *et al.*, 2014:220); and (iii) government agencies and their managers may feel pressured by their respective institutions to produce results, therefore they tend to act quickly before consulting the public. In Phase 1 of the IWP, an eradication programme was implemented by the City of Cape Town. The City of Cape Town also collaborates with Stellenbosch Municipality’s Eco-Centre to eradicate wasps, as well as to create awareness by means of SANBI-published articles in newspapers, radio interviews, and pamphlets distributed to the public. In the process of this programme, they realised that they needed to understand public

perceptions and attitudes first, before continuing on the programme, hence their decision to support my MA research that would allow them to create an improved eradication programme in Phase 2 of the IWP. Kraus and Duffy (2010) conducted a study in Hawaii on immediate and rapid responses to IAS and found that these also do not involve the public. This needs to be addressed, as their results revealed that the success rate of a programme is higher when a broader community of stakeholders is involved in the management process, as the community is able to assist in the reporting of the IAS (Kraus & Duffy, 2010).

It therefore becomes relevant to investigate what affects the public's response to IAS management programmes. Specifically, it seems that false information regarding the status of IAS results in distrust between the public and the IAS-management organisations, which negatively affects the public's rate of response to calls for reporting IAS.

The literature reviewed in this chapter reveals that effective management of IAS requires broad-based participation of stakeholders ranging from invasion biologists to lay persons. Secondly, when developing eradication programmes, IAS managers need to take into consideration social factors, as these directly affect the success of the eradication programmes. My study aims to shed light on the social factors that affect the management of IAS.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 INTRODUCTION

A review of the literature has revealed that not many studies have been conducted on the European paper wasp, and that this paucity of knowledge is especially notable regarding public perceptions and/or understanding of this IAS. This gap in the literature increased my interest in exploring public perceptions, knowledge and understanding with regards to the European paper wasp. Initially I intended to compare two opposite social classes in terms of their level of their knowledge of, understanding and perceptions of the European paper wasp, to determine to what extent the level of this knowledge, understanding and perception is influenced by background variables such as race and highest level of education. Furthermore, my intentions were to explore the extent to which background variables such as race and highest level of education are associated with the extent of cultural distance between the public's understanding of and the scientific (invasion biology's) understanding of IAS,. Lastly, I desired to examine the effectiveness of the communication on the European paper wasp that had thus far been dispersed in the Western Cape.

Due to the shift in research focus during data collection, as explained in Chapter 1, my interest then shifted to exploring public perceptions, knowledge and understanding of just one community, instead of two, with regards to the European paper wasp and whether language has a direct impact on public perception and the communication of the European paper wasp. To be able to venture into these research themes, a quantitative research approach was considered most appropriate to address the research questions, which are both descriptive and exploratory in nature. Exploratory research is often associated with qualitative research, but Bryman (2012:409) states that "quantitative research is often a good deal more exploratory than is typically assumed". According to Allan and Skinner (1991:23), my approach (or what they refer to as "research model") can be defined as exploratory quantitative research, which "allows for the relationships between variables expected to reveal themselves at the analysis stage instead of creating a hypothesis beforehand" (Allan & Skinner, 1991:216). In the case of my study, the nature of the cross-sectional study conducted is not able to explain much about causality, having said this the process still allowed for me to see what variables would come up instead of having a hypothesis.

Furthermore, an exploratory quantitative research model allows for flexibility, if ideas and objectives change during the course of the study (Allan & Skinner, 1991:217). In the case of my study,

some of these changes did indeed occur, and this research model could accommodate them. Using a structured interview schedule, I was able to direct interviews towards a focus on how the study population viewed the European paper wasp, their level of knowledge and understanding of, as well as their attitudes towards, the wasp. Another set of advantages of quantitative research that I could draw upon flows from its “preoccupation” with measurement (Bryman, 2012:164). First, “measurement allows us to delineate fine differences between people in terms of the characteristics in question”. The study population consisted of predominately black, Xhosa-speaking participants. Therefore, measurement allowed me to gather data on the finer differences between the participants who share the same cultural background. Secondly, it provides a consistent device or yardstick to make the above-mentioned distinctions. During data collection I worked with a team of fieldworkers, thus the structured measurement tool allowed us to be consistent in the data collection process, thereby guarding against variations in how data is collected, as this could affect the responses. Lastly, “measurement provides the basis for more precise estimates of the degree of relationship between concepts” (Bryman, 2001:164).

Initially my study focused on considering only three points of focus, namely perception, knowledge and understanding, but as I entered the field, it became clear that the issue of language, and its role in understanding these three points of focus, had to be included in the study. After arriving at this realisation, I proceeded to review literature on science communication and indigenous languages, which revealed that language is an important factor in understanding and measuring perception, knowledge and attitudes of the public with regards to science in general and, in the case of my study, the European paper wasp. Language affects not only how the public, but also entomologists and others in the field of environmental studies, view and construct this species. To further increase my knowledge on the relationship between science communication, PUS and language, I engaged, via online platforms, with science communicators around the world who are working on the topic of science communication and indigenous languages. I also had an informal discussion on this topic with a Xhosa lecturer at the Department of African Languages at SU. From these informal discussions and the literature reviewed, it became very clear that language affects the perceptions, knowledge and understanding I was interested in studying. Due to the nature of my research model, it was quite easy to accommodate the addition of this theme to the study.

The underlying purpose of my study – especially from my funder, SANBI’s, point of view – was to build a bridge between social research and natural science research. As a result, I had to acquaint myself with concepts and themes in entomology, finding myself switching between entomology and sociology in my thought processes. Collins (2013:163) states that sociologists working in a field of

natural science have to constantly alternate between the two worlds. By developing an understanding of the relevant entomological information for my study, I could view the problem from SANBI'S perspective, which provided me with an improved understanding of the problem of invasive wasps as a whole. Maintaining the distinction between the two worlds was important for this study, as I was given a mandate by natural scientists, which meant I had to understand the problem from their perspective, but I had to execute it in a social science format.

This chapter will inform the reader of the processes involved in answering the research questions using a cross-sectional design. I am aware that the cross-sectional design has some limitations. "Cross-sectional research design produces associations rather than findings from which causal inferences can be unambiguously made", therefore weakening internal validity (Bryman, 2001:60). Additionally, due to the use of data collection tools such as structured questionnaires and observation schedules, "ecological validity may be jeopardized because the very instruments disrupts the natural habitat" (Bryman, 2001:61). Firstly, the research approach and design will be described and justified. This is followed by a detailed description of the data collection method that was used. In that section, sampling and preparation for data collection will also be discussed. This is followed by a description of the processes involved in data analysis. Lastly, a discussion on ethical dilemmas raised by the study, as well as a reflection on the research process, will be presented. This reflection emphasises the challenges that I faced as a young black social scientists conducting research in a predominantly white area, and how these had an impact on my research, in particular in terms of the extent to which I could address the research questions I had initially developed.

3.2 METHODOLOGICAL APPROACH AND DESIGN

To achieve the desired outcome for my study, I decided to adopt a quantitative survey design. The reasons for selecting this design for my study is that the research questions are primarily descriptive in nature, and a quantitative survey design is useful for such descriptive analysis and in providing some level of accuracy in this regard (Babbie& Mouton, 2001:263).

Secondly, it is "probably the best method available" for me who, as a social scientist, is interested in "describing a population too large to observe directly" (as described below, this population is defined as head of households or adults above the age of 18 residing in Coasta Land, Kayamandi), and quantitative surveys are "excellent vehicles" for what I intended to do, i.e. measure attitudes and orientations in such a large population (Babbie & Mouton, 2001:232).

In addition, surveys are also the most widely used social science method in conservation-or ecology-related research such as mine, due to their structured nature which gives the researcher a relatively high level of control to guide the interview, and the responses from a survey are easily quantifiable (Newing, 2011:119). Another reason for choosing this kind of design is that it allows for easy replication, if the research process is described in sufficient detail, which I aim to do in this chapter (Bryman, 2001: 59–60; 177). Therefore, were the institution funding this project (SANBI) to decide in future to conduct a similar study with a different population (Babbie & Mouton, 2001:263), it could do so.

However, the design I chose also has limitations, in particular the inability of the survey researcher to “develop the feel for the total life situation in which respondents are thinking and acting to the degree that the participant observer can see” (Babbie& Mouton, 2001:263). In the case of my study, the interview process could have benefited from me spending some time in the community before conducting the study to understand the culture of the community and how the residents live, as there would have been some level of familiarity between myself and the respondents.

3.3 DATA COLLECTION METHOD

Data were collected by means of personal, one-on-one interviews, guided by a structured interview schedule. This data collection method was chosen mainly due to the advantage of being able to see the respondent’s reactions, as well as the ability to clarify items in the interview schedule (Oishi, 2003:8). Furthermore, in self-administered surveys the person other than the intended respondent can fill in the questionnaire without the surveyor’s knowledge. Therefore, one-on-one ensures that the intended respondent answers the questionnaire (Oishi, 2003:8).

A structured interview schedule provides more reliable measurement when one employs fieldworkers, as I did (see Section 3.6 below). As Rossi, Wright and Anderson (1983:169) state, one “cannot have different interviewers asking the various items the way it seems best to them or improvising variations on the wording for different respondents”. The standardised wording for each question ensures that each respondent receives the same stimulus (Rossi *et al.*, 1983:169). Standardisation assists in making sure that the test results are reliable.

Although it may be described as primarily structured, the interview schedule contains both closed and open questions. Closed questions render the processing of responses easy, and they enhance the comparability of responses. The schedule was divided into 4 themes: community

demographics; knowledge of the European paper wasp; knowledge of information communicated; and views on a proposed wasp-eradication programme. The test, which was in section two of the interview schedule consisted of ten items that primarily measured familiarity with specific terms and concepts. This test was compiled by adapting questions from various scientific literacy tests available in the public domain, as well as those developed by postgraduate students of IAS in response to a request from the C•I•B.

On the other hand, open questions provide the respondents with the opportunity to answer as they wish, which then allows for responses to be derived that would not necessarily have been considered by the researcher. Lastly, they do not suggest responses to the respondents, thus allowing the researcher to tap into their knowledge and understanding of issues in more depth (Bryman, 2012:246–247). Using both open and closed questions in my interview schedule allowed me to give the respondents an opportunity to explain, in response to open questions, how they understood some of the issues and concepts, while the closed questions guided the responses of the respondents in the direction required for my study. The former brought an element of social constructionism to the study, as the way in which the public constructs the European paper wasp could be explored to some extent with the open questions. Having said this, I am aware that social constructionism is predominately associated with qualitative research, but Bryman (2012:618) also advocates that quantitative research can play a significant role in relation to a constructionist stance.

3.4 SAMPLING

The interview schedule (see Appendix F) consisted of various questions to collect data on different aspects of the public's interaction with the European paper wasp, as well as on their views on the methods of communication used. Furthermore, the interview schedule also contained questions that provided the respondent with an opportunity to share their views on what communication methods could work best for them, and whether and to what extent they are willing to participate in the eradication process.

The schedule was divided into 4 themes: community demographics; knowledge of the European paper wasp; knowledge of information communicated; and views on a proposed wasp-eradication programme. Some of the questions included in this interview schedule were adapted from various online questionnaires on the related themes. The inclusion of themes and questions was also influenced by informal discussions with other scholars and members of the public on the issues

pertaining to my research questions. The interview schedule consisted mainly of questions on IAS, but also contained a section that tested the level of respondents' environmental-science literacy.

With measurement the issue of validity and reliability is raised. Validity is concerned with "whether an indicator (or set of indicators) that is devised to gauge a concept really measures that concept" (Bryman, 2011:171). Reliability is concerned with the "consistency of a measure of a concept" (Bryman, 2011:169). Issues of validity and reliability are very common in literacy tests. A test that faces similar issues as the one included in the interview schedule, is the test for academic literacy levels (TALL), which is used by major universities in South Africa to measure the readiness of prospective students for tertiary education. In a critical review of this test, Weideman (2006) states that "a close alignment is sought between the tests, the 'task based' language instruction that follows its administration and the learning an acquisition aimed for". He further states that, when testing language ability, for instance, what one needs first is a credible definition of academic literacy. Secondly, what should be measured is not language in another context, but it should be the competence in handling academic language. Furthermore, one must be able to operationalise one's definition of this ability (Weideman, 2006:84). When applied to scientific literacy, it should be noted that the definition of scientific literacy is unclear and highly debated, however successful scientific literacy tests can be conducted when one chooses the most appropriate definition and turn it into an operational definition.

It is of utmost importance that the respondents are comfortable – both from an ethics perspective, as well as because their discomfort could result in poor data (Bryman, 2012:220) – and that they do not feel ambushed into undertaking the environmental-science-literacy test. Before the test was administered, and as suggested by the Departmental Ethics Screening committee (DESC) that reviewed my ethics application, the respondents were informed that it was not intended to make them "feel or look stupid", but rather that this information was needed for the purpose of designing more appropriate communication material.

In the case of attitudinal questions, especially the open-ended ones, the interviewer was able to probe and prompt, if necessary (Allan & Skinner, 1991:227). Another advantage of face-to-face interviews is that when the respondent does not understand a question, they can ask for assistance. Also, face-to-face interviews tend to be completed faster than self-administered questionnaires (Bernard, 2013:219). In addition, face-to-face interviews allow one to use visual aids. In the case of my study, photographs (see Appendix B) of the European paper wasp in its various settings, as well as a specimen in a glass container, were shown to the respondents at the beginning of the interview. This was done because many people tend to mistake the wasp for honey bees, and we had to ensure

that the respondents and the fieldworkers were referring to the same insect. Another advantage of using visual aids is that it keeps the respondents focused on the topic, and it is also a useful cue to initiate discussion on the topic (Bernard, 2013:198).

In a multilingual society such as South Africa, it is very important that respondents are interviewed, and answer questions, in the language, they feel most comfortable (Babbie& Mouton, 2001:263). When participants are interviewed in their home language, they are able to express themselves better, thus making the data that they provide much richer (Nkomo, 2008:2). The English questionnaire was therefore submitted to the SU's Language Centre for editing and translation into Xhosa (and, when Onderpapegaai Berg was still being considered as a study site, Afrikaans).

In addition, translation would go some way towards ensuring that I created a culturally more appropriate measuring instrument (Bernard, 2013:306). As Walden (2002:118) suggests, one has to become familiar with the language and cultural point of view of the target population to develop such a measuring instrument. In the case of my study, the translation process did not render me familiar with the language or the cultural point of view of the target population. This inability of the translation process to render me familiar with the language or cultural point of view of the target population raised a question on ecological validity. Ecological validity is "concerned with the question of whether social scientific findings are applicable to peoples every day, natural social settings" (Bryman 2011:48). Does the instrument used in research capture the daily life conditions, opinions, values, attitudes, and knowledge base of those we study as expressed in their natural habitat" (Cicourel, 1982:15, as cited in Bryman 2011:48). Without any prior knowledge of the "natural habitat" of the study population I was not able to make sure that the instruments, Rather, it was only upon entering the field that I developed a sense of the cultural point of view of the community. It is also interesting to note that, despite being black, born in Zimbabwe and having grown up in the Eastern Cape amongst Xhosa-speaking residents, it became clear that I was not familiar at all with the social and cultural context of the study population.

Following the translation, the questionnaire was piloted with five participants, of which two are Xhosa-speaking, one speaks English and two are Afrikaans-speaking. I requested the assistance of two friends who are fluent in Xhosa and Afrikaans to assist me in conducting the pilot interviews. The respondents had to emulate as close as possible the characteristics of that was initially intended as the population. Therefore the selection of these respondents was not only based on their race and home language, but their residential area and socio-economic status was taken into consideration as well. The piloting was conducted to determine whether the questionnaire was clear, thus reducing the likelihood of questionnaire-related response errors (Waldo, 2002:57). As Newing (2011:142)

observes, “when piloting, you will always see that there are questions that people fail to understand or interpret in different ways”. Secondly, piloting allowed me to evaluate the questionnaire items in terms of whether they elicit any cognitive or emotional responses (Waldo, 2002:82). This applied in particular to the test-like section in the questionnaire, which needed to be constructed in a way that did not result in any negative emotions such as feeling stupid or inadequate, on the part of the respondent. The feedback from the pilot sessions was quite positive, and it is interesting to note that none of the Xhosa speaking participants noticed the terminology challenge that was later discovered in the field.

3.4.1 POPULATION

Considering my research aims, the population I studied needed to have most likely seen or experienced the European paper wasp. To best achieve this, initially I purposively chose to define the population as the residents of two residential areas or suburbs in Stellenbosch, Onderpapegaai Berg and Kayamandi, because according to the SANBI wasp team, they both have been invaded by the European paper wasp. In addition, socio-economic differences, such as in terms of highest level of education, between these two areas allowed me to take socio-economic and other, related factors – such as race – into account.

The residents of Kayamandi are predominantly black and Xhosa-speaking. This racial profile of the suburb can be understood against the historical background of its establishment. Kayamandi was formally established in 1941, but its informal establishment can be traced to the 1920s. Due to the industrialisation that took place in Stellenbosch prior to the 1920s, there was a great demand for low and semi-skilled labour, which attracted black individuals who had migrated to Cape Town, mostly from what were then called Transkei and Ciskei, in search of employment (Rock, 2011:11). The Native (Urban Areas) Act of 1923 and the Group Areas Act of 1950 restricted where people could and could not stay. Thus these migrants from what is now called the Eastern Cape experienced challenges when they arrived in Stellenbosch and settled in an area which was predominantly white (Rock, 2011:15).

The total population of Stellenbosch by 1921 was just 7300, of which 50% were whites, 47% coloureds and 2% to 3% blacks. Prior to the 1920s, the majority of the black population was spread around the farms, but around 1918 an informal settlement began to form around modern-day Adam Tas Road (Rock, 2011:17). This area was owned by the Libertas Farm and subsequently Stellenbosch Farmers Winery. This area was variously called Mon Repos, Platteklip Location, or Kaffir Location.

Once the migrants settled, the farmers were uneasy about the development of this location, and they wanted to use the land for farming. After discussions with the Stellenbosch Municipality, the coloured community in this area was placed in Du Toit and a new area was needed for the black location. In 1941 this location was moved to Lot 48, Du Toit (Rock, 2011:20-23). To date, Kayamandi has a population of approximately 24,645. Approximately 28% of the population obtained matric while only 4.3% of the population have a higher education qualification. 29% of the population are unemployed, while majority of the working class population fall within the R19, 601-R38, 200 income bracket. Followed by 13,4 % falling within the R38 201-R76,400 income bracket (StatsSA, 2016: 1).

On the other hand, Onderpapegaai berg is a middle class community with a population of approximately 1504. Majority of the residents at 79% are white followed by 12% of Black Africans and 7% coloureds. Language distribution in this community is 79% Afrikaans, followed by 17% English. With regards to education, 64.7% of the population have a higher education qualification, while approximately 26% of the population obtained a matric. In this community, 11.9% are unemployed while majority of the population at 23.9% fell within the R153,801-R307,600 income bracket, followed by 22,7% falling within the R307,601–R614,400 income bracket (StatsSA, 2016: 1).

Purposively selecting two residential areas, which are opposites in terms of social class, is referred to as extreme or deviant case sampling (Bryman, 2012:419). In addition, the areas are situated close to where I reside, thus reducing time and costs involved with fieldwork.

Therefore, both practical considerations and the purpose of the study guided me in the initial selection of the two residential areas (Babbie& Mouton, 2001:167). Furthermore, the method of selection was influenced by the consideration that the results of this limited master's study will not be generalised to Stellenbosch (Bryman, 2012:176).

While visiting the two selected residential areas, I discovered that Kayamandi consists of different sections, which have different housing types, such as flats, formal housing and informal housing in the form of shacks, while Onderpapegaai Berg was much more homogenous in this regard. I then once again used my judgement to select the residential section in Kayamandi that would yield the most useful data for the study (Babbie& Mouton, 2001:167). Coasta Land, which is the formal-housing section of Kayamandi, was chosen, mainly because it has a more formal structure, similar to Onderpapegaai Berg, this allowed me to control as far as possible for housing type, and obtaining or constructing a sampling frame would be much easier than for the areas containing informal-housing and flats. In a developing country such as South Africa, sampling frames are not always readily available, especially where informal housing is concerned, because, for example, informal housing does not appear on official records of authorities, or no records are

available of newly erected informal settlements. My population was therefore initially defined as adult residents of Onderpapegaai Berg and the Coasta Land section of Khayamandi.

3.4.2 SAMPLING DESIGN

After the purposive selection of the residential areas, I intended to apply a probability sampling design, in particular systematic sampling with a random start and stratification by area. After several months' unsuccessful attempts to obtain a sampling frame from Stellenbosch Municipality and from survey research companies that have conducted research in these areas, I resorted to personally constructing a sampling frame of both residential areas, by physically traversing each of the residential areas and listing each house. In the sampling frame of 96 houses, the houses were initially ordered according to street names. I then allocated a number to each house, starting at number one, whereafter I randomly decided to select every 10th house on the list (Babbie & Mouton, 2001:190).

On some dwellings in Kayamandi, there were two dwellings with a different household residing in each. In cases where both dwellings were formal housing structures, one was chosen at random. In cases where there was a formal and an informal structure, the former was selected. This was done mainly to keep the residential setting similar to that of Onderpapegaai Berg and thereby control for housing type; and secondly, wasps are most likely to be seen around the structures of formal housing (Veldtman, 2014). Finally, this is also the method used for the South African Census of 2011 (StatsSA, 2011:5).

The head of the household was the preferred interviewee. If he/she were not available, the most responsible available adult (18 years or older) was requested to participate in the study. It was quite interesting to observe that, in some of the households where elderly people resided, they preferred their children or grandchildren to respond, despite the fact that the interview was conducted in a language that they understood. This may be ascribed to the fact that the elderly tend to view their children and grandchildren as more educated than they are. If there was no one at the selected dwelling, or a resident refused to participate in the study, the dwelling to the left of the one initially sampled was used to replace it.

I entered the field site of Onder Papegaai Berg after spending two weeks in Kayamandi, where the response rate (roughly 22 completed interviews) was quite high. Filled with high expectations of a similar outcome in Onderpapegaai Berg, I was severely disappointed. On my first day in the suburb, I was met with hostility and suspicion by the residents, some stopping and asking me what I was doing there. When I approached some homes, I was mistaken for someone begging, and was not

given a chance to explain myself; some residents blatantly ignored me and others merely said they were not interested. This experience repeated itself on the second day, leaving me feeling traumatised and bereft of some of my dignity, while I still had no data. At the time of data collection, I had been residing in Stellenbosch for seven years, and this was the first time I had personally experienced such extreme forms of racism. After consultation with both my supervisors, I decided to cease attempting to collect data in this residential area, and to rather use the increasingly limited time I had left for data collection to return to Kayamandi and collect more data there, as there was no reason to expect that the response in Onderpapegaai Berg would improve. Entering Kayamandi the second time, I visited the houses that were not selected in the sampling frame the first time around. Thus, I eventually did not draw a sample of households in the selected area of Kayamandi. That means that the results of my study will not be generalised to any larger population, as the whole population of the selected area in Kayamandi was approached for data collection. Onderpapegaai Berg, however, was dropped from the study.

3.5 RECRUITMENT AND TRAINING OF FIELDWORKERS

Due to language constraints, i.e. the fact that I am not fluent in Xhosa and not an Afrikaans speaker, as well as time constraints, three fieldworkers were initially recruited to assist me in the data collection process, including two final-year undergraduate students who reside in Kayamandi, thereby to some extent addressing safety concerns. Moreover, as residents of the township, they could relate to the participants. I therefore followed Babbie and Mouton's (2001:251) guidelines as far as possible, i.e. that a fieldworker should have the ability to speak the home language of participants fluently, be from the same area and fieldworkers should match the respondents in terms of race. The Afrikaans fieldworker, a young, white woman, was a postgraduate student in Sociology. She was chosen by virtue of her race as well as her socio-economic status, which made it possible for her to relate to the residents of Onderpapegaai Berg. Lastly, all three fieldworker candidates were students in the social sciences, which was an added advantage because they had a good understanding of social science research.

Waldo (2002:123) stresses the importance of not only hiring competent research staff, but also that they are to be trained and supervised. I therefore held a two-hour training session in August for the fieldworkers. During this session, we covered interview techniques, and, very importantly, ethics. The fieldworkers were familiarised with the questionnaire (Waldo, 2002:124). Unfortunately, due to unforeseen circumstances, the Afrikaans fieldworker had to withdraw from the study a week before

data collection. As this was the time of final exams at SU, it was difficult to find a replacement, and I alone had to conduct fieldwork in Onderpapegaai Berg. As explained earlier, the problem of non-response in this suburb would probably have been averted, had a white, Afrikaans-speaking fieldworker collected the data there.

3.6 THE COLLECTION OF DATA

In total, 60 interviews were conducted from mid-October to mid-November 2015. It emerged during data collection that the decision to collect data by means of face-to-face interviewing was indeed a sound one, as the fieldworkers and I could encourage the potential respondent to participate, keep their attention, probe for responses and further elaborate on questions they did not understand (Bryman, 2012:253). This emerged to be particularly useful in the case of my study as there was a terminology barrier, therefore concepts could be explained better. The structured interview schedule also allowed us to ensure that the interview remains within the boundaries of my research topic, as some respondents tended to add more information to their responses that tended to lead the interview into an irrelevant direction. Also, during the interviews, some of the participants would ask questions that were not related to the study (out of curiosity, I would assume). The schedule therefore worked well as a compass to bring the respondents back to the topic at hand, and the training of fieldworkers played an important role in this regard, as close familiarity with the interview schedule assisted them in getting an interview back on track (Bryman, 2012:217).

As Bryman (2012:217) instructs, “respondents have to be provided with credible rationale for the research in which they are being asked to participate and giving up valuable time”. The interviews therefore began with an introduction of who we are, the purpose of the study, and my affiliation with SU. This introduction was followed by a request to respondents for their verbal consent (see Appendix C) to participate in the study.

Interviewers read out the questions and recorded responses on the schedule, with the exception of the scientific-literacy-test questions, in which case the respondents were provided with the questions printed on a piece of paper, which they themselves then read and answered on the piece of paper. After an interview, the interviewer would then transfer those answers onto the interview schedule. This combination of structured interviewing and self-completed questionnaire as data collection method was necessary to assure confidentiality and minimise the respondent’s embarrassment in case they answered incorrectly or did not know an answer.

At the beginning of the interviews respondents were presented with a photograph and specimen, in a glass container, of the European paper wasp. They then tended to agree that they had seen the species, but during the interview they would refer it to as a honey bee. After a few instances of this occurrence, I decided to add a photograph of a bee, so that I could show respondents the difference between the insects. But I then realised that I felt uncomfortable with forcing a particular perspective on them, as it would defeat the object of the study. When realising this, my fieldworkers and I attempted to explain the difference to the respondents, but the confusion persisted.

I initially experienced this confusion as a setback that had to be managed. As a researcher, it was difficult to determine whether the respondents had actually experienced the wasps, or merely bees. This was not a completely unexpected challenge, as I was already aware of the fact that the public tended to mistake the wasp with, and consider it as, a kind of honey bee. However, it was also beneficial to the study, as it raised a number of very interesting questions. For example, were the respondents actually confusing the wasp with a honey bee, or had they seen and experienced the wasp, but constructed it as a bee? As respondents seemed to attach more negative connotations to honey bees compared to the wasp, probably due to their greater awareness of the bee and its effects, do the respondents' perception of the European Paper wasp as a bee affect the way they deal with the wasp?

During the course of the interviews, some respondents would refer to the wasp as *unomeva*. After a consultation with a lecturer at SU's Department of African Languages, I got to understand that this term refers to any insect that stings. Therefore, it is not a specific term used in the Xhosa language for the European paper wasp, but rather for any insect that is perceived or understood to have the characteristics of stinging. This is an important observation for understanding the construction of the wasp amongst the Xhosa respondents in Coasta Land, Kayamandi. The SU Language Centre, which translated the questionnaire to Xhosa, did not translate the term European paper wasp, but rather placed an "i" in front of European paper wasp, so that it read *iEuropean paper wasp*. From a methodological point of view, this situation highlighted the importance of a researcher being in tune with her respondents, and challenged my fieldworkers and I to manage the situation in a way that does not degrade the respondents.

3.7 PROCESSING AND ANALYSIS OF DATA

The data from the interviews were processed and analysed using the IBM statistical package for the social sciences (SPSS) Statistics. After creating a dataset and entering the data, the data were cleaned. According to Babbie and Mouton (2009), no matter how careful one is during the data entry process, some errors are inevitable. Data cleaning is therefore important, and two types of cleaning were done. First, possible-code cleaning involved checking for codes that fall outside the range of codes ascribed to a particular variable's attributes. Secondly, contingency cleaning was done in the case of contingency questions (of which I had a number in my interview schedule), to check whether data had been entered within the specific limits set logically by those questions (i.e. some respondents should not have data for some contingency questions) (Babbie & Mouton, 2009:418). Once a cleaned SPSS data set had been created, I conducted quantitative analysis to answer my research questions:

- What is the level of awareness of the European paper wasp, amongst residents of a primarily African, low-income community?
- Does language have an effect on the understanding of that public's perceptions, attitudes and knowledge of the European paper wasp?
- What are that public's perceptions (positive or negative) regarding the eradication of the European paper wasp, and which factors influence these perceptions?
- What is that public's opinion on the SANBI brochure on the European paper wasp?
- What are the population demographics of the study population?
- What is the level of scientific literacy amongst the study population?
- Does the study population have any knowledge of the European paper wasp?
- What is the study population's perceptions of the communication of the European paper wasp to the public?
- Is the communication of formal scientific knowledge of the wasp in coherent with the public's life experiences of the wasp?

Descriptive analysis was undertaken "to summarize data and present them in an easily assimilated form" (Newing, 2011:257). The technique of univariate analysis was used to present the basic characteristics of my data according to the themes that formed the sections of my questionnaire. The data was displayed through the use of diagrams. The chief advantage of diagrams is that they are relatively easy to interpret and understand (Bryman 2011:337).

3.8 ETHICAL CONSIDERATIONS

In social science research, as in any other academic field, “the researcher has the right to search for truth but not at the expense of the rights of the other individuals in the society” (Babbie& Mouton, 2009:520). To guard against any violation, certain ethic-related steps had to be taken before and during the course of my study.

Firstly, and before embarking on data collection, an application had to be made to the Departmental Ethics Screening Committee (DESC) of SU’s Department of Sociology and Social Anthropology. The application was approved , subject to minor modifications, and the study was considered low-risk, as there was a very small likelihood that the respondents would be harmed by their participation. Considering this low level of risk, it was not considered necessary to obtain informed consent, rather consent, was attained verbally from each of the participants, as outlined in an informed consent script (see Appendix E), which was available in English, Afrikaans and Xhosa for the fieldworkers to use at the beginning of an interview. The combination of structured interviewing and self-completed questionnaire as data collection method was necessary to assure confidentiality and minimise the respondent’s embarrassment in case they answered incorrectly or did not know an answer.

Potentially invading respondents’ privacy for the sake of a study (Bryman, 2012:12) is an ethical issue I had to consider. To address the issue as far as possible, the interviews were conducted during working hours (10:00 to 16:00). Conducting the interviews after hours was avoided, as participants are busy during this time, preparing dinner and spending time with their families. This definitely had an impact on the amount of data collected, though, as we could have conducted more interviews after hours when more people would have been at home. Secondly, the age distribution of our respondents would have been more representative of the population. As will be discussed in more detail in the next chapter, the age distribution of respondents was biased towards the younger generation.

The verbal-consent process involved explaining to potential respondents a few ethics-related concepts, i.e. that the study was voluntary and no form of incentive was provided for participation. It was very important to make this clear, because when a researcher or fieldworker knocks on the door and requests research participation, the potential respondents’ daily activities are disrupted and they are expected to reveal some personal information that they might not be comfortable sharing (Babbie& Mouton, 2009:520). Therefore, they were informed not only that participation is voluntary, but that at any point during the interview they have the right to withdraw from the study.

Despite the fact that the participation was voluntary, the revealing of personal information, such as level of income and highest level of educational, could have made the participant feel uncomfortable or embarrassed, especially in cases where the fieldworkers were living in the community studied, thus there was a possibility of emotional harm (Babbie & Mouton, 2009:522). To guard against this, the fieldworkers signed a confidentiality form (see Appendix X), and the participants were informed that all the information they provided was confidential. Therefore, their interests were protected at all times (Bobbie & Mouton, 2009:523). Personal information, such as the name and surname of the respondents, was not asked in the survey, and the reporting on the results (in aggregated form) was therefore anonymous.

After the interview, the respondents were provided with a sheet containing my contact information, as well as that of a research officer of SU, whom they could contact if they felt their rights as research participants had been violated.

3.9 KEEPING A RESEARCH DIARY

The research process is a very lengthy one, which involves much reading and conceptualisation. I was also quite fascinated by my research topic, therefore I was always engaging in discussions and debates with other scholars or members of the public. Such discussion opened my eyes as to people's thoughts with regards to science communication, wasps and the environment. In particular, the sub-field of science communication within the discipline of sociology was quite new to me, and as a result, I joined a number of science-communication and public-understanding-of-science (PUS) platforms on the internet and via social media, to assist me with keeping track with developments in the field, and also to garner assistance with regards to my project. During the course of my research, I also attended a number of seminars, presented by SU's Centre for Research on Evaluation, Science and Technology, on science communication and PUS. As I became involved in conversations with other scholars or just general members of the public, comments were made that influenced my research, especially during the development of my data collection tool.

All the information I received from these sources I would record in a research diary, this allowed me, at a later stage, to reflect on how this information may influence my research. In addition to my observations and thoughts from discussions, my diary consisted of methodological notes (Bernard, 2013:351–2).

For example, during the course of my research, I experienced a few challenges and setbacks, and my research diary was a tool I used for my own debriefing, to put to paper my thoughts in this

regard. During data analysis, the information I had gathered and thoughts written in my diary became very useful, especially since it allowed me to refer to observations from my fieldwork. A research diary also allows one to keep track of one's thoughts for reflection purposes, and I was therefore able to look back at my initial objectives, to keep track of which of these I had accomplished.

3.10 METHODOLOGICAL REFLECTION

My research posed a number of challenges, which tested my resilience and faith that I would actually complete this project. Two major “curve balls” were thrown at me: accessing a sampling frame (a SANBI staff member insisted on a representative sample of Stellenbosch) and finding willing respondents in Onderpapegaaï Berg. I attempted for months to obtain a sampling frame of Stellenbosch as a whole through various methods – such as approaching survey companies who have worked in these areas; using Google Maps; and approaching the municipality for a list of home owners – but all of these efforts came to no avail.

When I realised how much time had passed without any positive outcome, I decided to purposively select two suburbs – Kayamandi and Onderpapegaaï Berg – as two socio-economically and culturally different populations, which would allow me to compare the two areas in terms of cultural distance between the residents and science, as described by Raza *et al.* (2009). I personally visited each residential area and, with the help of three assistants, list all the residences in each, thereby constructing my own sampling frame. The struggle involved in obtaining a sampling frame highlighted the fact that I live in a country where reliable records of residence are not as accessible as one might presume, which limits the extent to which externally valid research results can be produced by a master's student, especially in areas where one cannot easily walk or drive through. When researchers are faced with this sampling-frame challenge, some areas and populations end up being under-researched, which in turn has an impact on the knowledge social sciences can produce on them.

To some degree, my experience at attempting (unsuccessfully) to collect data in Onderpapegaaï Berg (as described in Section 3.6 above) made me acutely aware of the reality that, who one is, does affect one's progress as a researcher. I had never considered that my colour could affect my research experience in such a profound manner. On further reflection, this experience demonstrated to me that research does not always play out as planned on paper, especially when dealing with people. Bryman (2012:15) reinforces this statement: “social research is less smooth than the accounts of the

research process you read in books [...] In fact, research is full of false starts, blind alleys, mistakes, and enforced changes to the research plan”.

Also, issues of race and class affect research in more numerous ways than is usually thought. Babbie and Mouton (2001:252) share a similar experience from a study conducted in a small town in the Western Cape. An insufficient number of white fieldworkers were recruited to interview white residents, and to make up the numbers, black fieldworkers were recruited. This proved unsuccessful, as the residents refused to speak to the black interviewers and in some instances even insulted them. South Africa provides extreme examples of such research experiences, because of the high levels of racism that are still evident in the country. The Onderpapegaai Berg community is heavily affected by the invasive alien wasp, but due to my race, the avenue of research in the community was closed to me. Also, my experience echoes the well-known notion that it is much easier for researchers to gain access to poorer communities than to wealthier ones. It seems that studying “down” (when the interviewer is perceived to be of a higher status than the respondent) produces better results than studying “up” (Babbie & Mouton, 2001:252). After returning to Kayamandi, this became very clear to me, as a young black educated female. On a positive note, I believe there is much to study in this world, and I will not be held back by my negative experience in one single community. Rather, I learned a lot from this experience and had to quickly redesign and, to a certain extent, reconceptualise my study, which I believe I did well, under the circumstances. Therefore, at the end of the day, even though I initially perceived this as a setback, I later interpreted it as merely another learning experience in my young career as a researcher – and there are many more to come.

CHAPTER 4: ANALYSIS AND PRESENTATION OF RESULTS

4.1 INTRODUCTION

This chapter will report on the data collected and analysed for the purpose of answering the research questions of this thesis. As mentioned in Chapter 3, the initial aim of this study was to explore public perceptions, attitudes and knowledge concerning the European Paper Wasp. Due to a shift in focus in response to challenges and opportunities that arose during data collection, the study also proceeded to explore the challenges associated with the use of scientific terminology in indigenous languages, as well as the methodological challenges involved in conducting this kind of research in a community whose members tend to have relatively low levels of education. The study also attempted to explore how these challenges may affect IAS management, as science communication is an integral part of such management.

The questionnaire was structured in a way that allowed some sections to be answered only by those who had some experience with the European Paper wasp at the time of data collection. As the fieldworkers and I realised during the course of the first seven interviews, the respondents seemed to confuse the wasp and honey bees. I then decided that, were the confusion to persist during the interviews, the interviewer should skip to the sections on the effectiveness of the communication on European paper wasp that had been disseminated to the public. As a result, some of the results have been produced by analysing data for a lower number of respondents, than others.

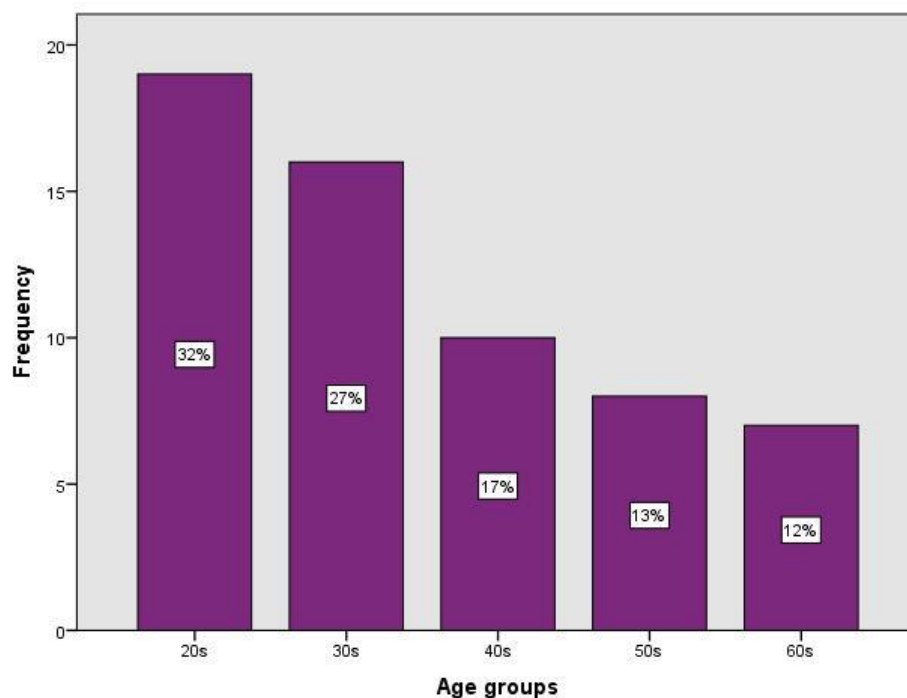
The reporting of the data is mainly descriptive, with a focus on the results of univariate analysis. The reporting is structured in line with the ordering of the items in the questionnaire, i.e. according to the following research questions:

- What are the population demographics of the study population?
- What is the level of scientific literacy amongst the study population?
- Does the study population have any knowledge of the European paper wasp?
- What is the study population's perceptions (negative or positive) of the communication of the European paper wasp?
- What is the study population's perceptions (negative or positive) of the proposed wasp-eradication programme?

4.2 POPULATION DEMOGRAPHICS

The population for this study consisted of 60 individuals, of which approximately 98% were black and less than 2% were coloured. Within this study population, there was a slightly greater male representation (52%) than female representation (48%). The age distribution of the respondents was also considered, as shown in Figure 1 below:

Figure 1: Frequency distribution by age



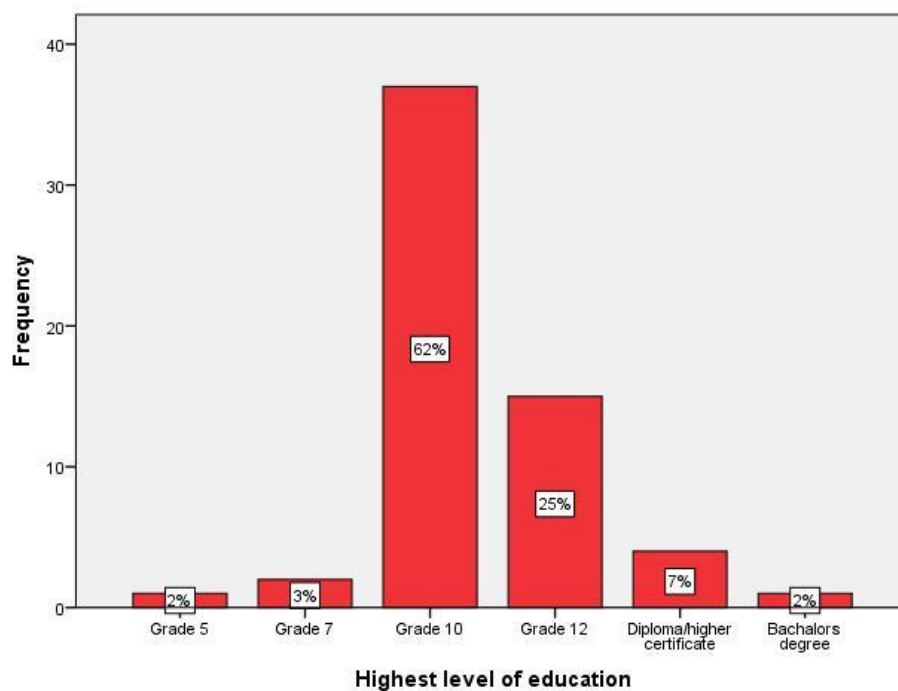
N=60

The majority (32%) of the population is in their 20s, followed by the cohort in their 30s (approximately 27%), and ten participants (17%) within the 40s age range. The less-represented age groups were in their 50s and the 60s, each comprising slightly more than 10% of the population. This age distribution, with its positive skewness towards the younger generation, is somewhat unexpected, as the data were collected during working hours, and one would expect that the majority of the younger generation, which constitutes at least part of the working age-population in South Africa (ages 15–64), would not be at home, while the older, retired individuals (55 and older) would be at home (Statistics South Africa, 2015:4). This may suggest a high level of youth unemployment in the community, as a relatively high percentage of especially the younger individuals of working-age population, of whom the (slight) majority are males, were found at home

during working hours. At 60% in 2008, the unemployment rate for young (15-34 years) African South Africans was estimated to be higher than that of other races (Klasen & Woolward, 2008:2). The challenges faced by the youth in finding employment are exacerbated by the fact that 55% of the youth's actively seeking employment have educational levels below matric, while an additional 36% only have a matric (Statistics South Africa, 2015:1).

These percentages are similar to those identified in the data. Figure 2 below shows that the majority – slightly more than 60% – of the population have a Grade 10 qualification as their highest level of education, followed by a quarter with a Grade 12 qualification. Another 5% has an even lower level of education (around 3% with a Grade 7, at and around 2% with a Grade 5, qualification at).

Figure 2: Frequency distribution by highest level of education



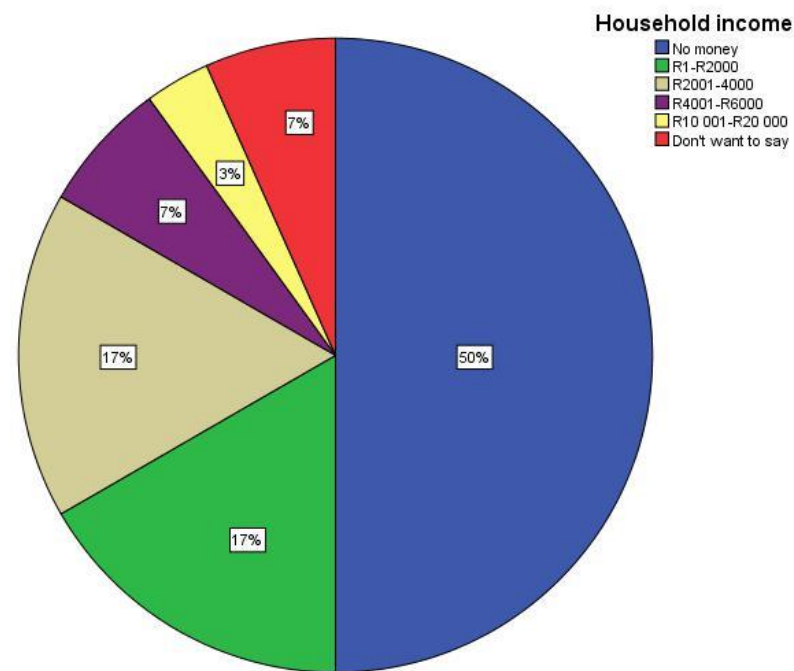
N=60

This means that two-thirds of the population have not completed the General Education and Training (GET) phase, which encompasses Grade 1–9 (Department of Basic Education, 1:2016). Only 7% of the 60 respondents have furthered their studies to obtain a higher certificate or diploma. The highest level of education recorded is a bachelor's degree, which less than 2% of the participants had completed by the time of data collection.

These figures are congruent with the ones for South Africa in general: in 2014 it was estimated that 47% of the country's high-school students drop out in Grade 10 (News24:2014-01-10). Such a high dropout rate at the GET phase has a possible negative effect on scientific literacy in South Africa in general, and in the community studies. At GET phase, science education is taught at entry level, whilst at the Further Education and Training (FET) phase, which encompasses Grades 10–12, there is a more focused science curriculum. Therefore, those that have not been exposed to much science education are highly likely to have a low level of scientific literacy. This also applies to the community studied, which therefore provides an extreme-case scenario for the potential difficulties involved in communicating science in a context characterised by low scientific literacy levels.

It may also be expected that the high unemployment rate, as suggested by the age distribution, as well as the low education level, would have a negative impact on the respondents' household income (another dimension of SES). Indeed, as Figure 3 below shows, approximately 50% of the population reported no household income, therefore one can deduce they are unemployed.

Figure 3: Frequency distribution by household income



N=60

Equal percentages (just under 17%) of respondents reported the two lowest household income levels of R1–R2000 and R2001–R4000. Less than 7% of the respondents reported subsisting on a household income of R4001–R6000, and less than 4% reported one of R10000–R20 000. It is important to note that the younger respondents might have misunderstood the question, thus reporting on personal, rather than household, income, and results should therefore be interpreted with caution.

The data reflect the fact that the study population of Coasta Land in Kayamandi, Stellenbosch, is a low-income community, despite the fact that it may be considered the more affluent part of Kayamandi due to the type of housing structures and comparatively better access to basic services such as water, electricity and running toilets (Statistics South Africa, 2015:1). The data have shown that majority of the respondents in this study have a relatively low level of education, and are most probably unemployed. The results of this study will therefore be interpreted against the background of this profile of predominantly black youths with a low level of education as well as low level of income.

4.3 SCIENTIFIC LITERACY

This section reports on the results of the scientific literacy “test” which was aimed at measuring the level of scientific knowledge, and in particular knowledge about IAS, among the respondents. When attempting to communicate a scientific message to a specific public, it is crucial to know that public’s level of scientific literacy, as it shapes the vocabulary and communication tools one uses when communicating (Miller, 1983:45).

The test results showed that the majority of the population (58%) fell within the above-50% range, followed by 38% in the below-50% range. Only a small percentage of less than 4% fell within the above-80% range. While conducting the interviews, it became evident to myself and the fieldworkers that the responses to the test were primarily random guesses. Some would read the first question, then say that they could never know the answer, and then they would guess. Therefore, the reliability of the test scores, i.e. whether the results are “repeatable” (Bryman, 2011:47), is highly questionable. In other words, if the same test were to be taken again by the same respondents, there is high probability that I would not obtain the same results.

4.4 PUBLIC KNOWLEDGE OF THE EUROPEAN PAPER WASP

This section provides a baseline as to how much the public know about the European paper wasp as an IAS, the public's experience with the wasp, the methods they are using to deal with the wasp, their perception and attitudes towards the wasp, and whether they are aware of any help available to them in dealing with the wasp.

Table 1 below shows that two-thirds (67%) of the 60 respondents reported having seen the wasp around their garden or house, with only the minority (12%) who reported not having seen this wasp. Approximately 1 in 5 of the population were unsure in this regard.

Table 1: Whether respondents have seen the wasp around their house or garden

	Frequency	Percent
Yes	40	67
No	7	12
Unsure	13	22
Total	60	100

Although the majority of respondents have observed the wasp, Table 2 below shows that only 12% report having been affected by the wasp.

Table 2: Whether respondents have been affected by the wasp

	Frequency	Percent
Yes	7	12
No	43	71
Unsure	10	17
Total	60	100

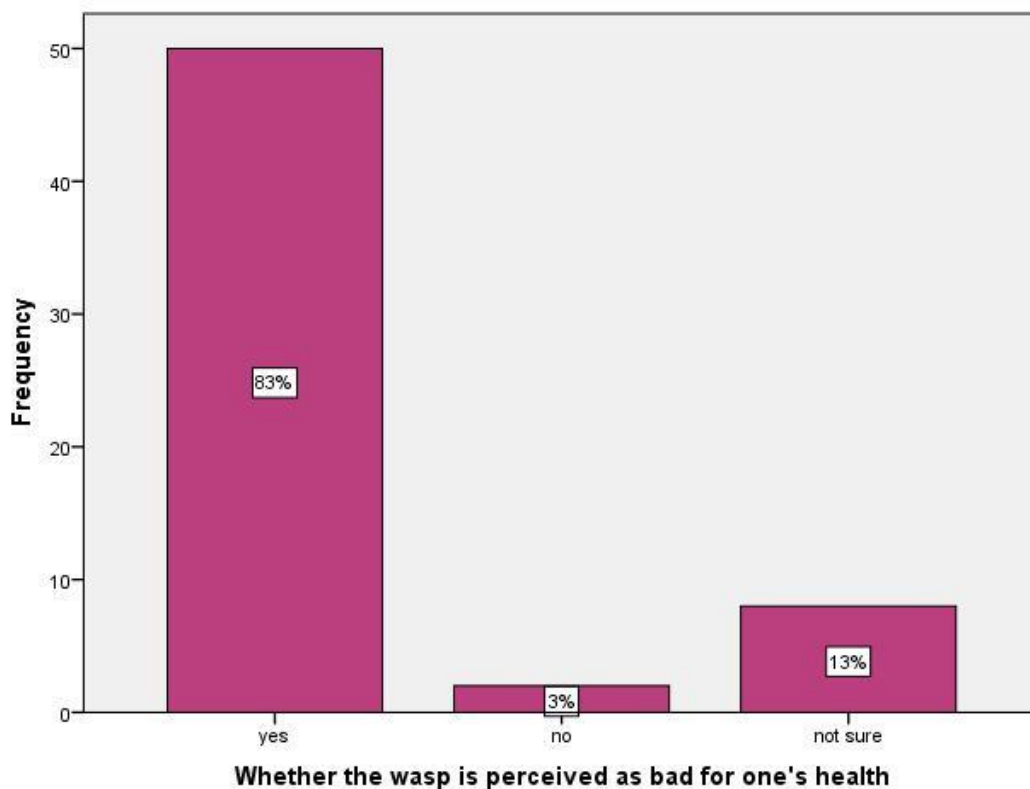
A large majority (71%) seems to have not been affected by the wasp, while 17% was unsure in this regard. In an open ended question, of those seven respondents who have been affected, five reported that they sting, while two considered them to be a nuisance in general.

SANBI's main concern is that, while the spread of the European paper wasp has increased over the past years in the Western Cape, there is still a lack of interest amongst members of the public on this issue. The results reveal that the majority of the participants have not been affected by the wasp, which could be the reason for the low level of interest in the issue, despite the information that had been made available (as mentioned in Chapter 1). As Miller(2004) suggests, the public will rather react to what affects them directly, than to attempts to transfer information to them.

As stated in Chapter 1, the European paper wasp is “less of a threat to biodiversity than it is to human health, urban quality of life and agricultural practices” (Veldtman, 2016:3). Therefore, it was important to know if the respondents are aware of the health effects of the wasp.

Figure 4 below shows that by far the majority (83%) of the respondents perceived the wasp bad for one’s health, followed by an estimated 13% of the population who were unsure. Less than 4% reported that the wasp was not bad for one’s health.

Figure 4: Perceptions of the health effects of the wasp



N=60

The 50 respondents who answered in the affirmative were asked to elaborate on their answer, and they were unanimous that the negative health effect of the wasp is a result of its sting.

The European paper wasp is characterised as a “fairly aggressive wasp” (Veltman, 2016), which builds nests on buildings and other man-made structures. In the case of wasp nests in gardens, where they can be obscured by vegetation, stings result from accidental nest disturbance (Beggs *et al.*, 2011:511). The wasp has a particularly painful sting, which can occasionally cause a life-threatening allergic reaction (Golden *et al.*, as cited in Beggs *et al.*, 2011:510). Thus the public’s association of the wasp’s sting with “bad health” is in line with the scientifically recorded dangers of

human contact with the wasp. The health risk associated with the wasp is one of the reasons for the rally to eradicate it. As a result of the stings, the wasp also disrupts human activity, such as outdoor recreation and forestry operations.

But honey bees also sting, resulting in an itchy patch that, if scratched, turns red, and if one is allergic, it becomes swollen. Therefore, to the naked, “untrained” eye (i.e. that has not been educated or informed about the differences between the wasp and the honey bee), the characteristics as well as the structure of these insects may seem similar especially in colour as shown in Figure 5 and 6 below.

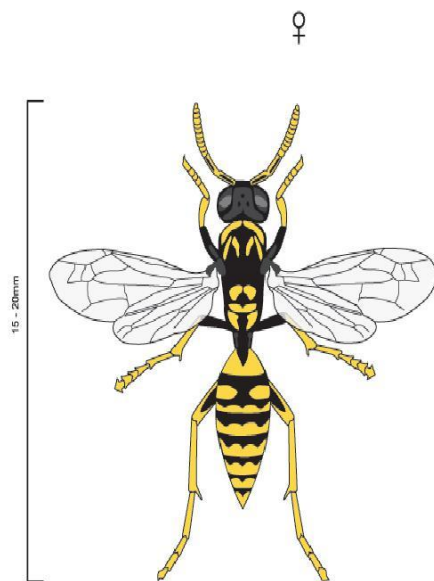


Figure 5: *Polistes dominula* wasp

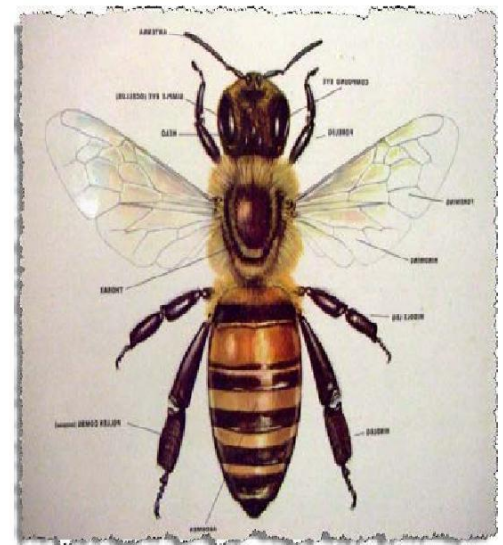


Figure 6 :*Apis mellifera*,Honeybee

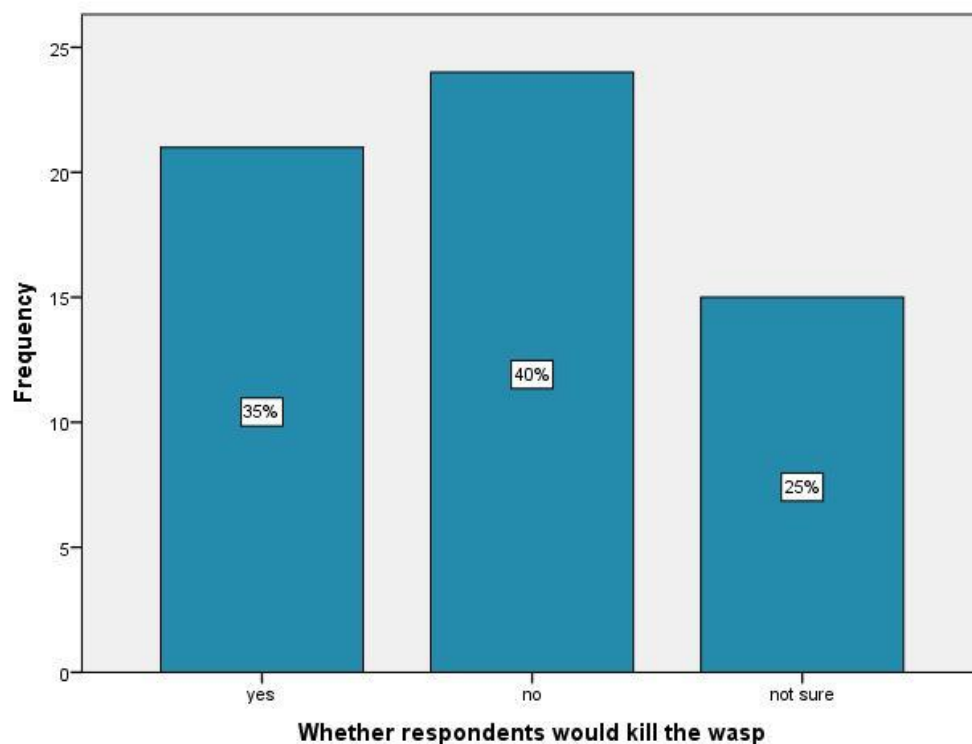
Therefore, confusion of the European paper wasp with the honeybee is expected, and it therefore not surprising that at this point (question on the health effects of the wasp) during the interviews the fieldworkers and I began observing the confusion, as statements such as “it stings when I am eating sweet things” were often uttered. The European paper wasp is attracted to human activity, but not sweet food, which is a characteristic associated with honeybees.

This raises the question of ecological validity as well as measurement validity, i.e. “whether a measure that is devised of a concept really does reflect the concept it is supposed to be denoting” (Bryman, 2012:47). The participants were confusing the European paper wasp with a honeybee, therefore it is not clear if questions were answered with reference to the concept of “bee” or “wasp”. For example, it is possible that, if respondents could have clearly distinguished the wasp from a bee, their methods of control could be different as to what they are currently using?

When asked what methods they are currently using to contend with the wasp, 4 of the 7 respondents that reported being affected by the wasps merely ignored them. The remaining 3 respondents reported using pesticides.

Figure 6 below shows that approximately a third (35%) of the respondents reported that, if they saw the wasp around their house or garden, they would kill it. The slight majority (40%) reported that they would not do so, while the minority, at 25%, were unsure as to what they would do.

Figure 6: Respondents' willingness to kill the wasp



N=60

This is a quite unexpected, and therefore very interesting, result, as the respondents unanimously associated human contact with the wasp with negative health effects, and one would therefore have expected them to kill that which is posing a danger to them. On the other hand, it is possible that the respondents think that trying to kill the wasp could increase their likelihood of being stung. Weighing up the risks, it might seem more reasonable to tolerate the “nuisance” species than taking the risk of being stung. It is also interesting to note that, although it seems the public does not know much about this species, they may be intuitively aware of the danger it poses. This could be attributed to the confusion with the bee, as a bee sting is associated with pain, itchiness and discomfort.

The results also suggest that the public constructs the European paper wasp in a different way from invasion biologists. The European paper wasp is seen by invasion biologists as problematic, as it poses a threat to natural and modified ecosystems, and therefore needs to be eradicated. The public, on the other hand, constructs this species as problematic as it is dangerous, but not dangerous enough to kill – or perhaps too dangerous to attempt killing without assistance. On this issue, an estimated 73% of the respondents were not aware of any help available to assist them with dealing with the wasp, and the remaining 27% were unsure. Thus, none of the respondents were certain about the availability of any help available to assist them in dealing with the wasp.

The results presented in this section show that respondents have not had any significantly negative experiences with the European paper wasp: the majority has not seen this IAS around their homes, and those who have, have not been severely affected by it. However, it is also clear from the results that there is at least a perception of some level of danger associated with the wasp, as the majority felt that it was bad for their health. Nevertheless, the majority of respondents would not kill this IAS if they came into contact with it. It is not clear whether this is because of fear, or merely a lack of concern. It is also possible that respondents feared being viewed as offenders if they expressed a desire to kill the insect. The latter interpretation is supported to some extent by the substantiate percentage of respondents who said they ignore it. And the low level of awareness regarding the help that may be available to them in dealing with the wasp seems to indicate that wasp-related communication in the area needs to be more visible. It is this topic that will now be explored.

4.5 COMMUNICATION ON THE EUROPEAN PAPER WASP

At the time of this study, articles in local newspapers and pamphlets had been used by SANBI to communicate the European paper wasp within the Stellenbosch municipal district and the City of Cape Town district. Furthermore, radio interviews were broadcasted in the City of Cape Town district. This section reports on whether the respondents had received any of the communication on the European paper wasp in their residential area. Secondly, the section also focuses on establishing what communication methods would work best for residents of Coasta Land, in part by determining how the respondents evaluated the pamphlet currently used by SANBI to communicate information about the European paper wasp to the public.

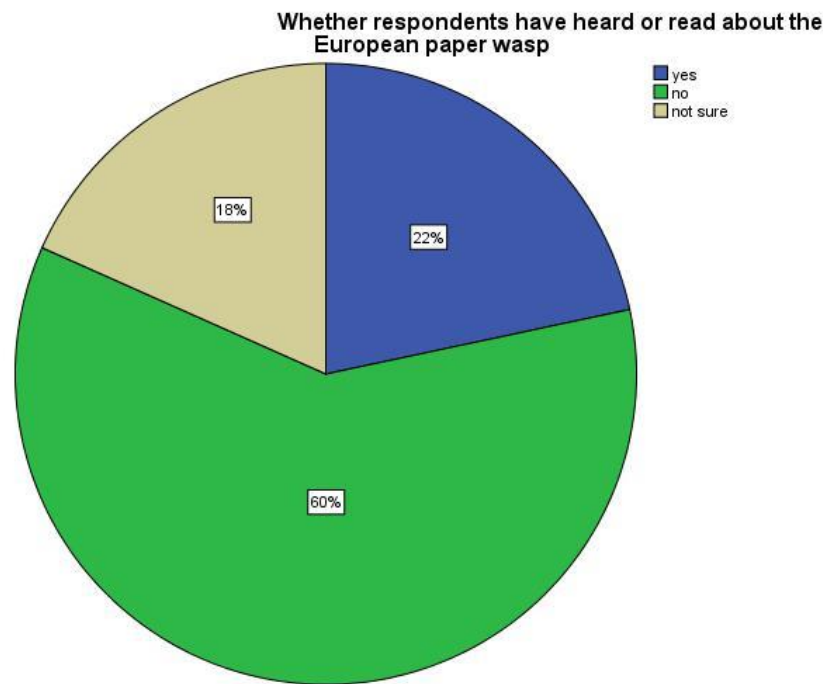
Figure 7: Exposure to information on the wasp

Figure 7 shows that the majority (60%) of the respondents had not heard or read about the European paper wasp by the time of the interview, and another 18% was unsure. Information about the wasp had therefore only reached approximately 1 in 5 of the respondents.

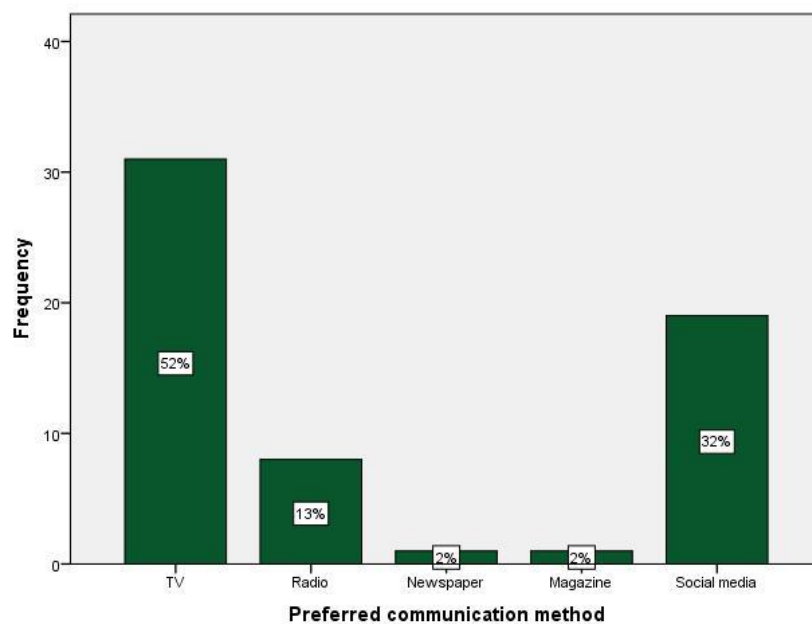
The 13 respondents who had read or heard about the wasp were asked two further contingency questions to determine the source of information about the wasp, and whether they found the information interesting. All but one respondent (who cited Facebook as the source) reported that someone had told them about the wasp. However, here it again became clear that at least some respondents confused the wasp with a honeybee, about which they had been told at an early age. None of the respondents found the information interesting, which could be attributed to the majority of the population not being affected by this IAS, and also not seeing the direct benefit of engaging with this information, especially if they perceive it to be about the honeybee. As Moser and Dilling (2004) suggest, people have an interest in scientific information when they see the direct benefit thereof.

Poor visibility of communication on this IAS in the community of Coasta Land was cited above as a possible reason for the respondents' general lack of information on the wasp. When asked directly whether they had seen any communication of the European paper wasp in their area, 59 of the 60 respondents responded in the negative, and one was unsure. Two possible reasons for the low visibility of the information that had been communicated in the area may be proposed. First, since

the majority of the respondents evince a low level of interest in, and understanding of, this wasp, they simply may not take notice of information on the wasp when it is provided to them. It is not an issue that is urgent and important to them, as there could be other pressing issues that they are paying attention too (Moser & Dilling, 2004:6), such as unemployment as reported in section 4.2. The second possible explanation is language-related: the local newspapers and the pamphlet are in Afrikaans and English, i.e. not in the home language of the majority of the respondents. Furthermore, the radio stations where the information on the wasp was communicated; are English and Afrikaans radio stations. Therefore, even if the information had been disseminated, because of a language barrier it may have been relatively invisible to this community.

In order to inform the development of more visible communication, respondents were asked what they thought was the best way to communicate information about the European paper wasp.

Figure 8: Preferred way to communicate information about the wasp



N=60

Figure 8 shows that the (52%) of the respondents preferred television, followed by 32% with a preference for social media. At first glance this might appear to contradict the previous argument of a lack of smartphone access preventing participation as citizen scientists. However, it is much easier to access social networks such as Facebook, than it is to upload a picture with the GPS coordinates onto a site. Thirteen percent suggested radio, while only a very small percentage (2% in each case) mentioned newspapers and magazines. The results show that two of the communication methods SANBI had been using at the time of the study (newspapers and radio) were the least preferred

communication tools. (The pamphlet was not included as an option in this question, as the second last section of the questionnaire was dedicated solely to an assessment of this method.) At first glance, the results might not be surprising, as it is common knowledge that in the digital era the use of print media, such as magazines and newspapers, is decreasing, while there is an accelerated growth in the use of the Internet, including social media, to access information. But for a community with a low SES profile such as this one, the shift to digital might not be as pronounced. The low preference for newspapers could also be a function of the local newspapers not being in their home language, or that they simply do not have access to the local newspapers.

The low desire for print media could also be attributed to the relatively low level of educational attainment of this community. The love of reading might not be a common value amongst the respondents. Furthermore, it is possible the use of radio is associated with the older generation, while the use of television is very common to the younger generation, as social media. Taking into consideration that the majority of the population was in their 20s and 30s, these results are not surprising. Amongst all the other communication tools developed by SANBI, the pamphlet has been one of their driving tools that the Institute would like to improve and use more in the future, which led me to ask respondents, by means of an open-ended question, to share their opinions on the pamphlet. The following response categories emerged from an analysis of qualitative data collected:

Figure 9: Opinions on the SANBI pamphlet

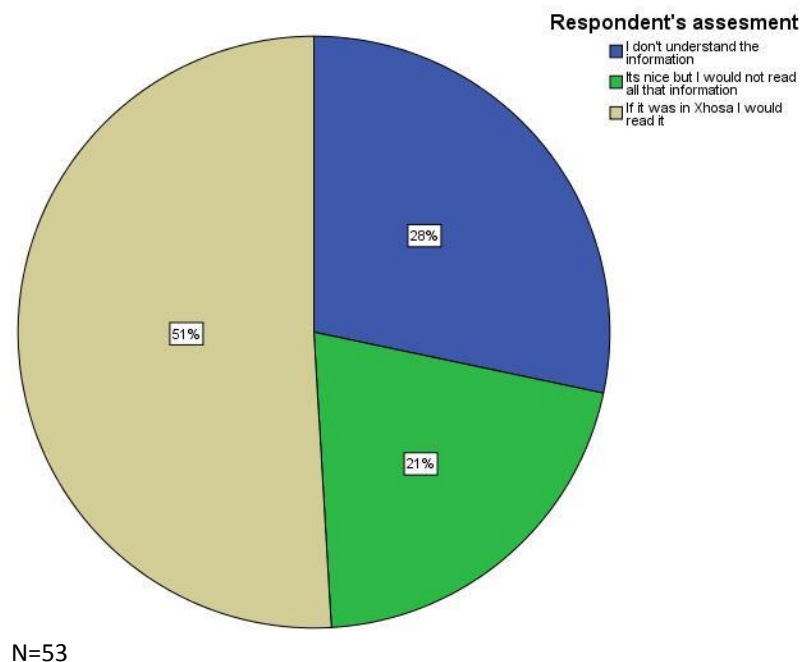


Figure 9 shows that half of the respondents reported that, were the pamphlet in their home language, Xhosa, they would read it. A further 28% reported that they did not understand the information on the pamphlet, while 22% found the design of the pamphlet to be attractive, but said that they would not read the information.

It is clear from the results that the main issue the respondents have with the pamphlet – SANBI's major method of communication with the public – is that it is not presented in their mother tongue. Nkomo (2008) states that scientific information presented in the public's native language facilitates a better process of engagement between science and that public. As stated before, the same applies to the online assistance tool developed by SANBI, which is only available in English. The European paper wasp has invaded some parts of the Western Cape, and the three main languages spoken in this province are English, Afrikaans, and Xhosa . According to statsSA (2016) 50% of the Western Cape population consists of Afrikaans first language speakers, followed by first language English speakers at 20%. While Xhosa first language speakers comprise 25% of the Western Cape population. This means that only the majority of the Western Cape population has access to the European paper wasp communication in a language they are comfortable with. This, in turn, means that there is a strong possibility that the minority of the Western Cape population are being excluded from participating in the management of this IAS, because of a lack of distribution of the information in all three main languages of the Western Cape, which could therefore contribute to the low rate at which the public has responded to calls to report European paper wasp nestings and observations.

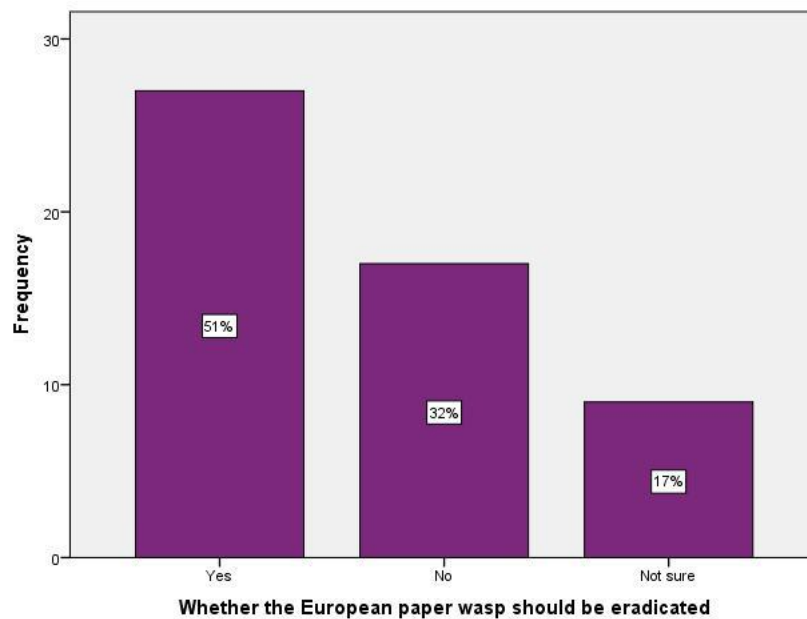
The results reported in this section show that interest in the European paper wasp as an IAS is very low amongst those residents of Coasta Land which were interviewed. This could be attributed to the invisibility of the information being disseminated, primarily because it is not available in their native language, Xhosa. Secondly, the lack of a direct, negative impact of the European paper wasp on their lives could be another factor that contributes to this lack of interest in the species. Lastly, the communication methods that are currently being used seem to be ill-suited to this community.

4.6 WILLINGNESS TO ASSIST IN THE ERADICATION OF THE EUROPEAN PAPER WASP

The last objective of the survey was to establish directly whether the study population would be interested in being active citizen scientists, in the sense of assisting with the eradication of the European paper wasp. The questionnaire was designed in such a way that only those who had seen information in their area and those who had experienced the wasp would provide data on this topic. However, due to the unforeseen changes in the population surveyed, and as the results from this section were an important part of the study, the questionnaire structure was changed so that all the respondents could answer the questions in that section.

As mentioned in Chapter 1, the success of the eradication programme would require a greater involvement of the public. As the wasp-eradication team cannot determine the location of every nest, they depend on the public to inform them of the wasp nests around their homes or residential areas. In so doing, the wasp eradication team is able to remove the wasps' nests, with the hope that eventually this species will be eradicated. Therefore, the public's opinion on this eradication programme is important to its advancement. It should be noted that information on the eradication programme had to be provided for the respondents to understand the questions on this topic, and to develop an opinion. The information provided could, however, have affected the reliability of the results presented in this section.

First, the respondent's attitudes towards the eradication of the European paper wasp was determined.

Figure 10: Opinions on eradication of the European wasp

n=53

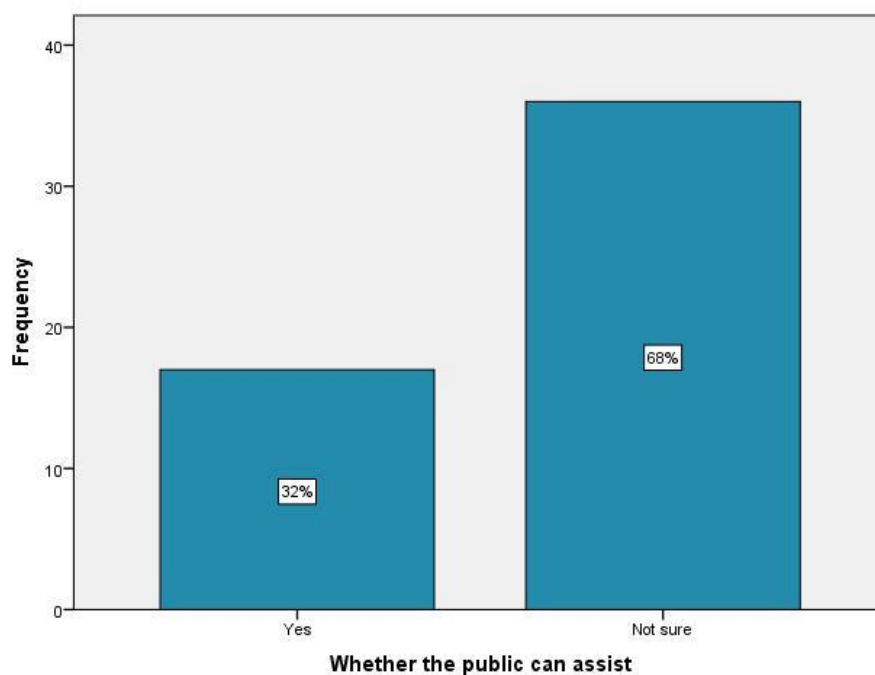
Figure 10 above shows that approximately half (51%) of the respondents agreed that European paper wasp should be eradicated, while 32% disagreed, and 17% of the respondents were unsure. The respondents who either agreed or disagreed, i.e. excluding those who were unsure, were asked to elaborate on their response. Those who agreed reasoned mainly that if it were causing problems (as explained by the interviewers, when they described the purpose of the eradication programme), it should be removed. Those who disagreed with eradication expressed a lack of understanding as to how these “bees” – as some would say – affected them and the environment. Once again, and as mentioned earlier, the effect of the European paper wasp on the natural environment is a “green” issue that the residents of Coasta Land are probably not very concerned with.

As mentioned above, the respondents were provided with a brief explanation of the eradication programme, and their responses were based on and influenced by the information provided. The resulting social desirability bias could explain the fact that majority of the participants agreed the wasp should be eradicated, but when previously asked whether they would kill the wasp, the majority answered in the negative. However, one may deduce that, if removing the wasp involves the respondents having direct contact with the species, they are not interested in doing so. As suggested before, this could be due to the stinging characteristic of the wasp. When the eradication of the wasp does not require any direct contact with it, then its eradication is supported. It was, however, also very clear that approximately 60% of the respondents struggled with the concept

(refer to graph) of removing “bees” because they are “bad” for the environment. Once again, the confusion between the wasp and the honeybee was apparent, and had an impact on the results.

In terms of willingness to assist in an eradication programme, Figure 11 below shows that 17 respondents were of the opinion that the public could assist in such an eradication programme, while the majority, approximately two-thirds, was unsure. And of the 17 that answered in the affirmative, the majority was unsure as to how the public could offer assistance.

Figure 11: Opinion on whether the public can assist with the eradication of the European paper wasp



n=53

This result makes sense, considering the respondents’ general lack of understanding of the wasp and its direct impact on them and the environment, as well as of the assistance that is available to the public. If members of the public do not understand what the problem entails, it becomes difficult for them to know how to deal and assist with that problem.

Table 3 below shows that none of the respondents themselves were willing (or even unsure whether they were willing) to contribute their time to assist in the eradication of the European paper wasp. With the exception of two of the participants who were fairly unwilling, all of the respondents who answered this question were not at all willing to assist with the eradication of the European paper wasp.

Table 3: Willingness to contribute time to assist in the eradication of the European paper wasp

	Frequency	Percent
Very willing	0	0
Fairly willing	0	0
Unsure	0	0
Fairly unwilling	2	4
Not at all willing	51	96
Total	53	100

It is likely that this lack of interest in assisting with the eradication of the European paper wasp can again be attributed to the public's lack of understanding of this IAS, its negative effects on the environment, as well as how it affects them directly. Therefore, asking them to give their time to a cause that they do not understand and that does not seem to benefit them directly makes no sense to them. This is especially true for residents of this community, most of whom are unemployed (as seen in the community profile), as they would rather invest their time in something that would yield some form of benefit for themselves and their family. This line of reasoning leads me to suggest that if there was some form of compensation offered, they would offer their time, despite the fact that they are not clear on the problems the wasp poses.

Considering these findings and the low household-income levels in this community, one would expect that none of the respondents would be willing to assist financially to an eradication programme. Indeed, as Table 6 below shows, none of the study population was willing (or even unsure whether they were willing) to contribute, in this case financially, to assist in eradicating the European paper wasp. Approximately a quarter (26%) were fairly unwilling, while the majority (74%) were not all willing to do so.

Table 4: Willingness to contribute financially to assist in the eradication of the European paper wasp

	Frequency	Percent
Very willing	0	0
Fairly willing	0	0
Unsure	0	0
Fairly unwilling	14	26
Not at all willing	39	74
Total	53	100

However, compared to the lack of willingness to contribute time, as presented in Table 5, these results on willingness to contribute financially are more positive. This a very interesting result, as it would be expected that the financial contribution results would be less positive.

Within, the scope of my analyses no reason could be found for this result. When asked why they are unwilling, the majority of the respondents stated that money is already scarce (as supported by the results reported in the first section of this chapter), therefore to contribute money to a cause that has no returns for them, makes no sense to them.

A similar lack of willingness was shown for reporting European paper wasp sightings through a call centre:

Table 5: Willingness to use a call centre to report observations of the European paper wasp

	Frequency	Percent
Yes	0	0
Unsure	7	13
No	46	87
Total	53	100

Table 7 above shows that, if it were made available, none of the respondents would use a call-centre service for reporting observations of the European paper wasp. The majority (87%) of the respondents reported that they would not use such a service, while the remaining 13% was unsure.

In order to interpret these results, one needs to consider that, for the public to make a phone call requires time and money that the respondents already indicated they are not willing to contribute. Also, and once again, the issue of a lack of appreciation of the direct danger of this IAS, which runs counter to creating any sense of urgency in reporting, is possibly a factor contributing to the lack of interest in reporting the nests via a call centre.

4.7 CONCLUSION

Public understanding of a scientific issue is a very important aspect of successful science communication on that issue. If the information that is communicated is understood well, it increases the rate of positive response. Thus, if the respondents had developed a better understanding of the European Paper wasp and its effects, they might have been more willing to assist in an eradication programme. Their lack of understanding, coupled with a context of poverty where survival and “brown” environmental issues take precedent over “green” ones, translates the eradication programme into an initiative of no value to the residents of Coasta Land.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

The field of PUS is concerned with issues related to the science–society interface (Raza, Singh & Shukla, 2009:270), which renders it a multidisciplinary discipline that attracts contributions from a variety of social sciences, including psychology and sociology. A sociological perspective was adopted in researching the topic of this thesis.

During the first phase of its development, the objectives of the field of PUS were “surveys that could measure the extent of the scientific knowledge, probe public attitudes towards science and scientists, and at times simply to explore the level of confidence or lack of confidence that a common citizen had in science” (Raza, 2009:269). By applying a predominantly quantitative survey design, my study attempted to attain some of these main objectives of this field. In the previous chapter, the results of the study were presented, with reference to each of the variables that were measured. In this chapter the themes that emerged from the results will be discussed. These themes combined conclude this thesis on the public understanding of the science and science communication concerning the European paper wasp, *Polistes dominula*, with specific reference to a sample of residents of Costa Land in Kayamandi, Stellenbosch.

It is important to note that all the communication sent out by SANBI included information on help that is available. At the time of writing, the City of Cape Town, Stellenbosch Municipality and SANBI were collaborating to assist with the eradication of the wasp. Wasp “clean-out” teams were established to remove wasps from residential areas at no cost to the public. The public could contact these teams via two methods: sending an email to the appropriate person at the City of Cape Town, and/or using iSpot: a online “friendly and free community helping to identify wildlife and share nature”(iSpot.org, 2016). People upload their digital images of a species, help each other identify it, and share and discuss what they observed. To use the service, one has to first register, and then upload an image. If it is identified as one of the highly sought after (in terms of risk) invasive alien plant or animal species, the coordinates attached with the image will be used to locate the sighting.

Considering the low income- and low education levels that characterise Kayamandi, this type of assistance might not be appropriate for that community, as it requires the members of the community to have easy access to the Internet and to have advanced smart phones that have email and camera features. These assistance methods were therefore developed on the basis of the

assumption that the public has access to a smart phone, and the knowledge needed to upload photos, together with their GPS coordinates, to the iSpot site. Furthermore, in South Africa cellphone data is quite expensive, adding a cost element to the use of these methods. Thirdly, there is no option for viewing the site in Xhosa, which may prevent members of the primarily Xhosa-speaking Kayamandi community from utilising the site optimally, thereby excluding them from this online community of citizen scientists. This, in turn, affects the wasp-eradication process, because only a small fraction of the South African public can assist.

Finally, in the context of grinding poverty, involvement in these types of citizen-science efforts are most likely not worth this community's while. Cock (2004) speaks of "green" and "brown" environmental problems. Green problems, such as biodiversity conservation, tend to be concerns of the white, middle class, while brown environmental issues such as access to clean water, sanitation, and waste removal tend to be concerns of black, low-income communities. Therefore, it is quite likely that, despite the tools provided, this community is simply not interested in participating in this kind of programme, because it does not constitute a priority concern in their lives.

5.2 SUMMARY OF RESULTS

The results pertain to predominantly black Xhosa-speaking, young residents with a relatively low level of educational attainment and residing in households with no or low income. Baylee (2008) argues that scientific literacy is necessary for an individual to fully participate in society. It also empowers a citizen to make personal decisions and appropriately participate in the formulation of public policies that impact his or her life. Baybee (2008) further argues that scientific literacy is not only about understanding, but this understanding leads to an attitude change that leads to action. Based on the low levels of educational attainment, the level of scientific literacy (with specific reference to biodiversity concepts and terminology) was expected to be quite low. However, when a test of scientific literacy was administered, it was clear that there much guessing took place, and therefore the reliability of the results are questionable.

It was during the test that terminology first arose as an issue, as some of the terms in the test did not have a Xhosa equivalent, were therefore not translated, and caused difficulties for respondents. The obstacle with terminology was not only experienced in the test, but with the translation of the main concept in the study, European paper wasp. It was translated by professional translators as *iEuropean paper wasp*, of which in essence is no translation at all. The respondents, however, often used an umbrella term, *unomeva*. This term is used in Xhosa to describe any stinging

insect, including a bee. Therefore, due to the lack of terminology in Xhosa, the respondents identified the wasp as a bee.

This finding is akin to the findings from a BBC World Service Trust study on the South African public's understanding of climate change (2010). The lack of terminology in local languages was also noted by this study. Terms for which there is no direct translation in, for example Sepedi and Zulu, are not accessible to many South Africans, thus preventing engagement on climate change, and increasing the perception that climate change is not relevant to them (BBC World Service Trust, 2010:3–4). If there had been terminology in indigenous languages, and therefore better understanding of the relevant concepts, the test results could have been different. As result of these problems of terminology and translation, it is very difficult to develop a real sense of the Coasta Land residents' level of understanding of the European paper wasp and its negative effects on both humans and the environment.

It seems the majority of the residents interviewed have seen the wasp, but only a small minority (less than 1 in ten) have been affected by it. Nevertheless, there seems to be a very high level of concern about the dangers the wasp poses to human health. Once again, this finding is akin to the BBC World Service Trust study on climate change: while there was a high level of awareness of the concept of climate change and its possible negative effects, at the same time there was a low understanding of what climate change is (BBC World Service Trust, 2010:3-4). This demonstrates that awareness and concern does not automatically equal understanding, which was also the case among the residents of Coasta Land.

Furthermore, despite the negative perception of the health effects of the wasp, a sizable proportion of the residents reported that they would not kill the European paper wasp. This could be attributed to an intuitive awareness of the likelihood of being stung, but also to some level of social desirability bias. The view of the European paper wasp as dangerous could be further attributed to the respondents' existing knowledge of a bee's painful sting – a characteristic they export to the wasp, which the majority perceived as a bee. The BBC World Service Trust also reported that the respondents were drawing on their existing knowledge of weather patterns to explain (not entirely correctly) the phenomenon of climate change. This reveals that there is much potential in using existing knowledge as a baseline to correct misconceptions.

My study further leads me to conclude that communication on the European paper wasp, mainly through newspapers and radio, has not reached the residents of Coasta Land, Kayamandi. A higher level of visibility would be achieved through television and social media. The pamphlet, which is currently SANBI's main communication tool, was found to be attractively designed, but the

information on the pamphlet did not interest the residents, mainly due to it being in English. This links back to the challenge relating to terminology, and needs to be recognised that it is indeed difficult for institutions such as SANBI to develop pamphlets and other communication tools in local languages if there is no terminology.

After being provided with an explanation of the eradication programme, the majority of the residents felt that the IAS should not be eradicated, but this could partly be attributed to them confusing the wasp with the honeybee, as some failed to understand why a “bee” should be eradicated. Most residents were unsure as to how the public can assist in the eradication of the wasp, and when presented with various options, the majority were unwilling to give their time or financial assistance, or to use a call centre to report observations of the IAS. In the light of the resident’s socio-economic profile, time and money are scarce commodities that residents would use first and foremost to improve living conditions.

These results echo the thoughts of Cock (2004) on “green” and “brown” environmental issues that illustrate class differences in the understanding of what “environment” is. For the lower classes, who are driven by unemployment and poverty, the environment involves “brown” issues, such as water, sanitation, urban pollution, electricity and waste removal. The upper classes, on the other hand, focus on “green” issues, such as the curbing species loss and habitat destruction. The eradication of the European paper wasp is primarily a green (biodiversity-related), middle-class issue, which for the poor, lower classes, such as the residents of Coasta Land, does not have a sufficiently negative impact on their standard of living to be addressed with urgency. This is distinctly revealed in their lack of interest to assist financially or give their time to the eradication programme. Having said this, it also has a human health component, which is a brown issue. It was similarly concluded in the BBC World Service Trust study that most South Africans view the issue of climate change as a “green” one, which can only be afforded by the rich and wealthy.

Another way of understanding this division is offered by Ziman (2001), who states that the use of formal scientific knowledge by the public depends on their need at a specific moment in time. Thus the level of response varies according to need, meaning that those who experience the direct impact of these wasps are the ones who will be willing to respond to the call to assist. These are not the sentiments expressed by the residents of Coasta Land, Kayamandi. Furthermore, as Ziman (2001) states, the meaning of a communication is actively constructed by the processes and circumstances in which it is communicated and received. The information communicated and the call to participate in the eradication programme should be understood within the socio-economic context of this

community, a context in which it does not make sense to give up time and money for a cause which does not promise any economic gain.

5.2.1 LANGUAGE AS A ROAD BLOCK IN THE UNDERSTANDING OF THE PUBLIC'S UNDERSTANDING OF THE EUROPEAN PAPER WASP

One of the first debates within the field of PUS revolved around the division of the public into two groups: those who are scientifically literate and those who are not (Raza, Singh & Shukla, 2009:270). The definition of scientific literacy that was used to operationalise scientific literacy in the context of my study-dealing with IAS is that of Miller. Miller (1983) defines scientific literacy as consisting of three dimensions: (i) an understanding of the norms and methods of science (i.e., the nature of science); (ii) a basic understanding and use of scientific and technical terms (i.e., science content knowledge); and (iii) an awareness and understanding of the impact of science and technology on society. He furthermore defines a scientifically literate citizen as someone who has a basic vocabulary of scientific terms and constructs, and a general understanding of the nature of scientific inquiry.

When measured against the above criteria provided by Miller (1983), the residents of Coasta Land in Kayamandi that were interviewed for this study cannot be described as such. As mentioned in Chapter 4, there were problems with regard to the reliability on the test scores, which could be a result of the lack of adequate translation of the test. This difficulty could likely have also have led to ambiguity and caused confusion for the respondents, thereby limiting their understanding of the many of the items in the interview schedule that were presented to them.

In the process of translating specifically the test section of the questionnaire, a number of challenges arose. Some of the terms were not translated into Xhosa, due to a lack of a corresponding term in Xhosa. Although this challenge was addressed by providing a Xhosa explanation, the original meaning of the term seems to have been lost. In other words, in a number of cases, lexical equivalence was not possible, i.e. the same question could not be asked in Xhosa using the same words as in the English interview schedule. This problem can be traced to the issue of conceptual equivalence, as many of the scientific terms in the test could simply not be translated “unambiguously” from the western culture, where they originated, to the Xhosa culture (Babbie & Mouton, 2001:238-239). One can therefore not conclude, with any degree of certainty, that the respondents are scientifically illiterate in terms of the vocabulary and nature of biodiversity and invasion ecology, as there is a high probability that they never understood what they were being

asked in the first place, It is quite possible that, were the respondents presented with this test fully translated, the results could be different, thus rendering it unreliable at present.

This translation obstacle presents a serious predicament for those who need to measure scientific literacy and cultural distance in a valid manner, and for science communicators, because mediation between two or more languages and the smooth interchange between one language and another is hampered by a cultural and language rift between western, English-speaking scientists and indigenous, African publics. Because the test, which was meant to provide information on a community's scientific literacy level, provided unreliable and therefore invalid results, it can therefore not be used as a basis to develop communication methods. Having said this, the other results of the study can be used to inform the development of communication methods.

In conclusion, this study has shown that methodologically it is highly challenging to conduct scientific-literacy tests in community such as Kayamandi. Due to the various languages and cultures in South Africa, many measurements do not work as well as in their original context of creation because of the obstacle of translation. One of the main aims of PUS is to address the challenge of communicating science to a diverse public in a form that they can understand (Raza *et al.*, 2009). And because of the vastly different levels of education and literacy, as well as the various languages, in South Africa, the country consists of highly diverse publics, which poses a greater challenge than in less diverse countries. For this obstacle to be overcome there needs to be collaboration between science communicators and linguistic professionals to find a way of presenting scientific-literacy measuring tools to the non-English-speaking public in a way that they can understand.

5.2.2 EVALUATION OF SANBI'S COMMUNICATION OF THE EUROPEAN PAPER WASP

One of the major aims of the ISP is to facilitate improved engagement with the public on IAS-related issues. It is based on the assumption that, if the public is able to engage with the information communicated to them, they will be able to become more active as citizen scientists, thereby assisting in management and eradication programmes. This programme is led by a team of natural scientists.

The deficit model is one of the elementary models in the field of PUS. This model characterises the public as deficit in knowledge, and argues that this deficit allows non-scientific assumptions to become entrenched, thus making it difficult for the public to take up new and correct information (Sismondo, 2010:176). Throughout the process of interviewing respondents, as well as on the basis of the analysis of the results, it became clear that the majority of the community of Coasta Land is

deficit in knowledge concerning the European paper wasp, as the members had difficulties conceptually separating it from the honeybee. The mere fact that the community is experiencing this confusion shows that its members are not aware of this species, the threats it poses, or how to deal with it.

Science communication is a “process by which the culture and knowledge of science are absorbed into the culture of the wider community” (Bryant, 2002:3). It can also be defined as “the use of appropriate skills, media, activities and dialogue to produce one or more of the following personal responses to science; awareness, enjoyment, interest, opinions and understanding of science” (Burns, O’Connor & Stocklmayer, 2003:190). SANBI has been involved in a process of disseminating information about the European paper wasp, with a desire to bring about these responses. They identified deficit in knowledge in the areas invaded by the wasp, and began a communication process, but did not receive the desired response. After various discussions with different members of the wasp team at SANBI, it became evident that there was no communication strategy in place. Methods were applied ad hoc, with no coherent set objectives in place. As far as I could determine, at the time of writing there was no system of evaluation in place to determine the effectiveness of the communication that SANBI had disseminated. I therefore decided to include sections in my study that evaluated, from the perspective of a South African public, the tools that SANBI has recently been using to communicate information on the European paper wasp.

The results from this evaluation of communication tools provided some explanation for the public’s low rate of response to SANBI’s calls for public participation in its eradication efforts. The results presented in Chapter 4, as well as summarised in Section 5.2 of this chapter, suggest that the communication methods developed by SANBI were unlikely to address the deficit in knowledge among residents of Kayamandi, as some basic principles, which are knowing ones audience, learning from others, evaluating ones activities and think creatively- in the development of the communication strategy were not adhered to (Bultitude, 2011). Furthermore, due to the ad hoc process followed in the development of communication methods, there was no strategy in place to identify various target publics and how best to communicate to each, taking into consideration social factors such as language and socio-economic status, and what the objectives of the communication are.

Consequently, impact evaluation, which “focuses on whether set objectives have been achieved” (Jensen, 2014:2), cannot be conducted as “a basis for practitioners to discover what aspects of science communication initiatives are working, in what ways, with which audiences and why” (Jensen, 2014:1). Good science communication therefore requires one keep impact evaluation

in mind, which requires upstream planning and clear objectives from practitioners. If these aspects had been in place, SANBI could have identified some of the challenges my study highlights, and thereby improve the communication process.

Furthermore, Jensen (2014:3) suggests that high-quality impact evaluation “requires training (either externally provided or self-taught) in relevant social scientific research methods (e.g. survey design)”. As mentioned in the beginning of this section, the team dealing with science communication at SANBI is comprised of natural scientists, who generally lack training in the social sciences, and this is a need to be addressed. This was evident during the several meetings conducted with some members of the wasp team and WRC that there was no understanding of how to tackle social science research. Scheufele (2013) agrees in that the challenge concerning science–public interfaces is due to the fact that scientists are trained in communicating their research to peers rather than to those outside the scientific sphere. Training in social science research methods, as well in science communication, will assist in addressing this challenge.

When planning is done properly, with evaluation in mind, it becomes a critical mechanism for avoiding unforeseen negative outcomes, which can be detected if the who, how and the why are answered, by applying principles of social science research and science communication, prior to the communication. In the case of the European paper wasp, SANBI’s methods were all ad hoc, and if a strategy had been in place, the issue of language in the case of communities such as Kayamandi would have been identified. This would have allowed the team to develop ways that would reach this community more effectively. When we are outsiders to a community, it is very easy for us to make incorrect assumptions about them as the “public” in PUS. Impact evaluation would guard against such incorrect assumptions, as it requires research on that public, and therefore on the best way to achieve one’s objectives. Another approach to evaluate SANBI’s communication methods involves application of Bultitude’s (2012) principles as a conceptual framework. As detailed in Chapter 2, Bultitude provides some practical suggestions for bridging the gap between the problem identification process (the public is deficit in knowledge) and the problem-solving process (science communication). The first error that SANBI made was creating communication methods with one general public in mind, which is an incorrect assumption, as my study clearly shows. Bultitude (2011) supports this by stating that there is no such thing as “the general audience”.

This is particularly true for South Africa, where the level of understanding differs vastly amongst different socio-economic, cultural and language groups. In such a context, the effectiveness of communication – the accurate receipt and use of information – requires “carefully defining intended audiences and by tailoring the level of information provided to each audience” (Bultitude 2011:37). If

SANBI had viewed the public as consisting of different audiences, they could have responded to at least the language variance amongst the different publics that my study highlights. Having said this, it is important to note that science communication is still a fledgling field of study in South Africa, compared to other parts of the world. Therefore, people holding positions as science communicators in institutions such as SANBI are natural scientists who are still finding their ground in this field, and for whom science communication is still a learning process.

As a result of a lack of appreciation for how publics differ, the remainder of the process of developing effective communication was adversely affected in the community I studied. If various publics had been identified, it would have been visible to the communication team that, to reach some of the publics, they would have to be more creative. When communicating, creativity is of utmost importance, especially in contexts such as the community that was the focus of my study. In a sense, then, the complexity of the South African population forces science communicators to be creative. As stated before, language barriers are a particular challenge, and coupled with the digital advancement that has shifted communication media from print to digital, requires of science communicators to develop methods that will be visually attractive and spark interest. The results of my study showed, however, that less than 20% of the Coasta Land residents interviewed preferred the methods (newspaper and radio) that SANBI had been using for communicating information on the European paper wasp.

Bultitude's (2011) third principle of effective communication is learning from others' experience. Most countries, have managed to control the spread of the European paper wasp with the help of the public, which shows that management with the assistance of an informed public is not only possible, but effective too. Therefore, increasing the probability of successful eradication. It is therefore important to identify methods used in other countries, especially those who have dealt with the wasp successfully, but adapting them to suit the South African context. This is particularly relevant as the European paper wasp is a very recent IAS in South Africa, and not much research has been conducted on it. Learning from other science communicators that have dealt with the topic of the European paper wasp, and that have delivered the message successfully, will assist in improving the quality, speed and effectiveness of the process of communication to the South African publics.

Bultitude (2011) also speaks of the evaluation of communication activities. By evaluating their communication processes by means of monitoring and impact analysis, SANBI would be able trace the effectiveness of those processes, and would also be able to ascertain what has been working thus far. Having said this, the fact that my study was supported by SANBI shows that the idea of evaluation is something that SANBI is currently taking into account.

In this section, I have used various science-communication principles from the literature to show where SANBI probably missed the mark when communicating on the European paper wasp. In response to their realisation of the public's deficit in knowledge of the European paper wasp, communication methods were developed to address that deficit. But there seems to have been a disconnect between the identification of the public's as deficit, the creation of the communication methods, and the dissemination of the information. This disconnect can be attributed to the lack of a communication strategy and, in particular, the lack of the crucial definition of who the public is that is deficit, as this sets the tone for the rest of the process, and my research in Kayamandi indicates that it was not given due consideration. In future, these principles could be used as guidelines for the development of communication strategies.

5.2.3 IMPACT ON INVASIVE SPECIES MANAGEMENT

The central question underlying the research is, "How does it affect IAS management?" The eradication of the European paper wasp is an IAS-species-management issue. Environmentalists, ecologists and others working in the field of IAS have realised that there is a need for partnership with and support of the public, an important factor in the success of IAS management, but the building of that partnership is dependent on effective communication with the public. Bremner and Park (2007) agree, stating that a major contributor to the success of these programmes is public support, hence "understanding the underlying attitudes of the public can help inform outreach education activities" (2007:306).

Therefore, before undertaking any form of science communication to the public in an attempt to build a relationship with that public, there has to be an understanding of the nature of the public that will be targeted. However, as my research has shown, it is highly challenging to effectively measure the public's attitudes in a context such as Kayamandi, which renders the relationship-building process difficult.

Larson, Phillips-Mao, Quiram, Sharpe, Stark, Sugita and Weiler (2011) provide a model for sustainable IAS management that consists of three pillars: environmental, social and economic. They argue that the social pillar – the incorporation of a social objective in IAS management – will result in the sustainability of such management. The social pillar consists of five measures of progress, namely involvement of multiple stakeholders in the management planning process; communicating progress; involving community members in the implementation of the project; developing education and outreach programmes; and increasing coordination of agencies and knowledge networks at all

levels. To be able to incorporate the social pillar effectively, once again an understanding of the target public is needed. When there is such an understanding, the management team is able to create the appropriate communication tools that will assist in the relationship building with the public. But the language challenge that is facing science communicators and environmental managers in South Africa has an impact on the management process, because not all publics are able to participate and render their assistance. The resulting lack of participation by some negatively affected publics hinders the IAS management process, because environmental managers do not obtain all the assistance they require.

5.3 RECOMMENDATIONS

My research has shown that successful science communication is not a simple task, yet it is not an impossible task. In this section, I offer some evidence-based recommendations on how SANBI could improve their communication to the public.

For an institution such as SANBI, science communication and public engagement is an integral part of what they do. Therefore, it is important for successful attainment of their goals to provide science communication and social scientific research training to all their staff members involved in the science communication process. The benefits of fully equipping their staff members involved in this process would be a more structured communication strategy that can yield better results, but also, were it to fail, the reasons could be easily identified. Secondly, considering the financial constraints within which an institution such as SANBI operates, a structured communication strategy would assist in maximizing the cost–benefit ratio, to best reach the set objects with the least amount of resources. Structure and direction also guards against any unanticipated expenses.

Where terminology is a challenge, one should build upon the community's current knowledge. In the case of the Kayamandi residents, the term *unomeva* continued surfacing during the course of the interviews. It was later discovered that this term refers to any insect with that stings (in a certain sense, on the level of the Linnaean “orders”, or even the genera, as Hymenoptera are characterised by a tail bearing a sting). Using graphics, SANBI can attempt to explain to the Xhosa speaking public that the European paper wasp is a form of *unomeva*, but needs a different name to distinguish it from the honeybee and from other stinging insects. Where applicable, communication should also be placed on communication platforms that reach the Xhosa-speaking publics, such as Xhosa newspapers and radio stations.

5.4 CONCLUDING COMMENTS

The main conclusion of this thesis is that language-related issues have an impact on whether one is able to measure science-related perceptions, attitudes, understanding and literacy in communities such as Coasta Land, Kayamandi. If measurement tools are not rendered in a language that the respondents can understand sufficiently to be able to complete reliably, one will continue producing results that are not a valid reflection of the orientations of the public(s) one intends to measure. Secondly, a lack of in-depth understanding of the contexts of various public(s) renders the communication process much more difficult, as such an understanding is required to understand the orientations of the public(s), in order to eventually develop appropriate communication methods informed by these orientations.

Specifically, without the development – in partnership with linguistic professionals – of appropriate terminology in indigenous languages for scientific terms, non-English-speaking communities will continue being side-lined from being effective citizen scientists with regard to matters that impact them. And without the development of such terminology, language barriers would continue to render it difficult to conduct research that will provide one with valid results on the public's perceptions, attitudes, understanding and knowledge concerning the European paper wasp, and therefore hamper the development of successful communication methods for communities such as Kayamandi. It is therefore not surprising that in South Africa, the majority of the PUS research conducted has involved white respondents (du Plessis, 2012). As a result of this, our understanding of the South African publics' understanding of science is limited to a small and relatively hegemonic "public", which shares many socio-demographic characteristics with the researchers studying it. My study has shown that there is so much more to learn from the under-researched publics, such as the residents of Coasta Land, Kayamandi.

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APPENDICES

APPENDIX A: *P. DOMINULA* SPECIMEN IN JARS



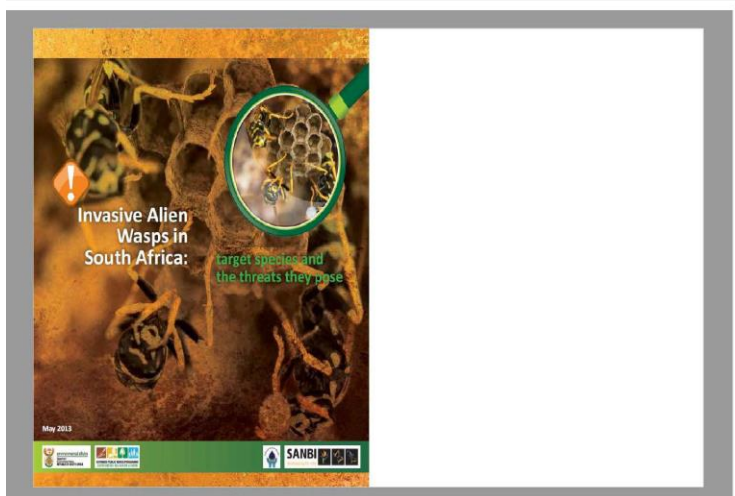
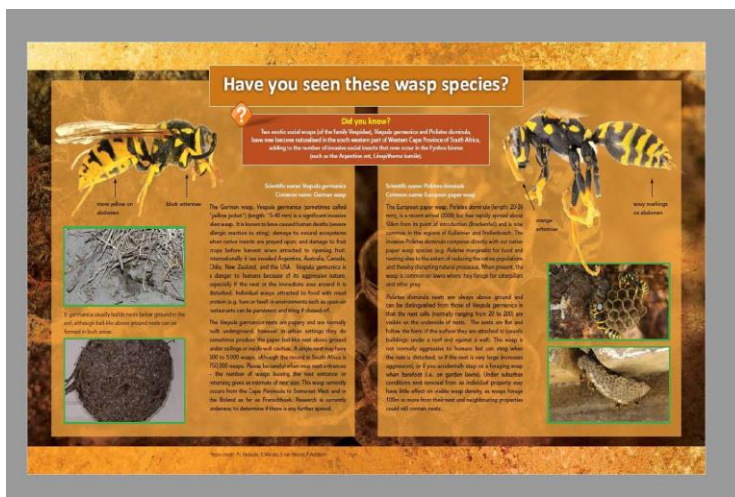
APPENDIX B: LAMINATED IMAGES OF *P. DOMINULA*



II



APPENDIX C: SANBI'S INVASIVE WASPS BROCHURE



APPENDIX D: FIELDWORKERS' CONFIDENTIALITY AGREEMENT

Title of Research Project: Beeware of the wasp: The role of language in studying and managing the European paper wasp.

Local Principal Investigator: Sinikiwe Simakani

As a member of this research team I understand that I may have access to confidential information about study sites and participants. By signing this statement, I am indicating my understanding of my responsibilities to maintain confidentiality and agree to the following:

I understand that names and any other identifying information about study sites and participants are completely confidential.

I agree not to divulge, publish, or otherwise make known to unauthorized persons or to the public any information obtained in the course of this research project that could identify the persons who participated in the study.

I understand that all information about study sites or participants obtained or accessed by me in the course of my work is confidential. I agree not to divulge or otherwise make known to unauthorized persons any of this information, unless specifically authorized to do so by approved protocol or by the local principal investigator acting in response to applicable law or court order, or public health or clinical need.

I understand that I am not to read information about study sites or participants, or any other confidential documents, nor ask questions of study participants for my own personal information but only to the extent and for the purpose of performing my assigned duties on this research project.

I agree to notify the principal investigator immediately should I become aware of an actual breach of confidentiality or a situation which could potentially result in a breach, whether this be on my part or on the part of another person.

_____ Signature	_____ Date	_____ Printed name
_____ Signature of principal investigator	_____ Date	_____ Printed name

APPENDIX E: VERBAL CONSENT SCRIPTS: XHOSA, AFRIKAANS & ENGLISH

IPHETSHANA LESIVUMELWANO SOMLOMO ELINEENKCUKACHA

Ezi ziinkcukacha zam nezomphathi wam zoqhagamshelwano (gqithisa iinkcukacha ezichwetheziweyo), ukuba unemibuzo okanye nantoni na ekuxhalabisayo malunga nodliwano-ndlebe olwenzileyo okanye ngeprojekthi ungathi mva uqhagamshelane nomnye wethu.

Igama lam ngu_____. Ndingumfundi [umntu owenza udliwano-ndlebe encedisa] umfundo owenza isidanga seemasters zeSociology kwiYunivesithi yaseStellenbosch owenza uphononongo eStellenbosch (ingakumbi e-Onder Papegaaiberg naseKhayamandi) sifuna ukwazi ngolwazi, ngeengcinga nangendlela yokubona izinto koluntu malunga nonomeva obizwa i-European paper wasp. Usapho lwakho luye lwakhethwa ngokungenanjongo kuluhlu lwabahlali bommandla ohlala kuwo, kwaye ndingathanda ukukumema ukuba uthathe inxaxheba kuphononongo ngokuba undivumele ndenze udliwano-ndlebe nawe ngonomeva.

Uphononongo lujolise ekuncedeni iZiko leSizwe leeNtlobo-ntlobo zezidalwa laseMzantsi Afrika ukuba livelise iindlela ezintsha nezisebenzayo zokunxibelelana ngeenkcukacha ezimalunga nesi sinambuzane eluntwini. Ekugqibeleni, ukuphumelela konxibelelwano kuza kuxhomekeka ekwazini ukufikelela kwiimfuno zeentlobo-ntlobo zamaqela abantu abachaphazeleka ngonomeva obizwa i-European paper wasp. Ngoko ke, ukuthatha kwakho inxaxheba kolu phononongo kunika ithuba lokuba neempembelelo ekwenziweni kwezi ndlela zonxibelelwano.

Ndifuna ukukuqinisekisa ukuba iinkcukacha osinika zona kolu dliwano-ndlebe azizi kunxulunyaniswa negama lakho nangayiphi na indlela. Naziphi na iziphumo eziye zapapashwa eziphuma kolu phononongo ziza kubhekisela kwiimpendulo ezidityanisiweyo zabo bonke abathatha inxaxheba. Ukuthatha kwakho inxaxheba kolu dliwano-ndlebe ukwenza oko ngokuzithandela akunyanzeliswa, kwaye ukuba uziva nanini na ngeli xesha kusenziwa udliwano-ndlebe ufuna ukuyeka okanye ungafuni kuphendula umbuzo, ungakwenza oko.

Ungathanda ukuthatha inxaxheba?

TEKS VIR MONDELINGE INGELIGTE TOESTEMMING

Dit is my en my toesighouer se kontakbesonderhede (oorhandig getikte inligting) hierdie. Indien u later enige vrae of kommer oor u onderhoud of die projek het, kan u gerus enigeen van ons nader.

My naam is _____. Ek is 'n [veldwerker wat hulp verleen aan 'n] meestersgraadstudent in Sosiologie aan die Universiteit Stellenbosch en ek onderneem 'n studie in Stellenbosch (spesifiek in Onder-Papegaaiberg en Khayamandi) oor openbare kennis, persepsies en ingesteldhede betreffende die Europese papierwesp. U huishouding is lukraak uit 'n lys wonings in u woonbuurt gekies. Ek nooi u nou om aan die studie deel te neem en vra dat u toestem dat ek 'n onderhoud oor die wesp met u voer.

Die studie is daarop gemik om die Suid-Afrikaanse Biodiversiteitsinstituut te help om nuwe en effektiewe metodes te ontwikkel om inligting oor hierdie insek aan die publiek te kommunikeer. Uiteindelik sal die sukses van die kommunikasie afhang van die mate waartoe dit in die behoeftes van 'n uiteenlopende groep mense wat deur die Europese papierwesp geraak word, voorsien. U deelname aan die studie bied daarom 'n geleentheid om die ontwikkeling van hierdie kommunikasiemetodes te beïnvloed.

Ek verseker u dat die inligting wat u verstrekk op geen wyse hoegenaamd met u naam verbind sal word nie. Enige resultate uit die studie word op die gesamentlike reaksies van al die respondente gegrond. U deelname aan hierdie onderhoud is heeltemal vrywillig, en indien u in enige stadium tydens die onderhoud voel dat u wil stop of nie 'n vraag wil beantwoord nie, kan u dit gerus doen.

Wil u graag deelneem?

SCRIPT FOR VERBAL INFORMED CONSENT

These are my and my supervisors contact details (hand over typed out information), if you have any questions or concerns about your interview or the project at a later stage you are very welcome to contact either of us.

My name is _____. I am a [fieldworker assisting a] Sociology master's student at Stellenbosch University who is conducting a study in Stellenbosch (specifically Onder Papegaaiberg and Khayamandi) on public knowledge, perceptions and attitudes regarding the European paper wasp. Your household was selected randomly from a list of residences in your area, and I would like to invite you to participate in the study by letting me interview you on the wasp.

The study is aimed at assisting the South African National Biodiversity Institute to develop new and effective methods to communicate information about this insect to the public. Ultimately, the success of the communication will depend on its ability to meet the needs of a diverse group of people who are affected by the European paper wasp. Therefore, your participation in this study offers an opportunity to influence the development of these communication methods.

I would like to assure you that the information you provide during the interview will not be linked to your name in any way. Any published results from the study will be based on the combined responses of all participants. Your participation in this interview is entirely voluntary, and if you feel at any given point during the interview you would like to stop or not answer a question, you are more than welcome to do so.

Would you like to participate?

APPENDIX F: QUESTIONNAIRES (XHOSA, AFRIKAANS & ENGLISH)