

**MARINE PLASTIC POLLUTION IMPACTS ON ECOSYSTEM SERVICES AND
LIVELIHOODS IN SOUTH AFRICA: A REVIEW AND STAKEHOLDER
PERCEPTIONS**



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By

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ABSTRACT

Marine plastic pollution is one of the major environmental problems globally, with adverse impacts on marine ecosystem services, functions and benefits and people. Yet, compared to plastic pollution impacts on terrestrial ecosystems, the impacts of plastic waste on marine ecosystems are little studied and poorly understood in South Africa. In response, research interest on the ecological and economic impacts of marine plastic pollution has grown rapidly but socio-cultural impacts remain poorly conceptualized and little understudied. This trend is arguably driven by the dominance of a quantitative paradigm which is arguably inadequate to respond to dynamic socio-cultural issues and contexts. Further, in South Africa, marine ecosystems are used by diverse groups of people ranging from subsistence users, tourism operators, commercial fishers and recreational users, meaning that addressing marine plastic pollution requires a multi-stakeholder approach. However, few studies explore the perceptions of diverse stakeholders regarding marine plastic pollution, its impacts and potential interventions.

Against this background, the objective of the thesis are twofold: (a) to argue for a more nuanced understanding of marine plastic pollution impacts on human well-being in order to strengthen conceptualization of impacts that goes beyond direct and quantitatively measured impacts (ecological, health and economic) but considers the socio-cultural dimensions of impacts (lifestyle disruptions, mental health costs and cultural and heritage impacts), and (b) examine stakeholders' perceptions of marine plastic pollution, its impacts and potential interventions in South Africa. Drawing on case studies, this study provides a working definition of the socio-cultural impacts of marine plastic pollution and a conceptual framework for categorizing the impacts. It highlights three dimensions of the socio-cultural impacts of marine plastic pollution (lifestyle, mental health, and cultural and heritage impacts). It also illustrates connections between marine ecosystems and marine-based livelihood activities with the social and cultural dimensions of human wellbeing to show the links between marine environments and socio-cultural contexts.

Concerning stakeholder perceptions, the study showed a tendency to associate marine plastic pollution with immediate, noticeable and easily quantifiable ecological impacts such as entanglement and ingestion of marine organisms, economic impacts and social impacts (e.g., loss of aesthetic appeal). However, secondary impacts such as loss of marine biodiversity and social impacts such as human health, were largely unknown. Moreover, there was heterogeneity in perceptions of marine plastic pollution impacts among the stakeholder groups. Prospective studies researching marine plastic pollution impacts should consider divergent and diverse perceptions of different stakeholders to capture the real costs of marine plastic pollution.

Keywords: Marine ecosystems, plastic pollution, stakeholders, ecosystem services

DECLARATION

I, Papama Yose, hereby declare that this thesis was written by myself, that the work contained herein is my original work that I carried it out under the supervision of Prof. Gladman Thondhlana and Prof. Gavin Fraser. All the sources and contributions have been duly acknowledged within the text and the reference list. The thesis is submitted in full fulfilment for the degree of Master of Science in Environmental Science in the Faculty of Science at Rhodes University, South Africa and has not been submitted for any other degree or professional qualification except as specified.

Signature: 

Date: 12 June 2023

Dedication

In loving memory of my beloved uncle, Mr Mcebisi Yose, hailing from the lineage of ooGqwashu, ooNtelele, ooManzini, ooGxiya, ooLawu, ooMadumenkazana, your untimely passing has left an irreplaceable void in our frail hearts. Nevertheless, your memory and legacy will continue to be an everlasting source of inspiration. I dedicate this thesis in your honour as a tribute to your profound impact on my life and a testament to the enduring love and inspiration you bestowed upon us. Although you are no longer with us to witness its completion, every page of this thesis bears the imprint of your profound influence.

One of your last words to me, quoting George Meredith, were, "*Don't just count your years; make your years count*". You embodied this wisdom, and I pledge to live by these profound words. I aspire and promise to be at least half of the man you were—an embodiment of integrity, a champion of unwavering principles, and a man of boundless kindness.

Phumla in eternity, bhuti wam, my brother; it is painful, but you served your purpose in this world, and we would be selfish not to let you rest in peace. This victory is yours, Mkhuluwa!!

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¹ Disclaimer: Any findings or recommendations expressed in this MSc thesis do not necessarily reflect the views of CSIR.

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LIST OF COMMON ABBREVIATIONS

Acronyms Definitions

Covid-19	Coronavirus disease of 2019
CSIR	The Council for Scientific and Industrial Research
DAFF	Department of Agriculture, Forestry and Fisheries
DFFE	Department of Forestry, Fisheries and the Environment
DDT	Dichlorodiphenyltrichloroethane
EEZ	Exclusive Economic Zone
ES	Ecosystem Services
FAO	Food and Agriculture Organisation
G20	Group of Twenty
GDP	Gross Domestic Product
GML	Global Strategy on Marine Litter
IPBES	Intergovernmental Platform for Biodiversity and Ecosystem Services
IUCN	International Union for Conservation of Nature
MA	Millennium Ecosystem Assessment
MARPOL	International Convention for the Prevention of Pollution from Ships
MPA	Marine Protected Areas
MSFD	Marine Strategy Framework Directive
NGO	Non-Governmental Organizations
OECD	Organisation for Economic Cooperation and Development
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated biphenyls
SDGs	Sustainable Development Goals
UN	United Nations
UNCLOS	UN Convention on the Law of the Seas
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
WWF	World Wildlife Fund for Nature

CHAPTER 1

GENERAL INTRODUCTION

1.1 Background and rationale

Marine plastic pollution is a pervasive and growing environmental problem globally, with substantial adverse impacts on the delivery of marine ecosystem services essential for economic activities (Aretoulaki et al., 2021; Rodríguez et al., 2020) and human welfare (Beaumont et al., 2019; Gall and Thompson, 2015). Marine plastic pollution is already posing serious problems for marine species including seabirds, mammals and inter alia (Arabi and Nahman, 2020; Naidoo and Rajkaran, 2020; Beaumont et al., 2019; Chapter 2). Further, marine organisms such as fish can mistakenly ingest microplastics and, in turn, can potentially transfer hazardous compounds to the food chain (Gall and Thompson, 2015; Sheavly and Register, 2007). Transferring these toxic compounds up the food chain could severely affect human health in ways we do not fully comprehend yet (Davison et al., 2021; Vethaak and Legler, 2021). Several studies have also indicated the negative economic impacts of plastic pollution on marine ecosystems, particularly experienced in coastal communities (Wootton et al., 2022; Walker, 2021; Phelan et al., 2020; Hugo, 2018). Consequently, there has been increasing recognition among nations and intergovernmental entities that marine plastic pollution is a serious global concern that requires urgent attention (Ericksen et al., 2023; Ferraro and Failler, 2020; Thushari and Senevirathna, 2020). As such, international efforts, including action guidelines, agreements, treaties, and regulations, have been designed to curb marine plastic pollution (Ferraro and Failler, 2020; Vince and Stoett, 2018), including the Ocean Plastic Charter (2018), Clean Seas Campaign (2017), Action Plan to Combat Marine Litter (2015), Global Strategy on Marine Litter (GML) (2012), and the UN Convention on the Law of the Seas (UNCLOS) (1994) (Ferraro and Failler, 2020; Vince and Stoett, 2018).

Notwithstanding these international instruments, several barriers still undermine efforts for reducing marine plastic pollution and mitigating its impacts. These barriers include fragmentation of the current international regulatory system (Abbott and Sumaila, 2019; Chapter 2 section 2.5), financial and technological limitations (Townsend et al., 2018), a lack of political will (Hugo, 2018), and poor conceptualization of marine plastic pollution (Townsend et al., 2018). Further, there is a lack of stakeholder dialogues and participation in

developing the intervention tools required to address marine plastic pollution (Hartley et al., 2018), though different stakeholders are affected by marine plastic pollution in various ways (see Chapter 4), making stakeholders' perspectives on marine plastic pollution and their impacts multifaceted (UNESCO, 2021).

Further, different stakeholder groups have varying levels of engagement with the marine plastic pollution concept. Some stakeholders, such as academics, may be well-versed in the impacts of marine plastic pollution and are working to change their behaviour and practices. In contrast, for other stakeholders, this may be a foreign concept where there is an opportunity for awareness raising (Pahl et al., 2020; Heidbreder et al., 2019). Consequently, a consideration of the multi-sectoral and multi-stakeholder perceptions can offer a chance to develop collective capacity through sharing knowledge, lessons, and experiences on the international, regional, national, and sub-national scales in order to inform current and future interventions and their implementations.

Presently, there are widespread societal discourses on the issue of marine plastic pollution among a wide array of stakeholders including the broader civil society, academia, plastic manufacturers, legislators, and general public citizens (Pereira et al., 2022; Wootton et al., 2022). Wootton et al.'s (2022) study found a lot of blame shifting among the fishery community, with commercial and recreational fishers blaming one another for contributing to marine plastic pollution and multinational companies and the government. As a result, there tends to be less urgency among the stakeholders to create change because they felt they are not responsible for marine plastic pollution (Wootton et al., 2022; Hartley et al., 2018). This lack of accountability and urgency among stakeholders can hinder efforts to create change.

Mehinto et al. (2022) affirm that stakeholders tend to have divergent viewpoints on the significance and urgency of marine plastic pollution, citing the example of the microplastic issue. Some stakeholders perceive marine plastic pollution as "*superficial*" (Burton Jr, 2017) and "*distractive*" (Stafford and Jones, 2019), while others view it as "*significant*" (Rochman et al., 2015) and "*urgent*" (Xanthos and Walker, 2017). This is also exemplified in the case of discarded fishing gear which is recognized as a major factor in marine plastic pollution

(Suuronen, 2022). Moreover, research shows that there are conflicting views amongst actors, with Non- Government Organizations (NGOs) and academics calling for solutions, including reporting the perpetrators abandoning their fishing gears in marine ecosystems and incentivizing responsible disposal of fishing gears. However, some fishing sector representatives contest these suggested measures by academics and NGOs based on economic concerns and the practicality of implementing such solutions (Suuronen, 2022). Such diverse and conflicting views and interests might have wider implications for finding effective governance and solutions for addressing marine plastic pollution (Pomeroy and Douvère, 2008; Chapter 4).

Taken together, there is compelling evidence that investigating the perspectives of diverse stakeholders, including local communities, experts, private operators and public entities, can advance our understanding of the contestations on marine plastic pollution and its impacts and, in turn, allow for the development of interventions for addressing it (McNicholas and Cotton, 2019). Yet, despite the importance of understanding stakeholders' views on marine plastic pollution, the social perspective lenses continue to be glanced over in debates on marine plastic pollution and its impacts (Pathak, 2020; Hartley et al., 2018). Therefore, an integrated approach that considers the social dimensions of marine plastic pollution and its impacts may provide useful insights into understanding marine plastic pollution, its impacts on ecosystem services and human welfare and developing interventions for reducing marine plastic pollution.

1.2 Motivation for the study

South Africa has one of the world's longest coastlines, bordered by the Indian Ocean to the south and southeast and the Atlantic Ocean to the west (DFFE, 2021). The country's oceans are rich in biodiversity and provide opportunities for the maritime industry including fisheries, mining, shipping, and other new sectors (DFFE, 2021). A study conducted by DFFE in 2010 found that the direct economic contribution of ocean activities to South Africa's Gross Domestic Product (GDP) was approximately 4.5% (DFFE, 2021), illustrating the value of the blue economy to the country's development agenda. However, the country is faced with a huge environmental challenge in the form of marine plastic pollution, which threatens to corrode the base for many ecosystem services. Studies show that South Africa produces enormous amounts of plastic waste that leaks into the ocean (IUCN, 2021; Verster and Bouwman, 2020; Jambeck

et al., 2018; Chapter 2, section 2.4). According to Jambeck et al. (2015), South Africa is regarded as the 11th largest contributor to marine plastic pollution globally. Furthermore, the South Africa National Biodiversity Assessment highlights growing concerns about plastic pollution, particularly the prevalence of microplastics, across all natural environments, encompassing both marine and terrestrial ecosystems (Skowno et al., 2019). According to a recent CSIR (2022) analysis, the annual cost of plastic pollution on marine ecosystem service delivery varies between R3.4 billion to R34.1 billion.

Given the adverse impacts of marine plastic pollution, it is plausible to argue that plastic leakage has deleterious effects on marine ecology, the economy and human well-being in South Africa and beyond. However, there are still huge gaps and unknowns in our understanding of the impact of marine plastic pollution on South Africa's economy and marine ecosystem services (Arabi and Nahman, 2020). These gaps are in part attributed to the ambiguity in conceptualizing marine plastic pollution impacts, which up until now have been shaped by ecological framings focussed on observable and quantifiable ecological impacts (Abbott and Sumaila, 2019). Correspondingly, there tends to be more focus on the ecological impacts of marine plastic pollution than on equally important social dimensions that are difficult to quantify and measure. Social dimensions that speak to varied perceptions of the impacts of marine plastic pollution are important to identify and understand, as they can form the basis for co-designing interventions to minimize or avoid marine plastic pollution. This thesis aims to contribute to the debate on marine plastic pollution by (i) unpacking the complex conceptualization of marine plastic pollution impact and providing a typology and characterization for understanding marine plastic pollution and (ii) exploring stakeholders' perceptions of marine plastic pollution.

Differences in the perceived impact of plastic debris pollution may result in contestations over the magnitude of the impacts and strategies for addressing it, as aforementioned (Hartley et al., 2018). Therefore, understanding stakeholders' perceptions of the effects of plastic debris on marine ecosystem services (e.g., fishers, beachgoers, etc.) can form the basis for understanding and tackling the marine plastic debris problem (Jefferson et al., 2014, Chapter 4). More importantly, taking into account the varied perceptions of stakeholders regarding marine plastic pollution is an acknowledgment that marine plastic pollution is a socio-ecological issue and critical for broadening understanding of impacts across a stakeholder gradient. In light of the

preceding context, the overarching aim of this study is to examine the perceived impacts of marine plastic pollution on marine ecosystems and the economy in South Africa from a multi-stakeholder perspective. The key research questions for the study included:

Research question 1: How can the socio-cultural dimensions of marine plastic pollution impacts on human well-being be conceptualized?

Research question 2: What are stakeholders' views on marine plastic pollution and its impacts on marine ecosystems and human well-being in South Africa?

Research question 3: What are the implications of the findings on marine plastic pollution debates and potential interventions?

1.3 Structure of the thesis

This thesis comprises five chapters, as illustrated in Figure 1. Chapter 1 provides background information about the study undertaken, its motivation, and three primary research questions. Chapter 2 provides an extensive desktop literature review. Chapter 3 presents a critical review of the conceptualization of the socio-cultural impacts of marine plastic pollution, including a definition and typology for identifying, categorizing and characterizing the impacts. Chapter 4 examines stakeholders' perceptions of marine plastic pollution impacts in South Africa. Both empirical chapters, Chapters 3 and 4, are presented in a paper format. Chapter 3 is published in an international journal outlet *Marine Pollution Bulletin* and Chapter 4 is under review in *Ecosystems and People*. Since some of the chapters are in paper format, there are instances of repetition of certain information. Chapter 5 concludes by synthesizing the findings and implications for marine plastic pollution management.

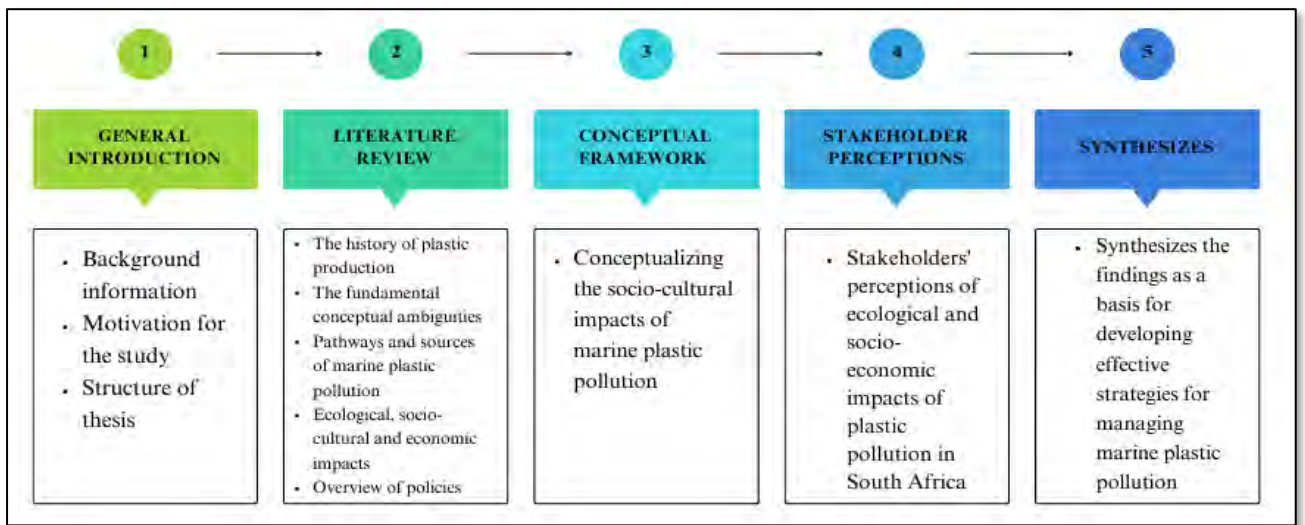


Figure 1. Organizational structure for the thesis chapters

CHAPTER 2

A LITERATURE REVIEW OF PLASTIC POLLUTION AND IMPACTS ON MARINE ECOSYSTEMS AND HUMAN WELL-BEING

2.1 Introduction

Over the last few decades, the proliferation of marine plastic pollution in marine ecosystems and its deleterious effects has become an increasingly contentious issue in scholarly and practitioner communities (Thushari and Senevirathna, 2020; Beaumont et al., 2019; Borrelle et al., 2017; Wabnitz and Nichols, 2010; Derraik, 2002). Annually, it is estimated that more than 10 million tonnes of plastic waste globally enter the ocean (Almroth and Eggert, 2019; Boucher and Billard, 2019). According to Beaumont et al. (2019), marine plastic pollution renders an annual loss of 1-5% in the delivery of ecosystem services provided by marine ecosystems, which translates to about \$600 billion to \$3 trillion in economic losses ².

Extending on Beaumont et al. (2019) analysis, the World Wildlife Fund for Nature (WWF) (2021) asserts that these figures only reflect annual costs. In reality, however, plastic leaks remain in the oceans for a very prolonged period, meaning the impacts will be persistent with lifetime costs (Murphy et al., 2022; Nielsen et al., 2020). Thus, the current and prospective future costs of marine plastic pollution on marine ecosystems must be considered when addressing this challenge. Despite these staggering figures and the steadily expanding body of research on the impacts of marine plastic pollution (Beaumont et al., 2019; Vince and Stoett, 2018; Vegter et al., 2014), there remains a theoretical gap in conceptualizing marine plastic pollution impacts (Chowdhury et al., 2021; Townsend et al., 2018), with notably few studies analysing the impacts from a socio-cultural perspective. This poor conceptualization can substantially undermine interventions for managing marine plastic pollution and its impacts. As a result, marine plastic pollution continues to be an increasing concern in many parts of the world (Jambeck et al., 2018).

² Figures are based on 2011 US price levels.

This is particularly true in light of the new recognition that environmental and social concerns are inextricably intertwined rather than distinct entities (Schmitz et al., 2012). As such, marine plastic pollution not only harms the environment but also exacerbates social injustices (Bennett et al., 2022; Parsons et al., 2021). For instance, the plague of marine plastic pollution tends to harm the most vulnerable people, such as women, disabled people and socio-economic disadvantaged people, in the world (UNEP, 2021). One example is small-scale fishers relying on fish and other marine resources for their livelihoods. However, marine plastic pollution can result in diminishing fish populations and higher rates of marine life mortality, making it difficult for small-scale fishers to sustain their livelihoods (FAO, 2019). This is also mirrored in the South African context. For example, according to a report published by the Department of Agriculture, Forestry and Fisheries (DAFF) (2016), South Africa has more than 30 000 subsistence fishers whose livelihoods are reliant on the marine ecosystem and probable experience after-effects of marine plastic pollution. However, there is still a lack of substantial studies that view marine plastic pollution from a broader environmental and social justice perspective. For example, there is a lack of vulnerability assessments to determine which stakeholders are most vulnerable to marine plastic pollution (Mills et al., 2011; Béné, 2009). Vulnerability assessments can help understand how impacts on stakeholders' livelihoods, health, and cultural practices influence their perceptions of marine plastic pollution. This, in turn, can aid in developing more effective, equitable, targeted, and localized interventions that build resilience, promote awareness raising, and strengthen capacity in mitigating the marine plastic issue. This is one example of how integrating social components such as stakeholder consideration, offers a realm of possibilities to transcend the current mitigation measures beyond what they are achieving now.

Given this background, this chapter reviews the literature on the research approach to studying marine plastic pollution and its impacts. This review provides an overview of (1) the history of plastic production and plastic accumulation in marine ecosystems, (2) the fundamental conceptual ambiguities relating to marine plastic pollution, (3) unpack the pathways and sources of marine plastic pollution, (4) discuss the ecological, socio-cultural, and economic impacts of marine plastic pollution and (5) provide a brief overview of some key policies that have guided waste management including plastic waste.

2.2 History, trends of plastic production and origin of marine plastic pollution

The use of plastic by humans has a lengthy and complex history that dates back to around 1600 BC (Fisher, 2013; Thompson et al., 2009). However, Leo Bakelite, a chemist in 1970, is considered to have pioneered the modern, synthetic polymers as people know them presently (Thompson et al., 2009). Plastics, which can be defined as a grouping of synthetic or naturally occurring polymer compounds that are remoulded under heat pressure and cooled to give shape—have a variety of industrial and commercial applications (Andrady and Neal, 2009). In addition, these contemporary plastics have attractive qualities such as being affordable, flexible, and moisture resistant, which has led to a growth in the demand for plastics globally (Andrady and Neal, 2009). For example, the plastics industry tripled its production in 1953 to 14 million tonnes, and by 1963 it had soared to 42 million tonnes (Yoshioka, 1964). A report by the OECD in 2018 indicates that the current global plastic production is around 407 million tonnes yearly.

Following this rapid increase in plastic production, a wide range of negative impacts, including air pollution (Mukheed et al., 2020), soil pollution (Mukheed et al., 2020) became noticeable (Ford et al., 2022; Mukheed et al., 2020; Ryan, 2015). As a result, by the 1950s, there was increasing attention to the adverse impacts of plastic contamination from the vast array of stakeholders including the academic community, policymakers, media, and the general public (Romeo et al., 2015; Ryan, 2015). However, for a considerable amount of time, primarily terrestrial ecosystems were the focus of the plastic contamination phenomenon (Townsend et al., 2018). It was only until the late 1960s, a decade later, that a few studies discovered that plastic pollution also has significant negative impacts on marine ecosystems when Kenyon and Kridler (1969) reported ingestion of plastic material by Laysan Albatrosses (*Phoebastria immutabilis*) on the northwest Hawaiian Islands. However, over time and in different contexts, stakeholders' perceptions of marine plastic pollution have varied and continue to vary more significantly than plastic pollution in the terrestrial environment. Research on marine and coastal debris ingestion by seabirds in South Africa began in the mid-1980s (Ryan, 1988, 1987), with earlier reports of plastic ingestion (Hughes, 1974, 1970 cited Ryan, 2015). Between 1985 and 1989, an increase in plastic debris, including particles as small as 2 mm, was observed

on southern and western beaches (Ryan and Moloney, 1990). Polyethylene pellet contaminants have been used to track changes in persistent organic pollutant (POP) concentrations along the South African coast (Ryan et al., 2012).

2.3 Conundrum in defining marine plastic pollution

Despite the growing concerns about plastic pollution in the marine environment, there is still much theoretical ambiguities in understanding the concept of marine plastic pollution (Pathak, 2020). For instance, some authors often conflate the terms “*marine debris or litter*” and “*marine plastic pollution*” in some contexts, such as in media reporting. According to the United Nations Programme (UNEP) (2009:1), marine litter can be defined as “*any persistent, manufactured or solid material discarded, disposed of or abandoned in the marine and coastal environment*” whereas, despite making up a significant amount (60%-80%) (Derraik, 2022; Themistocleous et al., 2020) of marine litter, marine plastic pollution is only one sort of marine litter (Katsanevakis, 2008). There are other types of marine debris including glass, rubber, metal, paper, cardboard, and textiles, that may pose different dangers to marine ecosystems (Katsanevakis, 2008). Therefore, using these terms interchangeably can lead to confusion and miscommunication among researchers, policy advisors and makers, and the public, as it may not be clear which impacts are being referred to.

In addition, there is ongoing public discourse around the theoretically proper approach in defining marine plastic pollution (Liboiron, 2015). This is because the term “*marine plastic pollution*” holds varying connotations among different stakeholders in different interdisciplinary disciplines such as environmental toxicology, anthropology, chemistry, economics, and public health (Pathak, 2020). Drawing from an anthropologist's perspective, Pathak (2020) postulates that plastic pollution can be perceived in three dimensions— spatial displacement sense, environmental pollution, and symbolic pollution. Pathak (2020) further claims that people can consider plastic pollution through a spatial displacement lens where plastic products are found in the marine environment where they ‘*matter out of place*’ and do not belong. This perspective emphasizes that plastic pollution can be considered an anomaly— a disturbance that alters the natural state of the marine environment. Secondly, some people perceive environmental pollution as a representation of the depletion of scarce resources, a threat to sustainability, and the release of toxic products to the environment (Pathak, 2020). In

this case, the emphasis is on the hazards caused by plastic debris found in the marine environment. Third, some people view plastic pollution as a moral transgression against the environment (Pathak, 2020). In other words, some people perceive the presence of plastic pollution as a violation of ethical precepts that include the responsibility to preserve the natural environment for future generations.

Rochman et al. (2016), for example, published a report that implicitly argues that “*perceived*” marine pollution such as loss of aesthetic or heritage values, is less valid than those that are measured and quantified scientifically. According to Liboiron's (2015) paper, some scholars believe that for something to be called pollution, it must be scientifically proven to be harmful to health. Douglas's (1966) pollution theory states that any form of waste (i.e., plastic waste) is not anomalous or even dangerous to any environment until religious norms, values, and practices constitute it. This certainly illustrates that there are opposing viewpoints, with some people viewing marine plastic pollution as a cultural and political concept, whereas others have an empirical view where measurable harm caused by plastic is considered before plastic debris is classified as marine plastic pollution.

Mæland and Staube's study (2020) also mirrored the same ideology that due to the various interpretations of how marine plastic pollution is defined, there are parallel arguments about whether global marine plastic pollution can be considered a “*mere environmental problem*” or a “*fundamental crisis*” (Vince and Stoett, 2018). Therefore, it is evident that how marine plastic pollution is framed and comprehended will determine policy responses. Ultimately, this suggests that the concept of “*marine plastic pollution*” is borne out of different social, cultural, and political-ideological positions. As a result, the interventions, research, and policies intended to address the negative consequences of plastic usage and disposal may be undermined by a failure to recognize the public discourses, varied cultural understandings, and contextual meanings underlying the term “*marine plastic pollution*”.

The importance of having a clear and comprehensive definition of marine plastic pollution is underscored by the divergent outcomes experienced by a hypothetical case scenario of two coastal communities, A and B:

Coastal Community A: *This community has an inclusive definition of marine plastic pollution, encompassing all forms of plastic waste, including microplastics and plastics beneath the water's surface. This broad definition allows them to identify the full spectrum of plastic pollution sources affecting their marine environment. As a result, they implemented proactive measures such as regular beach clean-up initiatives and fishing gear restrictions to combat this issue comprehensively. When they discovered that microplastics were a significant contributor to fish population decline, they promptly took action to reduce microplastic pollution. This timely response led to improvements in their fish stocks and, subsequently, their livelihoods.*

Coastal Community B: *This community uses a more restrictive definition of marine plastic pollution, which focuses on visible plastics, excluding microplastics and plastics beneath the water's surface. This restrictive definition can hinder their ability to recognize the full extent of the problem affecting their marine ecosystem. Consequently, they faced difficulties identifying the cause of fish population decline, leading to delayed action and prolonged negative consequences for their environment and livelihoods.*

Therefore, the key lesson here is that a clearer definition of marine plastic pollution ensures that all aspects of this environmental issue are appropriately identified and addressed.

Given the multiple interpretations of marine plastic pollution to clarify in the context of this study, we define marine plastic pollution as:

Presence and accumulation of plastic waste in marine ecosystems, including estuaries, coastline, and open oceans. Further, it refers specifically to the introduction and persistence of plastic waste that is discarded, abandoned or improperly managed, leading to their entry into the marine ecosystems and posing adverse ecological, social-cultural, and economic impacts.

2.4 Contradictory statistics of marine plastic leakage in South Africa

Despite the debates on marine plastic pollution discussed above, emerging studies assert that the amount of marine plastic trash in marine ecosystems is rapidly growing (Abbott and Sumaila, 2019; Almoth and Eggert, 2019). According to Beaumont et al. (2019), between 4.8 and 12.7 million metric tonnes of plastic from land-based sources leaked into the oceans in 2010. Therefore, it is imperative to tackle marine plastic pollution with urgency. In the South African context, there is no consensus regarding the amount of plastic that leaks into marine ecosystems, but it is widely acknowledged marine plastic pollution is real and impacts ecosystems and people.

According to a study by Jambeck et al. (2018), 90 000–250 000 tonnes of marine debris enter the South African marine ecosystems annually based on the assumption that 15–40% of the mismanaged waste of the coastal inhabitants (within a 50 km radius) reaches the marine environment. However, Verster and Bouwman (2020), after replicating assumptions that 15–40% of mismanaged waste from land-based activities enter the South African marine systems, critiqued the Jambeck et al. (2018) figures to be high and suggested that roughly 15 000–40 000 tonnes of waste enter marine ecosystems per annum. On the other hand, findings from the International Union for Conservation of Nature (IUCN) (2021) reported that 79 000 tonnes of plastic waste enter the ocean from land-based sources. The varying figures on the amount of plastic waste reaching marine environments highlight the significant uncertainty regarding the magnitude of plastic leakage to oceans in South Africa. The influence of climatic variabilities such as episodic floods was not considered in almost all of these studies, and as a result, the uncertainty surrounding the plastic leakage statistics provided by these studies may be more pronounced. For example, a case study conducted in Durban Harbour in South Africa (2021) revealed that April 2019 floods considerably increased the amount of plastic leakage to the Durban Harbour along beaches and estuaries significantly (Chikodzi et al., 2021). These studies also have a pitfall of basing their projected figures on macro-plastics only, perhaps due to the difficulties surrounding measuring and quantifying microplastic (Barnes, 2019; Eriksen et al., 2014). This suggests that values may be significantly understated.

In addition, since most of the marine plastic pollution originates from inland sources, precedents have been given to land-based sources (i.e., modelling and quantifying)

(Gamaralalage and Onogawa, 2020; Windom, 1992), and minimal studies have included the estimation of the marine-based source in determining the overall marine plastic pollution accumulated in coastal and marine environments of South Africa. The lack of evidence regarding marine-based sources of plastic pollution also contributes to South Africa's uncertainties regarding marine plastic pollution (Verster and Bouwman, 2020). Therefore, to fully comprehend the threats posed by marine plastic pollution to the South African oceans and beyond, further research is required on (i) quantifying plastic leakages, (ii) how marine plastic debris enters the oceans, and (iii) how much plastic pollution interacts with the marine organisms. Moreover, this contradiction in figures seems to highlight that stakeholder perceptions on the severity of marine plastic pollution in South Africa may differ depending on their interests and level of involvement on the issue, highlighting the importance of considering multiple perspectives in addressing this complex environmental challenge.

2.5 Sources and pathways of marine plastic pollution

2.5.1 Land-based sources

Most plastic waste that accumulates in marine environments emanates from terrestrial activities. In the South China Sea, a study by Lee et al. (2013) indicated that the bulk of plastic waste floating in shoreline ecosystems originated from recreational activities along the coast and other land-based sources such as harbour and residential operations. In addition, it was also found that the use and thereafter disposal of plastic bags, single-use plastics, containers, plastic in furniture, and micro-plastic found in materials like cosmetics, glitter, and microfibers by residents in close vicinity to marine environments significantly contribute to the problem. According to Jambeck et al. (2018), this is more common in developing countries where urbanization and informal settlements are prevalent and there is a lack of infrastructure for solid waste treatment. Plastic waste originating from land-based activities is transported by wind, natural waterways such as rivers, and human activities including illegal dumping (Verster and Bouwman, 2020). For example, informal settlements often have irregularly shaped narrow roads, thus making it difficult for waste collection trucks to access these areas. Subsequently, households often dispose of their waste in the communal dumps, which are dispersed by wind, foraging animals, and water run-off, eventually ending up in water bodies.

Although it is commonly known that land-based sources and pathways contribute to the pollution of marine ecosystems, there is still a dearth of empirical data and evidence to support these claims (Jambeck et al., 2018). One of the reasons is that most of the models used to estimate are based on dubious presumptions. This is particularly true in the case of African countries, including South Africa, where there is scarce research on this field, which leads to the extrapolation of data from models from other parts of the world (Jambeck et al., 2018). The social and economic conditions of South Africa may differ from those in other nations, which may have an impact on the ecological and environmental dynamics of the load and mobility of land-based plastics, which may not be accounted for by those models (Verster and Bouwman, 2020; Jambeck et al., 2018). These social and economic distinctions may relate to settlements, waste management policies, and service delivery (Jambeck et al., 2018). Therefore, more regional and temporal data studies are needed to customize marine plastic policies. Citizen science, which involves a broad range of stakeholders actively participating in data collection, analysis, and knowledge contribution (Geoghegan et al. 2016; Silvertown, 2009), can be a possible avenue to obtain such information. Through this collaborative effort, local community members and other stakeholders, for instance, may provide an opportunity to collect a wealth of information concerning marine plastic pollution that is otherwise difficult to gather. However, to truly achieve effective citizen science, it is necessary to identify and engage various stakeholders affected or interested in marine plastic pollution. Failing to engage stakeholders who are affected or have an interest may lead them to be inadvertently excluded from this process, leading to missed opportunities, insights and data that they could otherwise contribute. This highlights the importance of socially lensed perspectives in co-creating marine plastic pollution mitigation strategies.

2.5.2 *Marine-based sources*

Even though the magnitude and extent of marine-based sources of plastic pollution are less understood than land-based sources, some scholars suggest that these sources make a sizable contribution to the marine plastic pollution found in marine ecosystems. For instance, according to LI et al. (2016), marine-based sources accounted for 20% of the marine plastic pollution in the marine ecosystem globally. These figures provided by LI et al. (2016) contradict those provided by Peng et al. (2020) who claimed that marine-based activities cause just 2% of plastic pollution and that the other 98% is caused by land-based activities. These

“*estimate*” discrepancies reflect the current gaps and uncertainties in marine plastic pollution research.

Studies suggest that commercial fishing activities, navigation actions and waste disposal are key sources of plastic pollution (Ferraro and Failler, 2020; Thushari and Senevirathna, 2020). Approximately 640 000 tonnes of discarded fishing gears are added to marine ecosystems annually (LI et al., 2016). Notably, besides the aforementioned reasons including lack of financial constraints and technology capacity that underscore the knowledge of sources of marine plastic pollution, contestation among stakeholder representatives (even within the same stakeholder group) results in a lot of uncertainty (Pahl and Wyles, 2020). For example, some scientists contend that land-based sources are the main culprits of plastic pollution, while counter-argue that the primary contributors of plastic pollution in marine ecosystems are marine-based sources such as fishing gears and vessels (Henderson and Green, 2020). Notwithstanding the source of marine plastic waste, marine plastic pollution has a diverse array of impacts on marine ecosystems and human well-being. The impacts on human well-being can be experienced variedly depending on the socio-economic contexts of marine users.

2.6 Overview of adverse impacts of marine plastic pollution

Plastic pollution in the marine environment has a wide range of negative effects on the ecological, social and economic systems (Beaumont et al., 2019) (Figure 2.1). Extant literature focusses on the ecological impacts (Naidoo and Rajkaran, 2020) and, to some extent, economic impacts but comparatively, there is limited research on the impacts of marine plastic pollution on social dimensions relating to cultural identity, heritage value and other hidden social values (Jambeck et al., 2018; Gattringer, 2018). Chapter 3 highlights some of the social dimensions in detail and the consequences of overlooking these impacts. Figure 2.1 is an over-simplified framework that indicates that understanding the impacts of marine plastic pollution involves three interrelated components: ecological, social-cultural and economic systems.

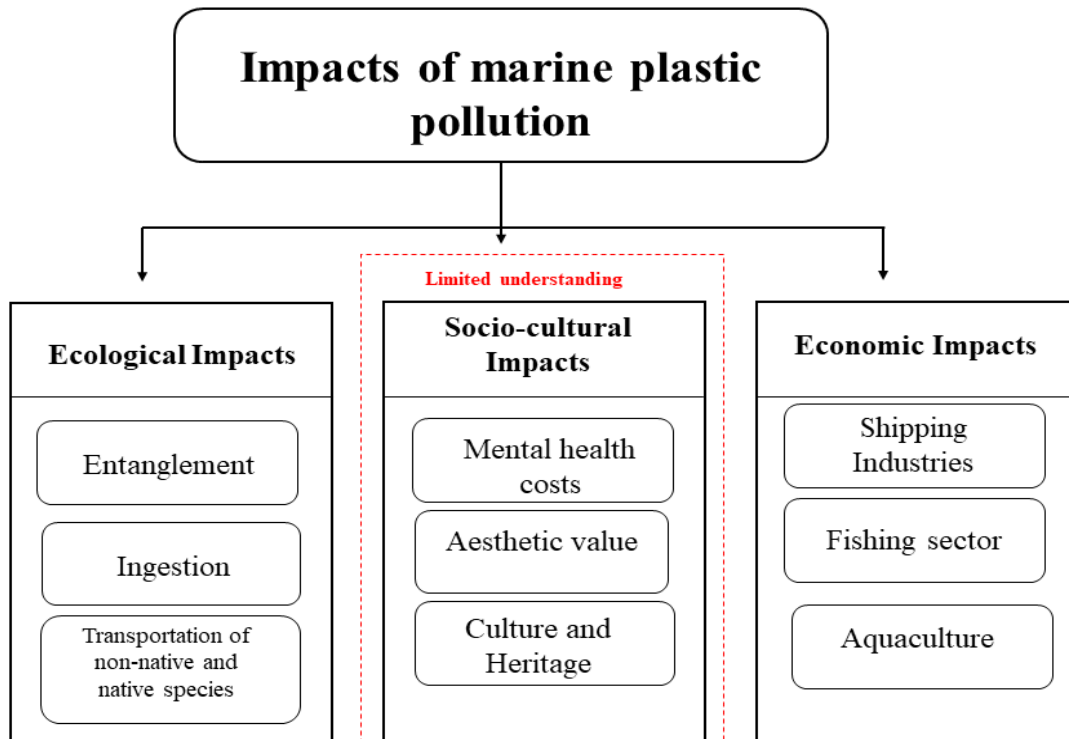


Figure 2.1 Categorization of adverse ecological, social-cultural and economic impacts of plastic pollution on the marine environment

2.6.1 Ecological impacts

Entanglement and ingestion

From an ecological perspective, plastic debris can entangle or be ingested by marine organisms or physically damage the marine environment (Gall and Thompson, 2015). Marine organisms, particularly those that inhabit marine environments (e.g., fish) and those that live in close proximity (e.g., birds), are at risk of becoming physically entangled and strangled by marine plastic pollution (Schuyler et al., 2018; Gall and Thompson, 2015; Wilcox et al., 2015). Plastic debris such as fishing gears, packaging straps and monofilament lines that enter the marine environment can entangle marine organisms (Naidoo and Rajkaran, 2020; Beaumont et al., 2019; Good et al., 2010), which can hamper the mobility of marine species, causing cuts and wounds, asphyxia or drowning, and even death. According to Sheavly and Register (2007), the US Marine Mammal Commission in 2014 documented 136 marine species entanglement occurrences, including 32 marine mammals, 51 seabird species, and six sea turtle species. Marine plastic ingestion by marine wildlife, which can occur through direct plastic consumption or indirectly through the food chain (Beaumont et al., 2019; Sheavly and Register,

2007), is a serious health concern. Floating plastic can be mistaken for food and consumed, resulting in sub-lethal and lethal harm to marine organisms (e.g., reproductive issues, carcinogenic diseases, and behaviour change) (Gall and Thompson, 2015; Sheavly and Register, 2007). For instance, plastic pellets may resemble fish eggs and plastic shopping bags can appear like jellyfish to sea turtles (Gall and Thompson, 2015). This is exemplified by the findings of Schuyler et al. (2015) study that showed 50% of green sea turtles in the eastern Pacific had ingested plastic that led to digestive blockages, internal injuries and death. In certain circumstances, predatory marine creatures ingest marine plastics indirectly by feeding on prey marine animals that ingested plastic debris (Sheavly and Register, 2007).

Biophysical marine environment and transportation of non-native and invasive species

Plastic pollution has the potential to physically harm marine habitats such as beaches, coral reefs, and other marine areas. Currents and tides transport plastic items like ropes, nets, and tarps, which may abrade, smother, and damage delicate marine habitats (Naidoo and Rajkaran, 2020; Beaumont et al., 2019; Good et al., 2010). In addition, plastic pollution in marine water bodies can smother seagrass and corals, causing increased siltation and turbidity and preventing sunlight from entering marine waters (Naidoo and Rajkaran, 2020; Gall and Thompson, 2015). Marine plastic pollution also adversely affects the marine 'systems' nutrient cycles (Arabi and Nahman, 2020). Plastic, for instance, could change the buoyancy of human waste released from marine outfalls, altering the transport of nutrients and carbon into the deep ocean and possibly causing nutrient cycles to become disrupted (Gall and Thompson, 2015). The low volumes involved in the world's carbon and nutrient cycles, however, indicate that this influence is extremely unlikely (Arabi and Nahman, 2020). Lastly, marine plastic provides a home for invasive organisms to attach themselves to and travel large distances (Naidoo et al., 2020). Floating plastics allow foreign animals and illnesses to cling and spread, possibly altering pelagic ecosystems (Dauvergne, 2018, Galgani et al., 2015, Holmes et al., 2012). Plastics can resist ultraviolet exposure and wave action while remaining buoyant for long periods, allowing colonized animals to travel enormous distances (Arabi and Nahman, 2020).

2.6.2 Socio-cultural impacts

Public health impacts

From a social standpoint, marine plastic pollution constitutes a public health risk to humans (Beaumont et al., 2019). Despite the paucity of empirical evidence, emerging research shows that people who consume marine species that have swallowed marine plastic may encounter health complications such as infertility and cancer because the hazardous chemicals and microplastic compounds ingested from marine organisms can impair their immune systems (Kumar et al., 2021; Dilkes-Hoffman et al., 2019). The consumption of marine organisms that have ingested plastic, particularly microplastics, is associated with a high risk of birth abnormalities and cancer (Arabi and Nahman, 2020; Naidoo and Rajkaran, 2020; Sheavly and Register, 2007). Microplastics were discovered in bottled water in the Mason et al.'s (2016) study done in the United States (US). Elsewhere, study findings show that microplastics were found in various personal care and cosmetic products such as face masks, that are absorbed through the skin (Gigault, 2018; Andrady, 2017). According to Bhuyan et al. (2022), even though microplastics are understudied-prolonged exposure to microplastics produces oxidative stress in cells, which causes accelerated skin ageing, oedema, immune cell impairment, and among other illnesses.

Although scientific research on the psychological impacts of marine plastic is relatively scarce, preliminary studies indicate synergies between the exposure of people to plastic pollution in marine environments and the adverse impact on mental health (Wyles et al., 2016). In the psychological literature records, marine environments are noted to yield psychological benefits to marine visitors. People who visit marine environments such as coastlines have reported feeling happier when in the marine environment and feel like they have escaped the everyday stressors and have a sense of being away and feeling revitalized, calmer and more refreshed (Wyles et al. 2016; Ashbully et al., 2013; White et al., 2013). This indicates that the emotional ties that people have with the marine environment and exposure to marine plastic waste can impact their mental health and mood by corroding that image of serenity and pristineness (Beaumont et al., 2019).

Impacts on cultural and heritage values

Plastic pollution is also associated with the loss of cultural values individuals and communities hold. For example, a vast amount of literature has identified plastic pollution as a significant reason that people have shorten their visit or avoid specific marine environments on particular beaches (Arabi and Nahman, 2020; Krellis et al., 2017; Jang et al., 2014). Often plastic debris is washed up on the coastline of marine environments, thereby decreasing the aesthetic appeal of the marine environment (Krellis et al., 2017). Most often in coastal communities, marine landscapes hold deep pristine beauty and spiritual significance (Martin et al, 2016) and marine plastic pollution may tarnish this, resulting in a less aesthetic appreciation for marine environments. This may adversely impact the cultural realities of these coastal communities, which take inspiration, meaning, and reverence from maritime environments (Martin et al., 2016). Marine plastic pollution can also disrupt cultural practices as marine environments play a significant role in cultural practices, ceremonies or rituals. Plastic pollution in marine setting can lead to difficulty carrying out these rituals, thereby leading to loss of cultural traditions and weakening community ties to the marine environments (Phelan et al., 2020).

In addition, the presence of marine plastic might adversely impact heritage value of maritime environments (Beaumont et al., 2019). Many individuals and societies have a cultural or emotional relationship with charismatic species such as sea turtles, birds and marine mammals (e.g., whales) (Arabi and Nahman, 2020; Beaumont et al., 2019; Gall and Thompson, 2015). When marine organisms die, human well-being is impacted since humans anticipate these charismatic organisms to exist for the benefit of present and future generations, regardless of whether they ever get to see and interact with them (Beaumont et al., 2019). Moreover, marine settings tend to have historic sites or cultural landmarks such as the Galapagos, Eolion, and Hawaiian Islands holding significant heritage value (Bonanno and Orlando-Bonanca, 2022). Marine plastic pollution, particularly when accumulating on shores or underwater environments, can degrade these marine sites, thus corroding their cultural and historical significance.

2.6.3 Economic impacts

Impact on the shipping industries

The adverse impacts of marine plastic pollution negatively affect the maritime economic sector (Aretoulaki et al., 2021). Adverse impacts on tourism, transportation/shipping, and fisheries are among the direct economic costs of marine plastic pollution. For example, in South Africa, the Cape Town Council spent an average of ZAR55 968 (US\$19 366)³ on beach clean-ups between 1992 and 1993 (Arabi and Nahman, 2020). A similar study in the Azores, Portugal, found that the direct economic costs of plastic pollution amounted to about ZAR11 563 056 (US\$791 718)⁴ in 2016. The local municipality of Azores spent approximately ZAR3 497 970 (US\$239 399)⁵ on a clean-up, including hiring a labour force in 2016 (Rodríguez et al., 2020). Professional fishermen, recreational fishers, shipping companies, and tourist operators interviewed reported marine plastic pollution incidents such as clogged water pumps in boats and ships, collisions with floating marine plastic litter, and entanglement of fishing boats by derelict fishing gear, costing the shipping and tourism industries about R2 949 559 (US\$ 201 866)⁶ annually. Damage to ships and boats frequently resulted in cancelled tourist visits, halted fishing activities, and lost work earnings (Rodríguez et al., 2020).

Impacts on the fishing sector

While there is no empirical evidence of the global impact of marine plastic pollution on the fishing industry in the existing literature, it is considered significant given that 1.4 billion people globally rely on seafood, which includes fish (Arabi and Nahman, 2020). Data from fish markets around the world show that commercial fish had traces of microplastics in their tracts and guts. Field studies, for example, show that approximately 2.6% of the fish found in the North Sea (Rummel et al., 2016), 18% in the Central Mediterranean and 25% of the fish taken in the United States of America (USA) west coast (Rochman et al., 2015), had traces of plastic residues. According to the UNEP (2009) report, the artisanal fishery sector suffered a yearly loss of US\$250 million due to the damage caused by the ghost fishing gears in the lobster fishery sector worldwide. In South Africa, a report by the CSIR in 2022 estimates direct

³ Figure based on 1992 dollar-rand exchange rate

⁴ Figure based on 2016 dollar-rand exchange rate

⁵ Figure based on 2016 dollar-rand exchange rate

⁶ Figure based on 2016 dollar-rand exchange rate

damages to fisheries, shipping, and marine and coastal tourism to range from R63.6 million to R475.3 million per annum.

2.7 Policy mechanisms, interventions and strategies for reducing marine plastic pollution

Various initiatives are designed to address plastic pollution in the aquatic environment on a global, regional and national scale (Thushari and Senevirathna, 2020). On a global context, the United Nations (UN) General Assembly on Oceans and the Law of the Sea are one of the institutions established to drive initiatives to mitigate the issue of marine plastic pollution (UNEP, 2017). On a regional scale, the European Union enacted the Marine Strategy Framework Directive (MSFD) to reduce marine debris and promote the sustainable use of marine resources (UNEP, 2017). In comparison, national legislation tends to integrate solid waste management policies with plastic pollution reduction strategies such as Marine Plastic Pollution Research and Control Act (Thushari and Senevirathna, 2020). Regardless of the spatial scale, these initiatives tend to adopt one or more of the following policy interventions and strategies (Clayton et al., 2021; Adam et al., 2020; Thushari and Senevirathna, 2020): Regulatory framework, Economic instruments, Evidence-based policy, and Behavioural interventions.

2.7.1 Plastic bag policies and their efficacy and barriers

There are presently no universal policy responses aimed at reducing marine plastic pollution (Clayton et al., 2021). As a policy response mechanism, many regions have implemented regulatory frameworks. Various countries have decided to impose voluntary plastic bans to reduce plastic waste (Behuria, 2021). Some countries impose partial bans (Clayton et al., 2021), while others implement strict legislation such as complete plastic bans (Adam et al., 2020). For example, several African and Asian countries have prohibited the use of plastic bags, such as Rwanda, Kenya and Uganda (Dikgang et al., 2012). It is worth noting that developing countries have often taken more rigorous measures against plastic pollution compared to advanced countries. Knoblauch et al. (2018) conducted a study revealing that 36 out of the 51 countries that had implemented plastic bag bans were located in the Global South, while 28 out of 39 countries that had opted to maintain taxes on plastic bags were in the Global North. This data underscores the proactive stance that many developing nations have adopted in addressing the

environmental challenges posed by plastic waste, particularly in contrast to some wealthier nations that have chosen to rely on taxation as their primary policy tool in this regard. Even though these legislative bans are viewed as harsh, often resulting in hefty fines or even imprisonment, their effectiveness is questionable. Due to lobbying by the plastics sector, which utilized both structural and instrumental powers to convince the government, certain African nations were compelled to lift their bans on plastic bags (Adam et al., 2020). In addition, Murphy et al.' (2022) study, which used cost-benefit analysis, estimated that the costs of marine plastic pollution regulatory interventions of coastal clean-ups might have temporal scale benefits due to tourism revenue. However, in the long run, indirect costs such as labour (i.e., salaries), transportation, and indirect costs such as opportunity costs may undermine this policy. Some policymakers use economic instruments to indirectly influence the amount of marine plastic pollution by imposing economic (dis)incentives such as taxes, charges, or subsidies (Oosterhuis et al., 2014). According to Oosterhuis et al. (2014), the effectiveness of these market-related policies is often low in many countries including England, Ireland and Portugal. In many cases, these policies are hampered by factors such as corruption, a lack of political support, a large informal sector, and a lack of capacity, infrastructure, and skills to implement them (Oosterhuis et al., 2014). In other regions, such as Africa, there is no published data to measure the effectiveness of economic instruments (Oosterhuis et al., 2014). Moreover, some market-related instruments tend to reinforce social injustice, disproportionately affecting vulnerable communities or nations. For example, Bashir (2013) revealed that women and informal traders in Nigeria rely on single plastic bags to give to their customers. In addition, due to the scarcity of clean water in Nigeria, clean water is sold in plastic sachets for affordability reasons. This means that a higher tax on plastic will have a negative impact on the livelihood activities of marginalized members of society. O'Brien and Thondhlana (2019) and Wagner (2017) argue that regulatory and economic policy mechanisms are not fully effective since they do not focus on source reduction. On the other hand, data-driven policies are challenging to implement, particularly in countries such as South Africa, where advanced technology to monitor marine plastic accumulation is lacking (Jambeck et al., 2015), making it impossible to develop and monitor baselines.

Since human beings are the sole cause of marine plastic pollution—production and littering of plastic in the ecosystems, changing people's attitudes, perceptions, and behaviours is essential in combating this problem (Hartley et al., 2018; Pahl and Wyles, 2017). Academics hold that

behavioural interventions can more effectively address waste management problems and plastic leakage into the oceans (Hartley et al., 2018). Policies alone are inadequate to increase awareness, broaden comprehension of the issue, or underline the need for action to a wider audience (Veiga et al., 2016). Löhr et al. (2017) state that, in general, educational initiatives against marine pollution have increased school children's comprehension and motivation to take action and embrace their social responsibility in tackling this issue. However, Bettencourt et al. (2021) emphasize that the approach to education affects how effective it is. Effective educational pedagogical strategies involve active and interactive activities such as exercising reflexivity, in contrast to conventional techniques, which primarily focus on imparting knowledge. For example, Arlinghaus and Johnston (2018: 113) state that "*Knowledge is not enough to change behaviour. If it was, no one would smoke or overeat to the point of becoming obese, and everyone would wear seatbelts and exercise*".

2.8 Conclusion

Marine plastic pollution is a growing global environmental problem with serious adverse impacts on marine ecosystems and human well-being. However, progress in understanding and addressing marine plastic pollution is constrained by conceptual ambiguity regarding the socio-cultural impacts of marine plastic pollution and a limited focus on the perspectives of multi-stakeholders regarding the impacts. Finding consensus for various interpretations of impacts is critical to advancing a collective understanding of, and co-developing pathways for the marine plastic pollution problem.

CHAPTER 3

CONCEPTUALIZING THE SOCIO-CULTURAL DIMENSIONS OF MARINE PLASTIC POLLUTION IMPACTS ON HUMAN WELL- BEING

Abstract

Marine plastic pollution is one of the major environmental problems globally, with adverse impacts on marine ecosystem services, functions and benefits and people. In response, research interest on the ecological and economic impacts of marine plastic pollution has grown rapidly but socio-cultural impacts remain poorly conceptualized and little understudied. This trend is arguably driven by the dominance of a quantitative paradigm which is arguably inadequate to respond to dynamic socio-cultural issues and contexts. This perspective chapter argues for a more nuanced understanding of the marine plastic pollution impacts in order to strengthen the conceptualization of impacts that goes beyond direct and quantitatively measured impacts (ecological, health and economic) but considers the socio-cultural dimensions of impacts (lifestyle disruptions, mental health costs and cultural and heritage impacts). Drawing on case studies, this study provides a working definition of the socio-cultural impacts of marine plastic pollution and a conceptual framework for categorizing the impacts. It highlights three dimensions of the socio-cultural impacts of marine plastic pollution (lifestyle, mental health, and cultural and heritage impacts). It illustrates connections between marine ecosystems and marine-based livelihood activities with the social and cultural dimensions of human wellbeing to show the links between marine environments and socio-cultural contexts. The chapter also characterizes the socio-cultural impacts of marine plastic pollution and suggests ways that socio-cultural impacts can be assessed and recognized. The paper is meant to provoke productive debate and policy and management options for addressing the impacts of marine plastic pollution in socially meaningful and equitable ways.

Keywords: Plastic pollution, ecosystem services, marine systems, marine ecosystem-based management, marine litter

3.1 Introduction

Marine plastic pollution is now widespread globally, with negative impacts on marine ecosystems and human well-being (Hardesty et al., 2022; Thushari and Senevirathna, 2020; Thompson et al., 2009; Derraik, 2002). Thus, there are calls for immediate international attention to understanding and addressing marine plastic pollution and its impacts (Ericksen et al., 2023). Yet, while research interest on the ecological and economic impacts of marine plastic pollution has grown rapidly, the socio-cultural impacts remain poorly conceptualized and little understudied. This trend is arguably driven by the dominance of a quantitative paradigm which is arguably inadequate to respond to dynamic socio-cultural issues and contexts. This perspective chapter argues for a more nuanced understanding of the marine plastic pollution impacts in order to strengthen the conceptualization of impacts that goes beyond direct and quantitatively measured impacts.

Plastic pollution is evident in different marine systems such as beaches, surface waters, along coastal areas, estuaries, high seas, and deep and remote parts of the oceans. Plastic litter get into marine systems by various pathways including rivers (Van Klink et al., 2022; Van Emmerik and Schwarz, 2020), wind action, sinks, tides and soil (Verster and Bouwman, 2020; Pawar et al., 2016; Ryan, 2015). Plastic waste comes in various shapes, forms and sizes including plastic bottles, floating barrels, plastic sheets, sub-microscopic particles and fibres (Landrigan et al., 2020), contributing up to 80% of all marine litter (Almroth and Eggert, 2019; Chapter 2). Due to weathering, mechanical abrasion and photodegradation (Rochman et al. 2019; Law, 2017), plastic waste in marine systems can disintegrate into minute particles known as microplastics and nanoplastics that are less than 5 and 1µm mm in diameter, respectively. Out of all forms of plastic, nanoplastics are still poorly understood in terms of both their concentration and health impacts on marine life and people (Stapleton, 2019; Wagner and Reemtsma, 2019).

The amount of plastic released into marine systems annually is approximately 10 million metric tonnes (Jambeck et al. 2015) and projections suggest by 2025, up to 150 million metric tons of plastic will be in the world's oceans (Geyer et al. 2017). Eriksen et al. (2023) estimate there are about 358 trillion plastics in the world's oceans, weighing between about 1 and 5 million tons. These statistics paint a worrying picture of a rapid, massive accumulation of plastic litter

in oceans globally, with serious negative impacts on marine ecosystems and human well-being. Therefore, an understanding of marine plastic pollution impacts is needed for evaluation and mitigating the impacts. All of the health effects of ocean pollution, according to Landrigan et al. (2020) tend to be experienced to be disproportionately and fall mostly on the vulnerable populations in the Global South - environmental injustice on a planetary scale.

Despite advances in our understanding of the adverse effects of marine plastic pollution, there is comparatively more research focus on ecological, health and economic impacts than intangible socio-cultural impacts of marine plastic pollution. Ecological impacts that are typically recognized in the literature include plastic entanglement, ingestion of plastic and suffocation of marine animals (Thiel et al., 2018; Gregory et al., 2009). Nearly 700 species, including endangered marine fauna, are adversely affected by marine plastic pollution (McNicholas and Cotton, 2019; Gall and Thompson, 2015).

Economic impacts include direct loss of income opportunities from marine-based livelihood activities such as subsistence or commercial fishing and recreational tourism and cleanup costs, which together result in a weakened maritime economy (Beaumont et al., 2019). It is estimated that the annual costs related to marine plastic pollution are between US\$500 billion and US\$2.2 trillion globally per annum (Forrest et al., 2019). Public health impacts can result from human consumption of contaminated seafood such as fish, oysters and mussels, which can result in diseases. Microplastics are known to adsorb other harmful chemical pollutants that may be present in marine environments including Polycyclic Aromatic Hydrocarbons (PAHs), Polychlorinated biphenyls (PCBs), Dichlorodiphenyltrichloroethane (DDT) and toxic metals (Rochman et al., 2019). Microplastics can get into marine food chains through the absorption by microscopic marine organisms, where they bioconcentrate (Kershaw, 2015). Consumption of contaminated seafood can result in diseases and conditions such as cancer (Wright and Kelly, 2017) and a reduction of male fertility (Gore et al., 2015). The links between nanoplastics and human health are still not fully understood (Landrigan et al., 2020; Wagner and Reemtsma, 2019). If marine plastic pollution continues unabated, it can result in obvious ecological, health and economic impacts, that in turn, negatively impact the socio-cultural dimensions of human well-being.

3.2 Neglect of the socio-cultural dimensions of marine plastic pollution

The socio-cultural dimensions of marine plastic pollution impacts are poorly understood and neglected in marine plastic pollution debates (Urquhart et al., 2011). The neglect of socio-cultural conceptions of marine plastic pollution impacts can be attributed to conceptual ambiguity emanating from the dominance of conventional economic valuation techniques in capturing the value of ecosystem services (Murphy et al., 2021; Chakraborty et al., 2020; Townsend et al., 2018) and varied ecosystem service classification frameworks (Hattam et al., 2015). The notion of ecosystem services (ES) has been instrumental in providing a framework for understanding the value of ecosystems to human well-being, which has been used as an incentive to engender environmental protection (Fisher et al., 2009). However, despite its inroads in science-policy interfaces, the effectiveness of utilitarian framing in general and the ES framework in particular, in leveraging support for environmental protection has come under scrutiny due to persistent environmental degradation (Muradian and Gómez-Baggethun, 2021; Schröter et al., 2014). Highlighting the limitations of utilitarian paradigms for environmental protection, Muradian and Gómez-Baggethun (2021) argue for a shift from utilitarian environmentalism (which is behind global environmental crises) to the morality of care. Thondhlana et al. (2020:1) reiterate the difficulty of conventional economic frameworks in capturing the non-material adverse impacts of wildlife conservation including negative physical experiences and negative emotions such as trauma, feelings of fear and anxiety.

Typically, indicators for ecosystem services tend to be used for measuring negative change or reduction of the service (Hattam et al. 2025). However, Hattam et al. (2015) note that there are few indicators of cultural services relative to provisioning, regulating and supporting services. The few available studies on cultural aspects tend to focus on recreation and tourism (Hernández-Morcillo et al., 2013), a trend that has been reported in marine systems by Liqueste et al. (2013). Hattam et al. (2015) and Milcu et al. (2013) report that most indicators for cultural ecosystem services generally lack clarity in their “*definitions, purpose and understanding of processes to be measured*”. It is plausible to attribute the lack of clarity of indicators to conceptual ambiguity in the definition, characterization and categorization of the socio-cultural dimensions of marine plastic pollution impacts due to the disproportionate focus on the utilitarian dimensions of marine ecosystems. In a marine ecosystem context, loss of sense of place, heritage, culture and other intrinsic values are generally unexplored due to challenges in

measuring these intangible impacts (Martin et al., 2016; Hattam et al., 2015; Daigle and Vasseur, 2019).

Meaningful and successful management of marine plastic pollution impacts requires an understanding of the social dimensions of impacts for two reasons. First, they are experienced by people in real life and can impact human well-being because marine based livelihood activities (e.g., fishing) contribute to the socio-cultural dimensions of human well-being (Gustavsson et al., 2017; Khakzad and Griffith, 2006). For example, marine-based livelihood activities form important contours for understanding people's cultural norms, activities and social lives. Khakzad and Griffith (2006) show the linkages between marine livelihood activities such as fishing and cultural identity formation and the unique lifestyles and norms of fishers. A study of fishing communities in the United Kingdom (Gustavsson et al., 2017) found that cultural and social capitals were strongly linked to fishing activities and intersected with the income generation of fishers. These examples suggest that marine plastic pollution can negatively impact people's ability to conduct marine-based economic activities, which can have indirect impacts on socio-cultural dimensions of people's wellbeing. Second, overlooking the socio-cultural dimensions of marine plastic pollution might diminish people's support for interventions for reducing plastic waste pollution. For example, Bennett and Dearden (2014) found that communities on the Andaman Coast of Thailand had negative perceptions towards marine conservation because marine protected areas (MPA) undermined their access to social and cultural assets. Yet, the socio-cultural dimensions of marine plastic pollution impacts remain largely understudied and unrecognized.

The complex interplays between marine systems and human well-being (Hattam et al., 2015), means that understanding the impacts would require a framework for identification and classification. For example, there is insufficient information to develop indicators for measuring marine ecosystem services such as inspiration for culture, cultural heritage, cultural diversity and spiritual experience (Hattam et al., 2015). By extension, there is insufficient information to measure the negative impacts of marine plastic pollution on the sociocultural dimensions of human well-being. Therefore, a more detailed understanding of the sociocultural impacts of marine plastic pollution impacts is needed, together with a typology for their classification.

Considering this background, this paper attempts to define, categorize and characterize the socio-cultural impacts of marine plastic pollution as a basis for advancing their recognition in marine plastic pollution debates. In doing so, this chapter highlights the complexities of identifying, measuring and integrating diverse impacts of marine plastic pollution and suggests pathways for interpreting and understanding them beyond current conceptions. The main purpose of this paper is not to merely criticize the assessment of tangible impacts (ecological, health and economic) of marine plastic pollution. Instead, its primary objective is to provide a framework for identifying, categorizing and characterizing the socio-cultural impacts of marine plastic pollution, which up to now has received scant attention in research. Acknowledgement of the socio-cultural dimensions of the impacts of marine plastic pollution can help in determining the overall effect of marine plastic pollution and building the empirical standing needed to leverage urgent international attention in developing strategies for reducing plastic pollution in the first place and mitigating marine plastic pollution impacts. Further, characterizing the impacts can ensure that the interventions are socially meaningful given varied sociocultural marine contexts.

3.3 Conceptualizing and defining socio-cultural impacts of marine plastic pollution

Perhaps the starting point for understanding the impacts of marine pollution should be highlighting the distinction between ecosystem services, functions and benefits. Ecosystem services are generally defined as the direct and indirect contributions of ecosystems to human well-being and are typically grouped into four classes: provisioning, regulating, supporting and cultural services (Kumar, 2010). Ecosystem services are also defined by IPBES (2021) as the “*ecological processes or functions which have value to individuals or society*”. Ecosystem functions are understood as “*the ecological processes that control the fluxes of energy, nutrients and organic matter through an environment*” (Cardinale et al., 2012: 60). According to Hattam et al. (2015: 65), “*ecosystem benefits are the things that people create or derive from ecosystem services*”. The direct and indirect benefits are turned into products or experiences (e.g., water purification, food, recreation and cultural values) that are not functionally linked to the ecosystems from which they were derived (Haines-Young and Potschin 2013).

The impacts of marine plastic pollution relate to the perceived or actual direct and indirect negative effects on human wellbeing. We provide a working definition of the socio-cultural impacts of marine plastic pollution as:

The actual and perceived intangible negative impacts on people's social and cultural lifestyles, mental health and sensory experiences resulting from the inability of degraded marine ecosystem to provide services, functions, and benefits considered important for human well-being.

The proposed definition highlights two important aspects that, we argue, are crucial for understanding the socio-cultural impacts of marine plastic pollution. First, marine plastic pollution can reduce the ability of marine ecosystems to provide services, functions and benefits in ways that contribute to human well-being. For example, marine plastic pollution can constrain marine ecosystems' ability to support marine-based livelihood activities such as fishing, which can result in actual or perceived livelihood insecurity and increased stress levels. Further, marine plastic pollution can mean that important ecological functions that maintain the natural stability of marine systems needed to support marine life are disturbed, resulting in an imbalance. This imbalance can affect various ecosystem services, functions and attributes that are important to human well-being such as the abundance and diversity of key marine species of individual, recreational or spiritual interest or that contribute to a way of life or cultural norms. Second, the impact can be either perceived or experienced. Users of marine ecosystems may have lived experiences of loss of ecosystem benefits such as food (e.g., fish and mussels) and aesthetic beauty due to marine plastic pollution (Beaumont et al., 2019). For example, indigenous fishers in Southwest India who fished on a local coral reef for food provision felt a sense of livelihood loss when fish availability declined owing to marine plastic pollution, which is reported to be prevalent in the region (Sahayaraju and Jament, 2021). On the other hand, some people may be afraid of losing marine ecosystem services without having had any experience with it. Some people can derive amenity services such as a sense of place and spiritual connection to marine environments solely from perceptions formed by what they see and hear on online platforms (i.e., the internet) and books rather than through physical experiences (Buchel and Frantzeskaki, 2015). Henderson and Green (2020) found that social media framed participants' negative perceptions of marine plastic pollution through reality television, documentaries, news outlets, social media, and visuals. This means understanding the socio-cultural impacts of marine plastic pollution on marine ecosystem services requires an

assessment of impacts as experienced and perceived. Another example is that plastic pollution might degrade the aesthetic appeal of marine environments such as beaches and estuaries, which can negatively impact the physical sensory experiences of people.

3.4 Classifying the impacts of plastic pollution on marine ecosystem services

Following the above-mentioned definition, the sociocultural impacts of marine plastic pollution can be divided into three major groups (Figure 3.1).

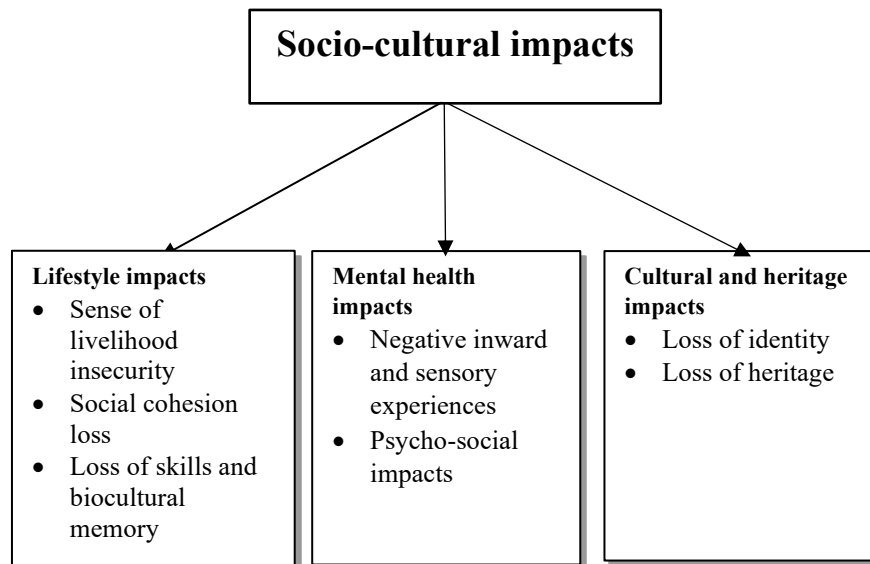


Figure 3.1: Categories of socio-cultural impacts of marine plastic pollution

The socio-cultural impacts of marine plastic pollution relate to negative intangible impacts that affect human well-being through the inability of marine ecosystem services, functions and attributes to provide the socio-cultural direct and indirect benefits (products or experiences) considered important by people, ranging from disruption of lifestyles and livelihood activities such as fishing, visual pollution that affects recreational activities and physical sensory experiences to cultural and heritage impacts (Asah et al., 2014; Beaumont et al., 2019). Socio-cultural impacts are largely intangible impacts and are very subjective and can be perceived or experienced differently by people.

3.4.1 Lifestyle impacts

Lifestyle impacts relate to a sense of livelihood insecurity and social cohesion loss from disruptions in marine-based livelihood activities such as fishing and recreational tourism. Beyond generation of economic benefits such as income, marine-based livelihood activities are important for social cohesion (Symes and Phillipson, 2009). Social norms tend to be internalized in groups through day-to-day livelihood activities and practices via a socialization process, which can become part of one's identity. Thus, disruption in lifestyle choices due to marine plastic pollution will directly destabilize socialization processes and social cohesion. Marine-based livelihood activities are also important for the development and transfer of traditional fishing skills and traditional ecological knowledge from one generation to the other. For example, Nabhan (2003) found that the indigenous Comcaac (Seri people) of northwestern Mexico have immense reserves of knowledge on biodiversity which has evolved over thousands of years and this knowledge is often embedded in complex cultural practices and important for regional conservation efforts pertaining to endemic and endangered species. Wilder et al. (2016) report how indigenous ecological knowledge relating to cultural traditions of fishing among the Comcaac people has contributed to species recovery, habitat restoration and sustenance of traditional livelihood practices. This means that the disruptions of marine-based lifestyles can constrain people's ability to practice their lifestyles and develop and transfer important traditional fishing skills and local ecological knowledge, which is an important part of fishers' identity and way of life.

3.4.2 Mental health costs

Negative inward and sensory experiences: Negative feelings might relate to people's inability to enjoy the benefits of marine ecosystem services such as swimming, beach walks or aesthetic beauty. Visiting marine environments for physical and recreational activities such as walking, running, and swimming has been linked to improved human health (Almroth and Eggert, 2020). Zabini et al. (2020) show that people's direct interaction with nature can result in direct multisensory experiences of nature, positive mood and tourism experience. It is linked to in-depth connections to nature, which encompasses the social benefits of being in nature. But visual pollution might impair people's ability to enjoy their views of marine ecosystems. Plastic debris washed up on the coastline of marine environments can cause visible deterioration of seascapes and thereby decreasing the aesthetic appeal of the marine environment (Bolívar-Anillo et al., 2023; Arabi and Nahman, 2020). Empirical evidence shows that visual impacts

of marine plastic pollution are linked to a significant decline in tourist acceptance rate and use of or visits to marine environments (Arabi and Nahman, 2020; Hayati et al., 2020). This means that the inability of marine ecosystems to provide services, functions and benefits for people can result in diminished psycho-social wellbeing.

Psycho-social impacts: We define psycho-social impacts, following Thondhlana et al. (2020:5), as “*a diminished state of psycho-social well-being*” arising from resentment and frustration arising from the inability of marine ecosystems to provide services, functions and benefits to people. Resentment and frustration can relate to the inability to undertake important livelihood activities such as fishing for subsistence or recreational purposes which could result in ill-being. This can be particularly felt by people with the responsibility of providing for their families. For example, fishers in Jayapura, Irian Jaya province, Indonesia, reported modification to their fishing behaviour by avoiding some fishing areas that were polluted, which in turn, disrupted their lifestyles and livelihoods (Nash, 1992). In some cases, the fishers had to use different fishing gear which means they incurred unplanned costs, which arguably affected their psycho-social health.

3.4.3 Cultural and heritage impacts

Disruption to lifestyles and livelihood activities may mean that social activities and cultural values associated with marine-based livelihood activities are negatively affected. As already mentioned, livelihood activities often form the lenses through which culture and identity are constituted. Urquhart et al. (2011) show important links between marine fishing activities, place identity, cultural heritage and identity, sense of place and social capital. Therefore, it is plausible to argue that disruption of livelihood activities can indirectly impact the social and cultural values that make up the identity of certain community groups. According to Urquhart and Acott (2010) the meanings that individuals ascribe to places can be expression of variety of historical, social and cultural structures. Thus, fishing as a marine based activity can be part of a broader portfolio of livelihood activities that transcend economic value (sea food such as fish or mussels) but represents a socio-cultural dimension of values including “*culture, families, community cohesion and place-based identity*” (Williams et al., 2021; Reed et al., 2013; Urquhart and Acott, 2010). For example, Reed et al. (2013) found that inshore fishing along the English Coast was highly important not only in economic terms but also in place identity

creation linked to fishing as a profession and the opportunities for fishing possible within different ecological settings. According to van Ginkel (2001:189), fishing is “*expressive and existential*”. The relationship between livelihood activities and culture and heritage is illustrated by the persistence of communities in undertaking livelihood activities even if it is no longer economically viable to do so. Concerning fisheries, Brookfield et al. (2005) state fishing serves as the bond that binds the communities that depend on fisheries together.

Marine plastic pollution might also have negative impacts on the heritage value of maritime environments through non-extractive uses of marine ecosystems (Beaumont et al., 2019). For example, many individuals and societies have a cultural or emotional relationship with charismatic species such as sea turtles, birds, and marine mammals (e.g., whales) (Arabi and Nahman, 2020; Beaumont et al., 2019; Gall and Thompson, 2015). The death of the species from entanglement and ingestion of plastic (Arabi and Nahman, 2020), might negatively affect people who value the existence values of these charismatic organisms regardless of whether they ever get to see and interact with the species (Beaumont et al., 2019). Therefore, marine dependent people can incur intangible socio-cultural losses through destabilization of livelihood styles which can undermine livelihood security, social cohesion and cultural (Symes and Phillipson, 2009).

3.5 Characterizing the socio-cultural impacts of marine plastic pollution

Given the complexity of marine plastic pollution, characterizing the sociocultural impacts can offer useful insights for conceptualizing them in line with the definition offered. Many of the sociocultural impacts share common characteristics and are closely linked to marine ecosystem services. For example, a decline in marine ecosystem services (fish availability) due to increased plastic pollution can result in high negative sociocultural impacts. Three key characteristics of the socio-cultural impacts of marine plastic pollution are discussed.

3.5.1 Impacts accrue at variable spatial and temporal scales

The abundance and intensity of plastic pollution in marine environments tend to fluctuate with seasonal variations (Pelamatti et al., 2019), with a corresponding variation in the extent of socio-cultural impacts. Although few studies have explored seasonal variations in plastic abundance in the marine setting (Moreira et al., 2016; Pham et al., 2014), there is a notable

positive relationship between precipitation and the prevalence of plastics found on beaches and estuaries (Moreira et al., 2016). This is because plastic pollution is carried by surface run-off into river systems, stormwater drainage systems, and ultimately to coastal waterways and beaches during wet seasons (Naidoo et al., 2020; Cheung et al., 2016). As a result, marine plastic pollution is more abundant during rainy seasons, and socio-cultural impacts can be more acute during the rainy season than during other seasons. For example, after a 90 mm rainfall event in the southern California coastal area, marine plastic pollution, particularly microplastic, was seven times more abundant than before (Cheung et al., 2016).

Furthermore, extreme weather events associated with seasonal changes such as tropical cyclones, which require summer conditions to form (e.g., high sea temperatures, evaporation rate, etc.), contribute to the heterogeneity of plastic floating in marine ecosystems (Veerasingam et al., 2016). After the Mexican Pacific Ocean was hit by eight tropical cyclones in July 2016, a high concentration of plastic was found floating in the area's bay (Pelammatti et al., 2019). Further, many studies on marine plastic abundance quantification often neglect seasonal changes in wind patterns and wave actions (Hermawan et al., 2017; Kukulka et al., 2012). According to Kukulka et al. (2012), marine plastic concentrations might be 2.5 times greater if correct wind models were used to assess the amount of marine plastic pollution. Another example is in the Selayar islands in Indonesia, where monsoon winds tend to be associated with large amount of plastic pollution from other regions via ocean currents (Phelan et al., 2020; Hermawan et al., 2017).

The impacts of marine plastics may also play out differently as shaped by spatial variability, e.g., in areas close to the marine environment versus those further afield and densely populated areas versus less densely populated areas (Crew et al., 2020; Kwon et al., 2020; Pham et al., 2014). For example, communities or stakeholders nearby any marine ecosystem (e.g., beaches, estuaries, coral reefs, bays, etc.) may perceive the socio-cultural impacts of marine plastic pollution as severe because they interact with the marine setting directly and frequently (e.g., beach walks, leisure or subsistence fishing, etc.). However, these impacts can also be experienced by people who do not reside close to a marine ecosystem but rely on or visit the marine environment.

Further, densely populated urban areas frequently generate massive amounts of land-based plastic waste that end up in the oceans (Pham et al., 2014; Goldstein et al., 2013). This is particularly true in urban areas with a high proportion of informal settlements, which often have poor solid waste management, resulting in plastic pollution finding its way to the marine environment compared to remote areas (Pham et al., 2014). As a result, identifying and mapping the socio-cultural impacts of marine plastic pollution and crafting interventions for addressing the impacts should consider the temporal and spatial dynamics of marine plastic pollution, which play a key role in the heterogeneity of socio-cultural impacts (Goldstein et al., 2013).

3.5.2 Impacts vary depending on socio-economic and cultural factors

The adverse impacts of marine plastic pollution may not affect communities equally. As the more affluent individuals may have alternate means to shield themselves from the negative impacts of marine plastic pollution, consequently, they may not be as affected as the poor (UNEP, 2021). For example, when marine plastic pollution interferes with socially and culturally important fishing activities, well-off people can consider alternative places to fish because they have the financial means to do so. In contrast, the poor may not have these options available to them. Correspondingly, the social costs (such as stress) of losing a food source due to marine plastic pollution may be higher for the poor than for the well-off (Henderson and Green, 2020).

According to the UNEP (2021), the debate on the adverse impacts of marine plastic pollution have rarely been viewed from an environmental justice perspective. Vulnerable populations such as indigenous peoples, women, migrants, children, and people with disabilities are disproportionately impacted by marine plastic pollution as argued by Landrigan et al. (2020). As already mentioned, marine plastic pollution threatens the livelihoods of those who rely on marine resources.

Moreover, plastic pollution is more common in the lower income nations than in affluent countries, where mishandling of plastic is rampant owing to a lack of infrastructure, corruption, systematic poverty, and inadequate governance systems (Browning et al., 2021; Cordier et al.,

2021; Dumbili and Henderson, 2020). For instance, despite the United States contributing significantly to marine plastic pollution, it ranks only 20th among coastal nations in terms of land-based plastic pollution (Tibbetts, 2015). China, Indonesia, and the Philippines, among other developing countries with a rapid increasing population near coastlines and insufficient waste management systems, occupied the top spots (Tibbetts, 2015). In turn, the impacts of marine plastic pollution are likely to be more severe in poorer countries.

Concerning perceived socio-cultural impacts, a different picture might emerge. For examples, people who visit the ocean for spiritual and recreational purposes might perceive the impacts as more severe than those who do not use the space for such purposes. Thus, the discussion and debates around the negative impacts of marine plastic pollution should evaluate to whom costs accrue and intervention options should be understood from socioeconomic and cultural gradients.

3.5.3 Links between economic and ecological impacts and socio-cultural impacts

The direct and indirect impacts of marine plastic pollution are closely intertwined. For example, monetary units can be used to estimate the loss of income that subsistence or commercial fishers suffer because of marine plastic pollution's adverse impacts on fishing activities (Arabi and Nahman, 2020; Rodríguez et al., 2020). However, this estimation cannot capture psychosocial costs impacts (e.g., stress and anxiety) that fishers may suffer from and cannot be quantitatively measured. Therefore, the intricate relationship between direct and indirect losses related to marine plastic pollution, which may be hidden in some circumstances, should be analyzed. Understanding and recognition of the socio-cultural impacts of marine plastic directly responds to environmental justice perspectives, and may assist researchers, scientists, policy makers and practitioners interested in the linkages between marine conservation and human well-being across complex social realities.

3.6 Measuring the socio-cultural impacts of marine plastic pollution

Measuring the socio-cultural impacts of plastic pollution on marine ecosystem services is notoriously challenging. Despite the measurability challenge, studies show that the use of marine ecosystems is highly valued from socio-cultural dimensions (Arabi and Nahman, 2020;

Beaumont et al., 2019; Beaumont et al., 2007), meaning the inability of marine ecosystems to provide these services due to plastic pollution can result in human ill-being. Capturing the sociocultural dimensions of marine plastic impacts requires the use of both quantitative and qualitative lenses and approaches. For example, further work is required to establish the effect of microplastics on human health, which to date is still poorly understood (Bhuyan, 2022). Personal interviews and focus group discussions can allow diverse marine users to articulate how their social and cultural lives are negatively impacted by marine plastic pollution. For example, understanding of the social values of marine based livelihoods requires capturing of people's history of using marine systems and their cultural and political contexts which can inform narratives, lived experiences and people's stories in relation to the perceived and actual impacts of marine plastic pollution. According to Thondhlana et al. (2020: 6), "*stories, feelings, experiences and narratives by local people provide contextual contours that can inform our understandings of non-material costs*" in this context those related to marine plastic pollution.

Assessment of the ecological and economic impacts of marine plastic pollution, which are largely known, is important but insufficient to address the intangible impacts people may incur due to pollution. While scientists and powerful actors might be interested in finding out the extent of pollution and its impacts on ecological and economic systems, varied users of marine systems might be more interested in the social and cultural disconnections from marine systems caused by plastic pollution. Recognition of these varied sociocultural impacts might be used to inform interventions for addressing plastic pollution in the first place. For example, a full understanding of marine plastic pollution's physical and mental health implications can be used to leverage responsiveness.

3.7 Conclusions

Much research has been devoted to understanding the ecological impacts of marine plastic pollution. Comparatively, the socio-cultural dimensions of impacts have been largely ignored and misunderstood. Developing balanced and equitable interventions for reducing marine plastic pollution and its impacts should consider the social and economic dimensions of impacts, paying attention to the marginalized. A pro-poor approach to understanding impacts is important, given poor people often bear the costs of ecosystem destruction. This paper has

provided a working definition of marine pollution impacts, along with categorization and characterization of the impacts for improved understanding. A key argument in the paper is that a balanced approach to understanding the impacts of plastic pollution on marine ecosystem services should consider both the ecological and socio-economic dimensions of impacts. The variability of the impacts, spatially and temporally, should be considered as well as the influence of social-economic contexts of individuals, communities and nations. The paper calls for marine ecosystem-level management frameworks to draw on the integration of diverse assessments of impacts to appreciate the full costs of the impacts on human wellbeing. Such an approach can ensure that interventions for reducing plastic pollution are aligned with goals for ensuring sufficient levels of marine biodiversity to support human well-being.

Chapter 4

STAKEHOLDER PERCEPTIONS OF THE IMPACTS OF PLASTIC POLLUTION IN SOUTH AFRICA

Abstract

There is widespread agreement that human actions are responsible for the ever-increasing marine plastic pollution, yet views on marine plastic pollution impacts tend to differ. This means that understanding the perceptions of different stakeholders on the impacts of marine plastic pollution can provide useful insights into viewpoints, which, can in turn, inform potential interventions. Using a semi-structured questionnaire, this study examined how 35 stakeholders perceived the ecological, economic and social impacts of marine plastic pollution in South Africa. The results demonstrate that stakeholders tended to associate marine plastic pollution with immediate, noticeable and easily quantifiable ecological impacts such as entanglement and ingestion of marine organisms, economic impacts and social impacts (e.g., loss of aesthetic appeal). However, secondary impacts such as loss of marine biodiversity and social impacts such as human health were largely unknown. Moreover, there was heterogeneity in perceptions of marine plastic pollution impacts among the stakeholders' groups. Considering that conflicting views might impede collective action for reducing marine plastic pollution, these findings have substantial implications for ocean and coastal management. Prospective studies researching marine plastic pollution impacts should consider divergent and diverse perceptions of different stakeholders to capture the real costs of marine plastic pollution.

Keywords: Human dimensions; human perceptions; marine environmental impacts; ocean plastic pollution, social impacts, marine environment

4.1 Introduction

Marine plastic pollution is widespread with serious adverse impacts on marine life and human well-being, which undermines the United Nations Sustainable Development goals of “*conserving and sustainably using the oceans, seas and marine resources for sustainable development*” and “*ensuring healthy lives and promoting well-being for all at all ages*” (Arulnayagam, 2020; Naidoo and Rajkaran, 2020; OECD, 2018; Gall and Thompson, 2015). From an ecological standpoint, macro and micro plastics in marine habitats negatively affect the structure and functions of marine ecosystems and a wide range of marine organisms, and in turn, reduces marine ecosystem services (Beaumont et al., 2019; Krellis et al., 2017). For example, the reduction of fish stocks can negatively impact the benefits available to people, including the quality and quantity of food (Akindele et al., 2021; Landrigan et al., 2020;). For instance, approximately 900 marine species interact with marine plastic pollution (Senko et al., 2020), with many of these marine species becoming entangled in plastic (Pawar et al., 2016). Some marine species can ingest plastics directly or through the food chain, resulting in sub-fatal impacts such as reproduction defects, general health implications, or lethal effects. Furthermore, marine plastic pollution such as discarded fishing gear (e.g., fishing rope and nets) can collect on the seafloor, causing damage to marine ecosystems such as coral reefs and mangroves (Naidoo and Rajkaran, 2020; Beaumont et al., 2019; Pawar et al., 2016; Gall and Thompson, 2015). Altogether, plastic pollution can result in the degradation of marine ecosystems (Beaumont et al., 2019; Heidbreder et al., 2019; Hartley et al., 2018), which can, in turn, impact humans.

From a social-economic perspective, there is growing evidence and recognition of the impacts of marine plastic pollution (Pahl et al., 2020; Van Rensburg et al., 2020). These include reduced aesthetic appeal, which can affect the sense of identity and community (McNicholas and Cotton, 2019), limitations in recreational opportunities (e.g., swimming) and loss of tourism revenue (Aretoulaki et al., 2021), and high costs to municipalities through clean-ups or repair of marine services infrastructure (e.g., boats and ships) (Thushari and Senevirathna, 2020). A study conducted in Bali, Indonesia, found that plastic pollution reduced the perceived aesthetic value of the surveyed tourists and locals (Giesler, 2018). Similarly, based on a study in the Maldives, Patti et al. (2020) found that tourists were less likely to travel to visit the Maldives if they believed that plastic pollution was a problem and tourists were willing to spend more for experiences elsewhere that were plastic pollution free. Furthermore, marine plastic

pollution can pose health risks to marine users. For example, macro plastics can result in injuries (e.g., severe cuttings) to swimmers or beach walkers. Microplastics are also linked with cancerogenic diseases and fertility abnormalities linked to the consumption of marine products with traces of microplastics (Thushari and Senevirathna, 2020).

Despite the growing research interest on the impacts of marine plastic pollution, the social impacts remain relatively unknown or hidden (Jambeck et al., 2018; Green et al., 2015) relative to the ecological (Naidoo and Rajkaran, 2020; Beaumont et al., 2019; Rochman et al., 2016; Chapter 3) and economic impacts (Abbott and Sumaila, 2019). This is because marine plastic pollution is customarily approached from the domain of ecology and conventional economic valuation (Gattringer, 2018), which often inadequately considers the non-tangible impacts (e.g., sense of place, aesthetics and memories) of marine plastic pollution. Further, the different ways the impacts are variedly perceived by different actors is rarely considered, yet this understanding is needed to develop interventions for addressing marine plastic pollution. The social dimension of marine plastic pollution impacts can be notoriously complex to grasp, identify and address due to the varied experiences, values and interests of marine users and potential conflicts in the way interventions are conceived. For example, people who rely heavily on marine resources (e.g., fisheries) for their livelihood may have a more negative perception of the impacts of marine plastic pollution as their sustenance income is likely to be negatively affected than recreational users who occasionally visit the beach for leisure.

Consideration of the social dimensions of benefits that come from the marine environment such as cultural connections, memories, inspirational qualities, sense of place and identity from multiple actors' perspectives, is a complex challenge that frequently does not fit into the conventional approaches to valuing marine resources and policy framing (McKinley et al., 2020). By extension, the social dimensions of plastic pollution impacts are highly neglected. Openly acknowledging the complex social realities can assist in delineating the full suite and diversity of the costs associated with marine plastic pollution (McNicholas and Cotton, 2019) to the different stakeholder groups. Therefore, insights into stakeholder perceptions of the impacts of marine plastic pollution are crucial for formulating effective and progressive actions and solutions.

4.2 Conceptualizing perceptions of multi-stakeholders

Schermerhorn et al. (2005: 75) define perceptions as the “*process by which people select, organize, interpret, retrieve, and respond to information from the environment around them.*” Perceptions can lead to mental expressions and constructions, impacting people’s perspectives and behaviours (Uhl-Bien et al., 2020; Schermerhorn et al., 2011). Individual attributes such as gender, age, education, career, socio-cultural contexts, sea/landscape surroundings, and institutional and policy contexts can influence their perceptions (Schermerhorn et al., 2005). For instance, research suggests that socio-demographic variables such as gender and educational attainment might predict the level of concern for environmental problems such as marine plastic pollution (Potts et al., 2016; Zelezny et al., 2000). For example, women are generally more concerned about environmental risks such as marine plastic pollution than males and are more likely to be pro-environmental than their male counterparts (Potts et al., 2016), but this relationship is not linear and always predictable (Beaumont et al., 2019; Potts et al., 2016).

Further, highly educated individuals tend to be more environmentally conscious overall than less educated individuals (Hartley et al., 2018; Gifford, 2014). This would suggest, tentatively, that highly educated people are more likely to appreciate the impacts and act in the interest of the environment. For instance, a study conducted in Brazil found that individuals with higher levels of education were more likely to have negative perceptions of marine plastic pollution and to take action to reduce their plastic consumption (Gelabert et al., 2021). Beyond socio-demographics, contextual antecedents can be important in shaping people’s perceptions of the impacts of marine plastic pollution (Pahl et al., 2020). For example, people who visit the ocean frequently may be more concerned by marine plastic pollution and even more willing to volunteer for clean-ups than those who do not. In addition, social identity can shape people’s perspectives and habits regarding marine plastic pollution. For example, individuals who self-identify as pro-environmental are more likely to be worried about the impacts of marine plastic pollution and willing to take action than those who do not (Pahl et al., 2020). A study that explored the attitudes of 584 residents of Hong Kong towards marine plastic pollution found that individuals who identified as pro-environmental were more likely to be concerned about marine plastic pollution and take action to reduce their plastic use than those who did not identify as pro-environmental (Wong et al., 2019).

The media can also play a huge influence in shaping people's perspectives as media can form the social context within which societal issues such as sustainability challenges are negotiated and consumed. For example, GRID-Arendal article (2022:1) refuted some of the environmental worries related to marine plastic pollution that media outlets frequently propagate as misconstrued statements, myths and without any empirical standing. These statements include “*plastic pollution is a leading threat in marine ecosystems*”, “*microplastics are a major threat to human health*” and “*plastic accumulated in marine systems will surpass the quantity of fish*”. In line with this viewpoint, Stafford (2019) argues that the media, governments, and the general public have overemphasized ocean plastic pollution as a major threat at the expense of greater threats such as overfishing and climate change. These contradictory views imply that there might not be uniformity in stakeholder perceptions of the impacts of marine plastic pollution, owing to their exposure to media. It can be argued that people’s income status may expose them to various media platforms where sustainability issues are debated, which can sensitize them about the adverse impacts of environmental degradation, which in turn, can increase their concerns about the environment. Thus, it is plausible to argue that the varied contexts people find themselves in can explain varied perceptions of marine plastic pollution which may result in contestations over the magnitude of the impacts and strategies for addressing them (McNicholas and Cotton, 2019).

Therefore, understanding and accounting for these competing stakeholder perceptions of the impacts of plastic pollution on marine ecosystems and in turn, on marine ecosystem services can form the basis for understanding and tackling marine plastic pollution (Jefferson et al., 2014). This is particularly important and relevant to South Africa’s context, marked by significant and enduring social and economic disparities among its population (Hull and James, 2012). Very few studies have examined stakeholder perceptions of marine plastic pollution in South Africa, with one notable exception (Van Rensburg et al., 2020) but from a consumer perspective. South Africa’s marine ecosystem supports various industries including tourism, fishing, mariculture, underwater infrastructures, mining, and the nation’s cultural heritage (DFFE, 2021). Exploring perceptions and knowledge across a stakeholder heterogeneity gradient may help develop coordinated marine plastic pollution interventions to ensure equity and stakeholder responsibility to sustain marine ecosystem benefits. Insights into the range of perceptions across stakeholder gradients may offer an opportunity to systematically guide positive social change processes such as social justice. Furthermore, it can support the

development and evaluation assessments of effective communication and behaviour change interventions around mitigating marine plastic pollution. Considering this background, the aim of this study was to (1) examine stakeholder' perceptions of the impacts of marine plastic pollution on marine ecosystems in South Africa, (2) compare and contrast perceptions and knowledge relating to the impacts of marine plastic pollution, and (3) discuss policy implications for reducing marine plastic pollution in South Africa.

4.3 Methods

4.3.1 South Africa's marine ecosystems and socio-economic status

This research was undertaken in South Africa, a country with a coastline of approximately 3 650 km and an Exclusive Economic Zone (EEZ) (see appendix 1) of over one million km^2 (Griffiths et al., 2010). South Africa has a wide array of marine ecosystems such as estuaries, beaches and open seas making it rich in marine species. South Africa's marine ecosystems accommodate approximately 12 914 species, out of which 33% are endemic (Naidoo and Rajkaran, 2020). However, like many other developing nations, South Africa has poor waste management capacity in which in part, explains marine plastic pollution. Approximately between 15 000 and 40 000 tonnes of plastic enter South Africa's marine ecosystem annually, leading to the environmental degradation of marine ecosystems (Vester and Bouwman, 2020).

South Africa has a population of about 59 million, characterized by a high degree of socio-economic variability owing to the country's past apartheid legislations (Statistics South Africa, 2012). According to Leibbrandt et al. (2012), South Africa's household income inequality is generally high, with a Gini-coefficient of about 0.7, which is worse than other countries with comparable development challenges such as Brazil, Mexico, and Thailand. This inequality is not limited to economic inequalities but extends to access to fundamental amenities such as water, electricity, education, and health care facilities (Statistics South Africa, 2012). People's involvement and interest in marine ecosystems, or lack thereof, may be influenced by these socio-demographic disparities. As a result, South Africa presents a relevant context to study the multi-faceted perspectives of marine plastic pollution.

4.3.2 Research design

The study involved stakeholders located across five South African provinces (Eastern Cape, KwaZulu Natal, Gauteng, Limpopo and Western Cape) between October 2021 and April 2022. The study sample comprised 35 respondents, with 46% (n = 16) residing in the Eastern Cape, 34% (n = 12) in the Western Cape, 14 % (n = 5) in KwaZulu Natal, and 3% (n = 1) each in Limpopo and Gauteng provinces. This study was exploratory (Etikan et al., 2016) and used a snowballing sampling approach to get insights into the self-reported perceptions of the impacts of marine plastic pollution. The snowball sampling strategy entails individuals referring potential research participants who may fit the criteria of the study (Parker et al., 2019). Participants, hereafter referred to as stakeholders, were selected through criterion sampling by selecting all of the subjects who fit into one or more of the following categories: stakeholders with a stake in the management of marine plastic pollution, who benefit from marine ecosystems and are adversely affected by marine plastic pollution, and those who may be contributing to growing threats posed by marine plastic pollution. The stakeholders were identified through online, and print document searches and reviews linked to the marine plastic issue including websites, news sources, official publications, NGO reports, and academic databases⁷. Overall, six groups of stakeholders were identified namely academics⁸, tourism operators, government officials, fisheries (commercial and small-scale fishers), civil society (e.g., Non-Profit Organizations and private sectors) and marine recreational users (Figure 4.1).

The key limitations of the sampling strategy employed in this study relate to sample selection bias (Smith and Noble, 2014), response bias (Smith and Noble, 2014) and the inability to generalise the findings due to the small sample size (Marshall, 1996). Nonetheless, the objectives of this study were not to generalize the findings but to gain transferable insights of a complex and subjective research question about the perceived impacts of marine plastic pollution by a diverse group of marine stakeholders. Therefore, the small sample size is not concerning (Malterud et al., 2016). A reflective notebook was kept for recording all potential

⁷ The sources used to build the marine stakeholder database include Marine Pollution Bulletin Journal, Google Scholar, WWF reports, DEFF reports, FAO reports, National Geographic articles, GRID-Arendal articles, among others.

⁸ Although in some instance the academics usually fall under civil society group, for the purpose of this research, academics were presented as standalone group because of their specialized focus on marine research which may set them apart from other civil society actors such as NGOs.

biases or preconceptions to avoid such biases in collecting and interpreting the data⁹ (Noble and Smith, 2015). Data (audio recording and forms) collected from the stakeholders were meticulously recorded and continuously reviewed to ensure that the results reflected the stakeholders' actual perceptions (Noble and Smith, 2015; Sandelowski, 2006; Long and Johnson, 2000). The results also included verbatim (direct quotes) of the stakeholders to substantiate the claims (Noble and Smith, 2015, Slevin, 2002).

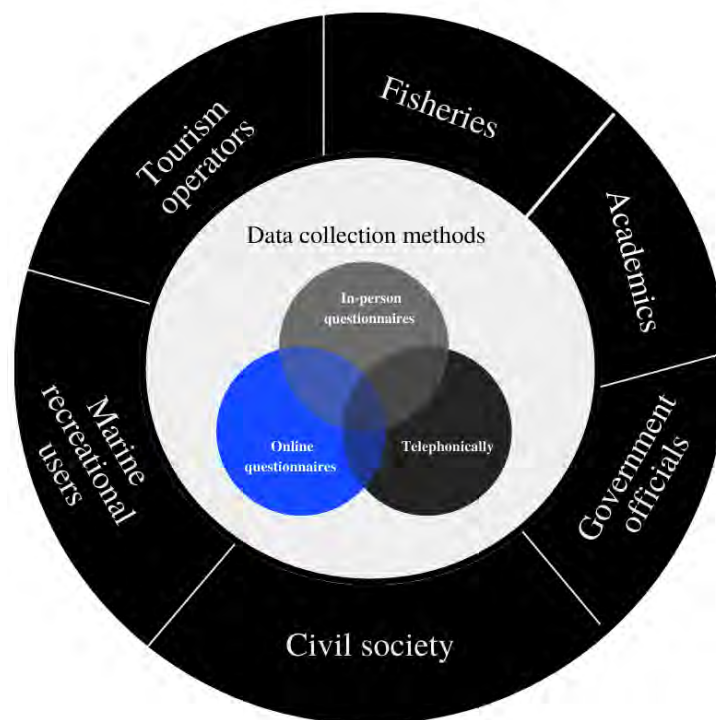


Figure 4.1: Categorization of stakeholder groups

4.3.3 Data collection

Data for this study were collected through a semi-structured questionnaire. A pilot study was administered to check for accessibility, errors, ambiguity, and inconsistencies in the questionnaire among 16 individuals¹⁰. The questionnaire was subsequently amended. First, a concise definition of marine environments and marine plastic pollution was included in the questionnaire. This was done to (i) to provide stakeholders concise understanding of the marine

⁹One example of bias is that because I am an Environmental Science student with strong views on plastic pollution, I probably could have interpreted data selectively, focusing on the evidence that coincides with my viewpoints and ignoring the contradictory information.

¹⁰ The 16 individuals that complete the pilot questionnaire include Environmental Science postgraduate students and staff members at Rhodes University.

plastic pollution and (ii) avoid confusing marine ecosystems with other aquatic ecosystems like river systems or lakes. Second, the phrases “*marine plastic pollution*”, “*marine plastic waste*” and “*marine plastic litter*” were no longer used interchangeably; rather, “*marine plastic pollution*” was used throughout the questionnaire to be consistent and eliminate ambiguity. Third, unclear wording was rephrased to be more straightforward. Fourth, a place for optional comments was added to the sections where stakeholders had to select from the stated impacts and rate their severity. This allowed stakeholders to add any comments or other information they felt was pertinent. Due to time and financial constraints and Covid-19 restrictions, the questionnaires were administered in person, telephonically and online¹¹. Six stakeholder representatives who were nearby answered the questionnaires face to face. Three respondents who were not available for face-to-face interviews completed the questionnaire using virtual platforms, Zoom and Microsoft Teams, and one interview was administered telephonically. For the remaining 25 stakeholders (see appendix 4), a Google form and Qualtrics survey software tool (Smart survey), an online version of the questionnaire was created, and the link was emailed to the specific respondents identified. The interviews conducted in the preferred language of the stakeholders (English or IsiXhosa), took between 45 and 60 minutes. Ethical clearance for the study was granted by the Rhodes University Human Research Ethics Committee at Rhodes University (Reference Number: 2021-5106-6117).

The semi-structured questionnaire contained six sections. The first section of the questionnaire collected information on the socio-demographic information of the stakeholders including gender, age, education level, employment status and income source. The second section of the questionnaire asked individuals to describe their interactions with, usage, and interest in maritime environments. Stakeholders who had multiple interests in the marine environment such as recreational and small-scale fishing interests were asked to identify their primary interests or involvement in the marine environment. Section four covered people’s knowledge and perceptions of the impacts (ecological, social and economic) of marine plastic pollution. The respondents were asked to indicate whether they associated the impacts listed in the questionnaire with marine plastic pollution or not. For each listed impact, stakeholders had three options ranging from “*Yes*”, “*No*” and “*I do not know*”. Participants were asked for any

¹¹ I acknowledge the inherent limitations of integrating data from online surveys, telephonically and face-to-face interviews. To overcome this issue the questionnaire for all the stakeholders was standardized and provided clear instructions to enhance data comparability.

additional remarks and to state any impacts they felt the questionnaire did not cover. Participants were also asked to rate the severity of ecological, social and economic impacts they identified on a five-point Likert scale (1 = very low, 2 = low, 3 = moderate, 4 = high, and 5 = very high). In section four, the stakeholders were asked to provide their knowledge of sources of marine plastic pollution and potential intervention strategies.

4.3.4 Data analysis

All the data acquired from online questionnaires were transcribed and entered into a Microsoft Excel spreadsheet. Prior to analysis, qualitative responses in which respondents expressed their opinions on marine plastic pollution were compiled and recorded. Nominal responses were categorized and given numerical scores using Excel's logical expressions (Ifs statements) function. Thematic analysis was used to code the nominal responses and then categorise the emergent findings from the questionnaires. Thematic analysis involves identifying patterns and themes across a dataset (Maguire and Delahunt, 2017). This analysis approach allows adaptability which can be used across different questions to assist in understanding the respondents' position, insights, and knowledge regarding a particular topic. Following Maguire and Delahunt (2017), thematic analysis was carried out in five phases. These included (i) familiarization with the data, (ii) searching for themes, (iii) coding the themes, (iv) reviewing and amending the identified themes and (v) writing up. Direct quotes from the stakeholders were used as a form of evidence to support claims and express the meanings of the study (Noble and Smith, 2015; Newing, 2010; Slevin, 2002). Descriptive statistics in the form of percentages and means were used to calculate the frequencies of responses such as (a) perceived ecological, social and economic impacts of marine plastic pollution, (b) severity of the impacts, and (c) sources of marine plastics. All the stakeholder' scores were averaged for the ecological, social and economic impacts, and the standard deviation was calculated.

4.4 Results

4.4.1 The socio-demographics of the stakeholders'

A summary of the socio-demographic profile of the respondents is provided in Table 4.1. Approximately 60% of the stakeholders were males. The average age of the respondents was 47.8 ± 14 years, ranging from 18 to 85 years. The sample size was slightly skewed towards the older age group. The majority of respondents (43%; $n = 15$) was between the ages of 46 and

65. More than half of the respondents (51%) reported monthly incomes of more than ZAR30 000 (or US\$1 650), followed by an equal proportion (6%) of respondents reporting monthly incomes of between ZAR15 001-ZAR30 000 (US\$825-US\$1650)¹² and ZAR6001-ZAR15 000 (US\$330-US\$825). Only one respondent reported earning less than ZAR2 000 (US\$109.99) per month. A sizeable proportion of the respondents (34%) preferred not to indicate their monthly income. A large proportion of the respondents had high levels of education, with over two-thirds (86%) having tertiary level education, followed by 9% with secondary level education. Only two stakeholders had no formal education. Overall, the socio-demographic profile of the respondents is indicative of a generally well-off group of respondents.

Table 4.1 Socio-demographic profile of the respondents

Variable(s)	Proportion (%) of respondents
Gender	
Female	40
Male	60
Age range (in years)	
18-35	29
36-45	9
46-65	43
66-85	17
Preferred not to say	2
Income (ZAR)	
<R2 000	3
R2 001- R6 000	0
R6 001-R15 000	6
R15 001-R30 000	6
>R30 000	51
Preferred not to say	34
Education level	
No formal education	5
Primary education	0
Secondary education	9
Tertiary education	86

¹² The US dollars figures are based on 2022 rand to dollar exchange rate

4.4.2 Knowledge and perceptions of marine plastic pollution impacts

Ecological impacts

Figure 4.2 shows the proportion of respondents with knowledge of the ecological impacts of marine plastic pollution. Overall, the respondents were generally aware of ecological impacts of marine plastic pollution, with at least 60% of the stakeholder's showing knowledge of each listed impact. However, there were variations in the proportion of respondents who knew each listed impact. Nearly all the respondents (94%) indicated they were aware of entanglement of marine species by plastics. Similarly, a high proportion of respondents knew about the ingestion of plastic by marine species (86%) and the blockage of intestinal tracts of marine organisms such as fish and marine mammals (80%). Death of marine mammals, decrease in fish quantity and plastic leachates were identified by a sizeable proportion of the respondents ranging from 69% -74%. Comparatively, adverse ecological impacts of marine plastic pollution such as reproductive issues in marine wildlife, declines in marine species richness and reduction in biodiversity were known by a smaller proportion of respondents (Figure 4.2). Most respondents felt that these impacts were not easily noticeable hence they are not aware of them.

Taken together, the results tend to indicate that most respondents were aware of impacts of that are easily observable such as the entanglement and ingestion of plastic by marine species, as opposed to the impacts that are difficult to measure or observe such as the loss of biodiversity or decreased species richness. A recreational user, for instance, stated that their perceptions were formed based on visuals they had seen on a television programme: *"I have seen how it negatively impacts aquatic wildlife on the Natural Geographic channel"*. Academics and members of civil society who were interviewed noted that they had worked extensively on marine plastic pollution research and monitoring of marine plastic pollution respectively. For example, a stakeholder who was representative of civil society members said, *"Our organization has placed greater emphasis on recording marine plastic debris and monitoring fishing vessel compliance with marine pollution regulations such as MARPOL"*.

Disaggregation of the findings shows that some respondents were more aware of certain impacts than others. For example, all academics (n = 6) and civil society stakeholders (n = 9) agreed that "blockage of intestinal tracts" is associated with marine plastic pollution, whereas only 40% of tourism operators were aware. Other stakeholders such as tourism operators and

recreational users, were more conservative and frequently cited “I do not know”. For example, one commercial fisher stated, *“I cannot answer some of the questions as I have no first-hand knowledge or experience in the effects thereof. I doubt any normal person could tick any answer than “I do not know” unless they are researchers directly involved in researching it”*. Interestingly, some stakeholders gave identical responses to certain questions, but their motivations for doing so varied. This could explain why various stakeholders may hold similar perceptions but have different motivations for doing so. For instance, one marine scientist stated, *“I do think that marine plastic pollution does cause marine reproductive abnormalities; however, I am choosing I do not know on the questionnaire based on the fact that there are currently no empirical studies to support this claim”*. A small-scale fisher answering the same question remarked, *“I do not know if the plastic pollution can result in reproductive challenges for the marine wildlife as I have never observed it or heard about it hence, I decided to choose I do not know”*.

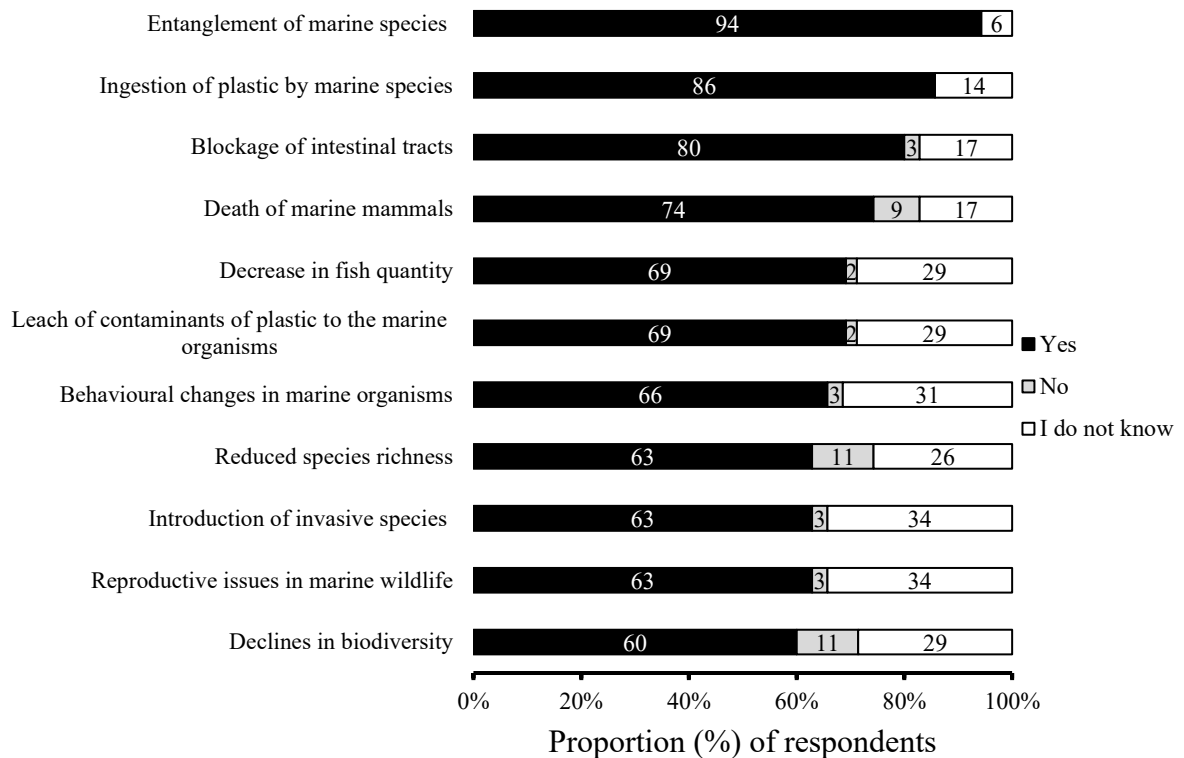


Figure 4.2: Stakeholders’ knowledge of ecological impacts of marine plastic pollution

Economic impacts

In general, respondents were aware that marine plastic pollution resulted in negative economic impacts such as high clean-up costs (89%) and declining recreational and tourism industry (91%) and the commercial fishing sector (63%) (Figure 4.3). All the respondents perceived that marine plastic pollution negatively affected recreation and tourism, with the exception of two civil society stakeholders and one fisher. One tourism operator stated, “*My company depends mostly on tourism. Having dirty beaches, rivers and oceans negatively affects the tourism industry*”. An academic stakeholder said, “*Tens of million are spent per annum on removing marine litter*”. Meanwhile, one of the civil society respondents disagreed with the claim that marine plastic pollution negatively impacted recreation and the tourism industry, pointing out that most plastic is retained in the upper reaches of riverine systems and that only a small amount of plastic makes it to the coast and even a smaller amount to deeper oceans.

Further, despite the high level of agreement, comparisons between stakeholder groups showed that two out of six academics and two out of civil society disagreed that a decline in commercial fishing could be associated with marine plastic pollution. In contrast, government stakeholder groups and recreational users all believed that the decline in the commercial sector was linked to marine plastic pollution (Figure 4.3). The stakeholders who disagreed contended that while marine plastic pollution may marginally contribute to the fall in fish stock in the ocean, overharvesting of fish by humans was the major factor driving the decline citing scientific evidence.

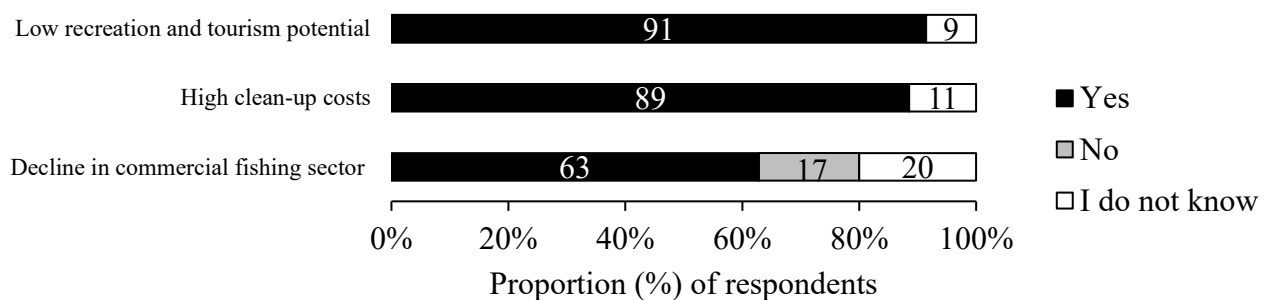


Figure 4.3. Stakeholders’ knowledge of economic impacts associated with marine plastic pollution

Social impacts

A substantial proportion of the respondents were aware that marine plastic pollution was associated with loss of aesthetic or natural beauty (91%), loss of livelihood strategies (74%) and injuries or loss of human life (69%) and loss of cultural heritage (Figure 4.4). Disease outbreaks and health complications to humans were cited by less than half of the respondents. Some civil respondents (3) said that disease outbreaks could not be attributed to marine plastic pollution citing that diseases were often linked with stagnant fresh water. However, two academics argued otherwise and stated that these diseases could occur in estuaries. The respondents who disputed some impacts cited lack of scientific evidence to support the claims. Nearly all (5) respondents representing the fishers' stakeholder group perceived that marine plastic pollution resulted in the loss of livelihood strategy. One of the respondents remarked that marine plastic pollution had provided them with a means of subsistence through their work in beach clean-ups.

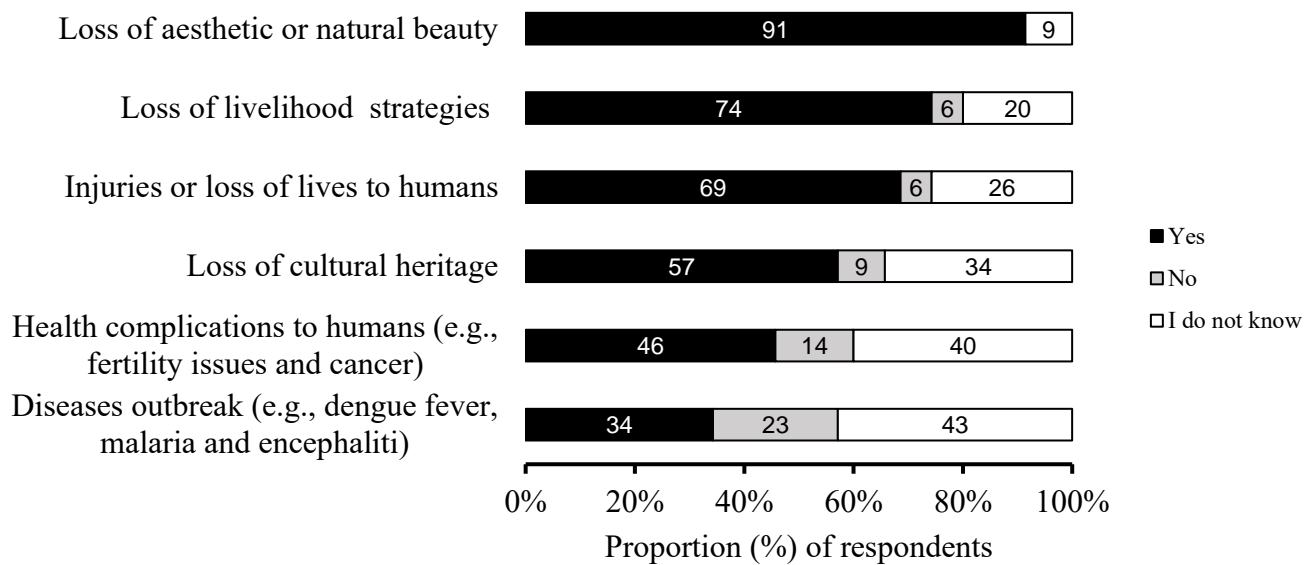


Figure 4.4. Stakeholders' knowledge of social impacts associated with marine plastic pollution

4.4.3 Rating of impacts

The respondents were asked to rate the ecological, economic and social impacts they identified on a Likert scale (Table 4.2). Most respondents assigned a high severity score to impacts such as death of marine wildlife (3.5 ± 1.4 , 89%); ingestion of marine plastic by marine species (3.3 ± 1.4 , 97%); leach of contaminants of plastic to marine organisms (3.3 ± 1.4 , 86%) and blockage of intestinal tracts (3.3 ± 1.5 , 89%) (Table 4.2). In contrast, the introduction of invasive species due to marine plastic pollution transporting marine plants, animals, and microbes across oceans (2.5 ± 1.5 , 86%) and change of marine habitat (2.7 ± 1.5 , 91%) were rated as less severe (Table 4.2). For economic impacts, stakeholders perceived the following impacts to be highly severe: negative impacts on the marine recreation and tourism industry (3.8 ± 1.3 , 91%), high clean-up costs (3.7 ± 1.3 , 97%) and losses to the commercial fishing sector (3.1 ± 1.5 , 91%). Concerning social impacts, the stakeholders perceived loss of aesthetic appeal or the natural beauty of marine environment due to plastic pollution as highly severe (4.0 ± 1.1 , 91%). A recreational user said, “*There is a loss of aesthetics. I no longer see the beauty I once experienced a few years ago*”.

Table 4.2. Respondent perceived severity of impacts of marine plastic pollution (1-5)

Impact	Mean ± SD	Proportion (%) of respondents
Ecological impacts		
Entanglement of marine species (e.g., seabirds, penguins, sea turtles, etc.)	3.1±1.4	97
Ingestion of plastic by marine species	3.3±1.4	97
Leach of contaminants of plastics to marine organisms	3.3±1.4	86
Introduction of invasive species as plastics transport marine animals, plants, and microbes across oceans.	2.5±1.5	86
Change of the marine habitat (e.g., composition), for example, by changing physicochemical water quality (e.g., alkalinity, oxygen levels, pH and others)	2.7±1.5	91
Reduced species richness	3.1±1.6	86
Declines in biodiversity	3.1±1.5	83
Behavioral changes in marine organisms	3.0±1.4	91
Reproductive issues in marine wildlife	3.1±1.5	89
Blockage of intestinal tracts	3.3±1.5	89
Decrease in fish quantity	3.1±1.6	89
Death of marine mammals	3.5±1.4	89
Social impacts		
Health complications to humans (e.g., fertility issues and cancer)	2.5±1.4	80
Disease outbreaks (e.g., dengue fever, malaria and encephalitis)	2.2±1.4	71
Injuries or loss of lives to humans	3.3±1.4	89
Loss of cultural heritage	3.0±1.5	91
Loss of aesthetic or natural beauty	4.0±1.1	91
Loss of livelihood strategies (e.g., fishing)	3.3±1.4	77
Economic impacts		
A decline in commercial fishing sector	3.1±1.5	91
Low recreation and tourism potential	3.8±1.3	91
High clean-up costs	3.7±1.3	97

The investigation of the severity of the negative effects of marine plastic pollution was further segmented to determine if there were any variances among the stakeholder groups. Although the mean stakeholder scores for the listed ecological, social and economic impacts may be relatively similar, there are modest variances between various stakeholder groups. For instance, the perception of the severity of the introduction of invasive species due to marine plastic pollution varied noticeably between academics and civil society stakeholders and those in government, the tourism industry, and recreational users. Academics and civil society rated the introduction of invasive species as less severe, while all the other stakeholders considered it moderately severe. Similar trends were noted for “*behavioural change in marine organisms*”

and “*change in marine habitat due to plastic pollution*”. Compared to other stakeholder groups tourism operators perceived the adverse impacts of marine plastic pollution to be very severe. Among all stakeholders, only recreational users perceived the adverse impacts on tourism and the recreational industry to be highly severe as evident in the following quotes:

“I do not enjoy going to the beach anymore because it is dirty” (Recreational user).

“Plastic pollution reduces where I can visit for pleasure; have to look at this awful stuff when walking along the beaches (and pick it up if I can, to dispose of later); it angers me that humans are so careless and foolish in the choices we make and so inconsiderate of others, mostly for the sake of convenience” (Academic).

It is important to note that certain stakeholders, particularly academics acknowledged the existence of some impacts but rated them low because they found it difficult to evaluate the severity of these impacts without comparing them to other environmental issues such as climate change.

4.4.4 Perspectives on sources of marine plastic pollution in marine environments

The respondents were asked to indicate sources of marine plastic pollution. The respondents within each stakeholder group showed a good understanding of land- and sea-based sources of marine plastic pollution. Only three respondents said they were unaware of the land- and marine-based sources of pollution. In terms of the land-based sources of marine plastic pollution, most of the stakeholders mentioned landfills (83%) and harbour and ports (60%) as key contributors. Stakeholders, particularly academics and members of civil society, stated that because landfills and harbours are mismanaged, they significantly contribute to marine plastic pollution. More than half (57%) of stakeholders felt that private households also contributed to marine plastic pollution (Figure 4.5). Some government officials, academics, and members of civil society believed that informal households were the key sources of plastic because they lacked suitable disposal facilities for their plastic waste. One of the stakeholders said, *“Significant portion of marine debris is washed down rivers especially in areas where rivers abut low-income housing that do not have sufficient waste removal services”*. When asked about the marine-based sources, the stakeholders cited shipping vessels (69%) and recreational and fishing boats (60%) as key sources of marine plastic pollution through direct littering and lost ghost fishing (Figure 4.5). However, several respondents showed differences in viewpoints. For instance, a tourism operator who owned recreational boats perceived that

because of rigorous laws, recreational boats contributed relatively little to marine plastic pollution and instead blamed commercial fishers and shipping vessels.

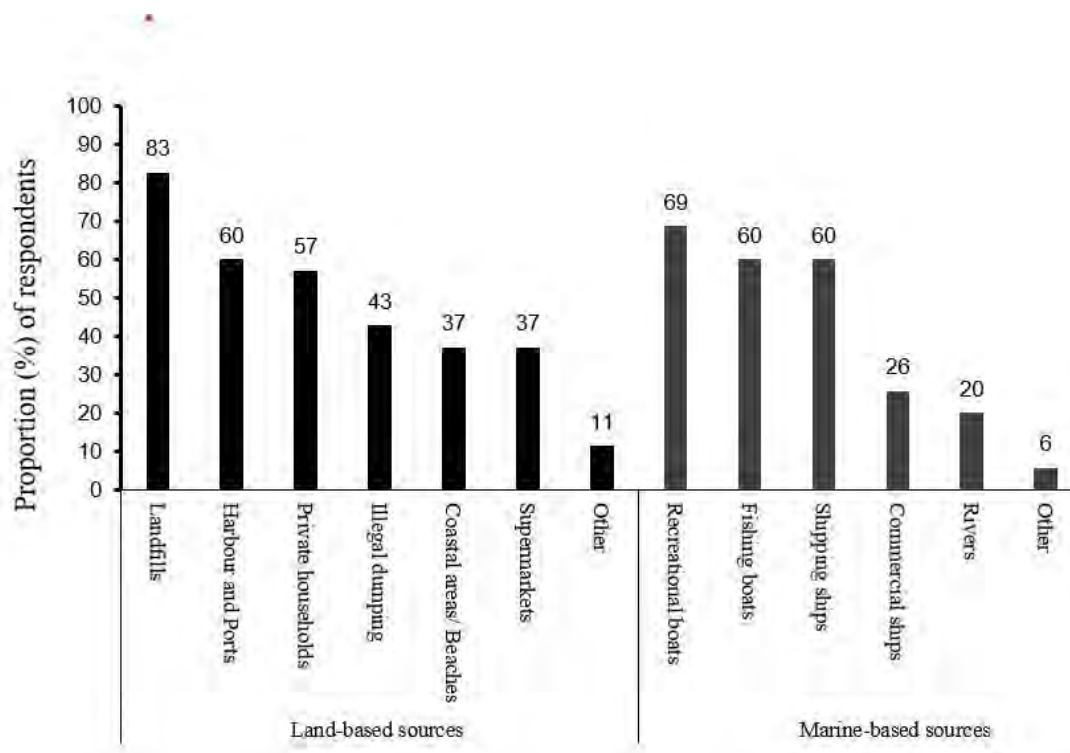


Figure 4.5: Reported sources of marine plastic pollution

4.4.5 Potential interventions for reducing marine plastic pollution

When asked about potential interventions for reducing marine plastic pollution the stakeholders mentioned three key themes namely, (1) behavioural interventions, (2) regulatory interventions; and (3) policy interventions. These interventions emerged from the stakeholders are grouped in a high-level conceptual framing in Figure 4.6. Behavioural interventions, as a first theme, include those interventions that deal with changing the behaviour and attitudes of people. One commonly cited behavioural intervention strategy was changing people’s behaviour through education and awareness, cited by nearly half (49%) of the stakeholders. Different stakeholders proposed various ways educational interventions could be implemented. Some said that educational programmes for promoting awareness should be done in different platforms such as schools and churches. Others highlighted that people need awareness about the impacts of marine plastic pollution, particularly those that are not easily visible such as the loss of biodiversity and contribution to climate change crises. One stakeholder stated, “*Make people to become more aware on its impacts; 50% of the people I conversed with on the subject*

still have no idea of its impact out of sight". However, there was a stark difference when stakeholders' responses were compared. Apart from behavioural intervention, most stakeholders demonstrated a good understanding of regulatory interventions highlighted as a second theme (Figure 4.6). Recycling was mentioned by 20% of the stakeholders. Some respondents felt that incentivising recycling could encourage recycling and reduce the amount of plastic reaching marine environments. Others said that recycling can have dual benefits, reduction of plastic pollution and job creation, especially in a South African context with high youth unemployment. Clean-ups were also identified as a key technical intervention. Most respondents stated that there is need for regular beach clean-ups. However, some respondents believed that technical interventions such as cleaning up beaches, were ineffective and that preventative interventions should be implemented before plastic pollution reaches the marine ecosystems. A government official postulated, *"There is a need to facilitate the reduction/prevention of plastic leakage from the source. Attempting to manage the issue once it reaches the ocean is expensive and ineffective"*.

Finally, as a third emerging theme, the respondents mentioned various policy implementation strategies that could be used to address these marine plastic pollution issues, including waste management policies, fiscal policies (such as taxes), plastic bags and others (Figure 4.6). Some respondents stated that rigorous single-use plastic bans should be introduced, and better management of landfills should be implemented to control marine plastic pollution. A few respondents admitted being pessimistic and stated that they could not think about any issue due to the complexity of marine plastic pollution, citing that it was obvious that none of the existing interventions were effective. Other respondents expressed that the issue was not about interventions per se but rather the political will to address marine plastic pollution.

It was also recognized by some stakeholders that multiple interventions working together can be more effective than single interventions as evident in the following statement by a civil society representative, *"A wide range of interventions are required to address and improve regulation of the production, use throughout the value chain and disposal of plastics. Recycling has an important role to play but is only a part of the solution, and better control and regulation of supply and demand are critical"*.

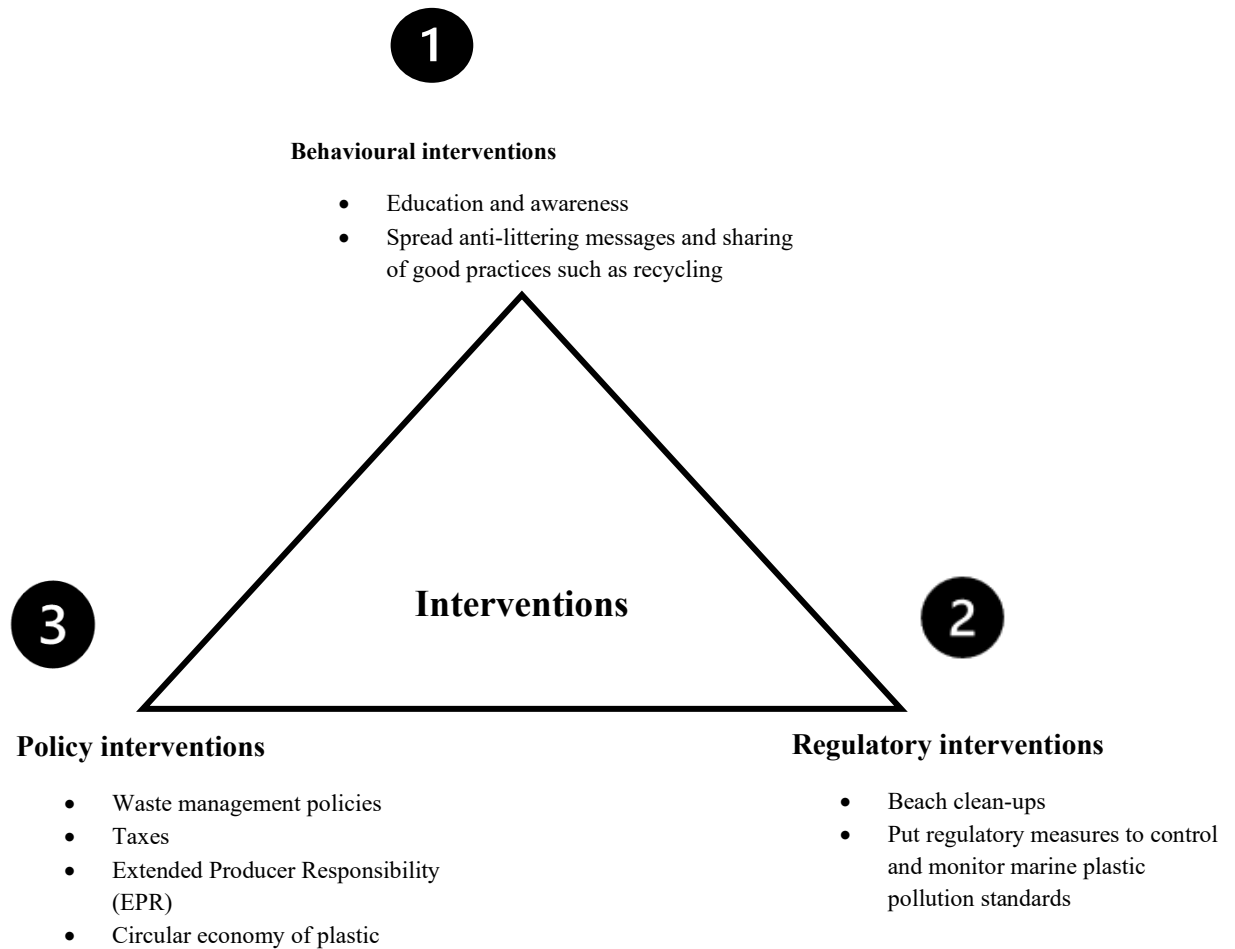


Figure 4.6. Schematic representation of emerging intervention strategies raised by various stakeholders who participated in the questionnaire

4.5 Discussion

4.5.1 Awareness of ecological, social and economic impacts of marine plastic pollution

Ecological impacts

This study aimed to assess marine stakeholders' perceptions of marine plastic pollution and its adverse impacts in South Africa. First, the results suggest that more stakeholders knew and easily identified visible ecological impacts and subsequently perceived them to be more severe than invisible ones. This is consistent with the economic valuation mantra focussed on the direct or immediate ecological impacts (e.g., ingestion and entanglement) while less attention is paid to non-material impacts that have a wide reach and far more significant damage in society (Arabi and Nahman, 2020; Beaumont et al., 2019; Gall et al., 2015; Hidalgo-Ruz & Thiel, 2013). The lack of appreciation of the secondary impacts of marine plastic pollution can be explained by the difficulty in measuring such impacts, which often require large-scale contexts and advanced econometric abilities that are currently lacking particularly in

developing nations such as South Africa (Townsend et al., 2018; 2014; Hidalgo-Ruz and Thiel, 2013). Given that advances in research can help in raising awareness about ecological impacts, it is plausible to suggest that the lack of documentation and the extent of these secondary ecological impacts, which are often linked with loss of ecosystem services, may explain the relatively low knowledge levels among stakeholders.

Therefore, there is a need to exercise caution when communicating information about marine plastic and its deleterious effects. For example, a failure to accurately predict the adverse effects of any indirect ecological impacts of marine plastic pollution such as loss in marine biodiversity, does not imply that those consequences do not exist. According to Beaumont et al. (2019) and Galloway et al. (2017), plastic in marine ecosystems alters the marine ecology, which can shift biodiversity. This is certainly relevant now that the resilience of marine ecosystems is more vulnerable due to the cumulative effects of over-exploitation, ocean acidification, and climate change (Ford et al., 2022). In addition, secondary impacts such as the increasing rate of invasive species because of floating plastic in the ocean, have been documented (Beaumont et al., 2019; Worm et al., 2006). Therefore, even though these secondary impacts may be partially hidden, stakeholders must be informed of these potential adverse effects and their probable severity in the long term if marine plastic pollution is left unabated.

Regarding the ecological impacts, the study found that experts such as scientists and civil society members tended to have a more understanding of the ecological impacts of marine plastic pollution, including the potential harm to wildlife and ecosystems (Gall et al., 2015). This is because many stakeholders, such as academics and civil society involved in this study, had received formal education in relevant fields, such as marine biology and environmental science, which provided them with a strong foundation of knowledge when it comes to the plastic pollution phenomenon. In addition, other academic, civil society and governmental officials had hands-on practical experience in marine-related fields, including plastic pollution and having access to capacitating resources such as workshops, professional networks and scientific journals.

While on the other hand, non-experts such as recreational users and tourism operators, seemed to have less technical knowledge about the issue and were less aware of the ecological impacts of marine plastic pollution. However, this lack of awareness did not necessarily equate to a lack of concern particularly. While the non-experts did not demonstrate the same level of in-depth knowledge as the other stakeholder such as academics, they often still exhibited very strong concern about the broader ecological impacts of marine plastic pollution. The reasons for this are multifaceted. For example, even if non-expert stakeholders lack expertise in the scientific and technical intricacies of ecological impacts, they can intuitively understand that plastic pollution has a negative impact on marine life and health. The visual impact of seeing marine wildlife being entangled or dying because of marine plastic pollution can evoke strong negative emotions from these stakeholders, thus reinforcing their concerns. Furthermore, media attention may have enhanced knowledge and concern among some of these groups. Exposure to grimy statistics and devastating imagery of marine plastic pollution in news articles, documentaries and social media campaigns may contribute to the heightened sense of concerns.

Economic impacts

The results highlight consensus amongst stakeholder groups regarding negative economic impacts. Most stakeholders concurred that marine plastic pollution drives up beach clean-up costs, has deleterious effects on recreational and tourism-related activities such as leisure boat trips and threatens the commercial fishing industry's viability. Furthermore, a substantial proportion of the stakeholders, particularly tourism operators and recreational users, perceived the economic impacts as moderate to highly severe. These findings are consistent with the literature records, which have reported that the economic sector bears high costs due to marine plastic pollution. According to estimates from a study done in 2010, the cost of cleaning the North Pacific Gyre between Hawaii and California alone was €317 million and coastal and beach clean-up costs of marine debris in the E.U. countries was €630 million (Goldstein, 2012). In South Africa, the Cape Town Council spent an average of R55 968 on beach clean-ups between 1992 and 1993 (Arabi and Nahman, 2020). The high level of awareness of the economic impacts of marine plastic pollution among the stakeholders can be attributed to the availability of instruments for measuring direct economic costs linked to the expenditure or borne by economic activities such as clean-up costs of beaches, costs of replacing lost fishing gears or damaged fishing boats or direct loss of income in marine tourism businesses such as leisure activities.

However, it is common practice to neglect less obvious indirect economic consequences such as loss of provisioning services like fish (Newman et al., 2015). This might be the reason why some stakeholders were unaware of the impact of marine plastic pollution on commercial fishing. Some stakeholders might not have taken into account the potential financial costs associated with fish quality loss or fish stock reduction from marine plastic pollution because such intangible impacts are difficult to conceive and measure. Depleted fish stocks or contaminated seafood due to marine plastic pollution can affect the food supply chain, negatively affecting fishers' livelihood and related industries, thereby reducing generated income. Glancing over these costs can severely underestimate the true costs of marine plastic pollution.

Social impacts

Social impacts were a highly contested category compared to ecological and economic impacts. Most respondents were aware of visual impacts such as the loss of natural beauty, the loss of livelihood opportunities and injuries to people. This is due to the fact that these societal impacts are observable. Visually, plastic contamination along the coast tends to discourage people from going to marine regions because the plastic-induced dirt evokes negative feelings (Beaumont et al., 2019; Hartley et al., 2015). Research conducted in Cape Town, South Africa, found that 40% of the foreign and 60% of the local tourists surveyed said that any type of marine litter would keep them from revisiting the beach (Arabi and Nahman, 2020). In terms of costs related to loss of livelihood strategies, many coastal communities that rely on fishing for subsistence tend to lose financial opportunities due to marine litter, which negatively affects the fish quality or kills them.

Regarding secondary externalities like disease outbreaks, the destruction of cultural heritage, and public health hazards, many stakeholders did not believe these impacts were linked to marine plastic pollution. Those who acknowledge these societal effects perceived them as less severe, except for the loss of cultural values that was rated very high. This is in line with previous scientific findings that show that marine plastic pollution's impacts on human health are poorly understood (Naidoo and Rajkaran, 2020; Vethaak and Leslie, 2016). For example, Hartley et al. (2015) reported that Europeans were quite concerned about the effects of plastic

pollution on marine habitats but less concerned about the effects on human health. Numerous factors may prevent various stakeholders from linking plastic pollution to deteriorating human health and disease outbreaks. For instance, even though professionals such as academics, members of civil society, and government officials might have heard about these social impacts, their perception of them as dangerous or even severe may be hindered by the level of empirical data supporting them. On the other hand, non-experts, such as recreational users, may not have heard anything about these impacts; thus, they cannot consider something a risk if they are unaware of it. This means that the exposure of knowledge or information to various stakeholders also contributes to the perceptions held by stakeholders. The heterogeneity in stakeholder responses highlights the need for tailored interventions that address specific concerns and priorities of different stakeholder groups. For example, policies that focus on reducing marine plastic pollution may be more effective in engaging and addressing the concerns of local fishers, while policies that target plastic packaging and consumption may be more relevant to consumers and industry stakeholders (Van der Werf et al., 2019).

Aside from the diverse range of stakeholders concerning social impacts highlighted in this study, it is important to highlight that many stakeholders were unaware of the social impacts of marine plastic pollution compared to the more acknowledged ecological and economic impacts. This finding is consistent with literature records (Aretoulaki et al., 2020; Pahl et al., 2020; Beaumont et al., 2019), which offer valuable insights into the underlying reasons contributing to this phenomenon. First, social impacts are rooted in the inherent complexity and multi-dimensionality—characteristics not customarily observed in the ecological and economic impacts. For example, the social impacts of marine plastic pollution encompass a wide array of dimensions, including changes in cultural practices, shifts in psychological values (such as a sense of restoration, e.g., feeling revitalized and refreshed) and alterations in community dynamics (White et al., 2013). These social impacts including psychological impacts such as negative emotions arising from marine plastic pollution are often nuanced, subjective and deeply intertwined. This implies that different stakeholders may have multifaceted perceptions regarding them depending on various factors such as their social context.

Less tangible impacts, are more challenging to fully grasp, assess, and quantify than tangible impacts, making them susceptible to being overlooked or undervalued compared to the more quantifiable ecological and economic impacts (Chapter 3). Moreover, social impacts tend to manifest at the local or community level, contributing to their limited visibility on a larger scale. While ecological and economic impacts can reverberate widely and draw attention due to their more obvious and tangible effects, the social ramifications of plastic pollution tend to be confined to specific locals or communities. This localized nature of social impacts can result in their omission or underestimation in broader discussions and debates, as they may not capture the attention of decision-makers or the public beyond those directly affected.

Moreover, unlike the more immediate and visible ecological and economic impacts, social impacts tend to unfold gradually, taking time to become apparent (Arulnayagam, 2020). As a result, this delayed emergence can lead to prioritizing urgent ecological and economic concerns, leaving the social dimensions being overshadowed or considered a less pressing challenge. Consequently, the time-sensitive nature of decision-making and policy formulation may inadvertently neglect the long-term social impacts of marine plastic pollution. Another key factor in neglecting social dimensions is prioritizing economic development and environmental conservation over social concerns. Economic growth and environmental sustainability are frequently prioritized in many spheres of policy and decision-making spaces such as global and National initiatives such as UNCLOS, with social dimensions receiving comparatively less attention, resources, and policy emphasis. This further perpetuates the marginalization of social impacts and reinforces their underrepresentation in discussions surrounding marine plastic pollution among the stakeholder groups.

4.6 Conclusions

This research examined the perceptions of multiple stakeholders regarding the adverse ecological and socio-economic impacts (encompassing socio-cultural) impacts of marine plastic pollution in a South African context. First, it was observed that nearly all the stakeholders were generally more aware of immediate, visible, and easily measured ecological impacts, such as ingestion and entanglement of marine plastics, than secondary and intangible impacts such as loss of biodiversity and changes in marine habitat. From an economic impact perspective, the stakeholders were able to identify these impacts because they are ascribed to a

market value. The findings also show that noticeable social impacts, such as unsightly environments, were recognized by stakeholders compared to invisible impacts, such as loss of cultural significance and public health risks. Altogether, the ability of stakeholders to identify the visible impacts can be linked to the dominance of the resource valuation paradigm that is linked to the quantification of benefits. However, the less recognizable impacts of marine plastic pollution are also associated with ecosystem benefits such as the ability of a marine ecosystem to provide food, good health and overall human wellbeing. Going forward, in-depth research is needed to investigate, in detail, the “*invisible sociocultural impacts*” of marine plastic pollution across a stakeholder gradient to fully account for the adverse impacts.

In addition, this study indicates that various stakeholder groups might hold diverse and divergent views on marine plastic pollution impacts. Thus, there is a need to consider how these divergent views may influence policymaking and how advocacy for addressing marine plastic pollution is approached. For example, if people have negative perceptions about marine plastic pollution, does it necessarily translate to active engagement in tackling the issue. Stakeholder representatives may enable collaboration, contribute knowledge, advocate for change, and assist with implementation which makes them crucial while trying to reduce marine plastic pollution. Stakeholders can create and put into action practical solutions that safeguard marine ecosystems and lessen the negative effects of plastic pollution on our oceans by collaborating. Therefore, more studies are required to study marine plastic pollution from a human dimension context.

CHAPTER 5

SYNTHESIS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

Marine plastic pollution and its adverse impacts on marine ecosystems and human well-being is a cross-cutting issue that requires immediate action to mitigate impacts. Despite recognition that marine plastic pollution is a cutting-edge issue, however, very limited research looks at marine plastic pollution from a socio-dimension-cultural standpoint. Consequently, this thesis explored the complex social dimensions of marine plastic pollution, encompassing an in-depth exploration of the sociocultural impacts it exerts on people, as well as an assessment of stakeholder perceptions regarding its negative impacts on ecosystem services and human well-being. This chapter synthesizes the findings and suggests strategies for managing marine plastic pollution and mitigating its adverse impacts on diverse stakeholders in South Africa. In addition, the chapter highlights future research needs for a more comprehensive and improved understanding of marine plastic pollution.

5.2 Summary of key findings

- Chapter 3 stresses the importance of understanding and addressing the socio-cultural impacts of marine plastic pollution. It argues for a balanced approach that considers ecological, economic, health and socio-cultural dimensions, spatial and temporal scales, and social-economic contexts when assessing the impacts of plastic pollution on human well-being. This requires the integration of diverse impact assessments into marine ecosystem-level management frameworks to fully appreciate the costs on human well-being and align interventions with people's needs views and experiences.
- Chapter 4 highlights that stakeholders are more aware of immediate and visible ecological impacts of marine plastic pollution than secondary intangible impacts such as loss of biodiversity, loss of cultural identity and heritage and destruction of marine habitat. Stakeholders are also more likely to identify economic impacts related to market value than indirect ones. Social impacts including unsightly environments are easily recognized, but less noticeable impacts like loss of cultural significance and

public health risks need further research. The study stresses the need to account for social impacts across a stakeholder gradient and to consider diverse stakeholder views when developing policies and advocacy efforts to address marine plastic pollution.

5.3 Implications of the findings

Overall, the findings suggest that South Africa lags behind developed countries in studying the impacts of marine plastic pollution on ecosystem services. Financial limitations, scarce resources, low ocean literacy, and lower prioritization, among others discussed in this thesis compared to other environmental issues, probably contribute to this gap. Most studies in this field focus on measuring the amount of plastic debris and its effects on ecological systems, while insufficient research on the social impacts is available. This means that the full extent of the effects of marine plastic on social systems and ecosystem benefits is not recognized. Therefore, the full costs are not fully appreciated.

Another important insight from this study relates to a dearth of foundational understanding of marine plastic pollution, from how it is defined to the conceptualization of adverse impacts. A flawed understanding of marine plastic pollution and its adverse impacts can result in misguided mitigation efforts. For example, failing to capture perceived intangible impacts, such as socio-cultural impacts, rather than direct impacts such as ecological impacts, may result in a lack of prioritization of those impacts neglected or not prioritized when drafting policies, resulting in an underestimation of the full suite of costs of marine plastic pollution to human well-being. Further, a weak conceptual framing of marine plastic pollution impacts implies that there can be miscommunication among stakeholders and thus impede an opportunity to enhance institutional capacity, raise public awareness and involvement and encourage behavior change. Therefore, this study's attempt to shed light on the complexities surrounding the conceptualization of this problem and possible avenues for framing marine plastic pollution and its impacts provides the first step in addressing the impacts of marine plastic pollution. By identifying and discussing these intricacies and proposing alternative strategies for conceptualization, the study paves the way for future research to provide a more holistic understanding of this critical environmental challenge.

The findings also indicate that multi-stakeholders hold varying and divergent views concerning the negative impacts of marine plastic pollution. Such a broad spectrum of perceptions can profoundly influence how the severity of impacts is perceived. Simply put, diverse perceptions can lead to contestations and, in worst-case scenarios, negatively influence the will to address this environmental and social concern. As a result, to tackle this issue effectively, it is essential to engage in a transdisciplinary stakeholder consultation process that considers the diverse perspectives of individuals and groups from a horizontal and vertical scale, including local, regional and global levels. By involving stakeholders with different socio-demographics, cultural identities, values and knowledge systems, the adverse impacts of marine plastic pollution, including who bears the costs can be better conceptualized.

Following this approach can enable crafting of more inclusive, effective, and equitable interventions, taking into account the unique circumstances and needs of all stakeholders. Adverse impacts of marine plastic pollution that manifest in specific community level such as social impacts including loss of heritage values but do not necessary reflect at a large-scale context can be better captured when all the stakeholders are integrated in the process of coming with concerted efforts to address the issue. This will require a collaborative effort involving governments agencies, NGOs, academic institutions, and the private sector to pool together knowledge and expertise and work towards a common goal of reducing marine plastic pollution and mitigating its impacts. The value of stakeholder engagement in marine plastic pollution is also exemplified by the recognition that plastic pollution is not an issue only in marine setting, but the land-based sources of plastic are huge contributors to marine plastic pollution. In this context, engaging with actors beyond marine space becomes crucial for crafting effective plastic waste management strategies that can minimize the movement of plastic from land to marine systems. Taken together, a multi-stakeholder approach to understanding marine plastic pollution and its impacts can provide a better understanding of the complex interplays between marine plastic pollution and human well-being, needed to design effective and meaningful interventions. In essence, with consideration of diverse stakeholder perspectives, we can unlock the potential of capturing the full spectrum of impacts.

5.4 Future research needs

Future research in South Africa can increase the scope of the research field by increasing the sample size of marine stakeholders to strengthen the validity of this thesis' conclusions. This can be accomplished by identifying appropriate stakeholders at various levels, such as global initiatives cascading down to regional, national, subnational, and local/community contexts. Adopting a monitoring and evaluation plan that may be done on a six to yearly basis may be appropriate to guarantee that stakeholder viewpoints are addressed equitably and that there is fairness. The evaluation findings will be used to improve stakeholder participation in the mitigation activities planned. Many stakeholders will ensure that diverse perceptions of stakeholders are well captured. In addition to incorporating stakeholder perceptions more, future research should pay more attention to social impacts, including mental health effects, social cohesion, and lifestyle impacts in the face of marine plastic pollution. Other studies may extend the simplified framework provided in this study by integrating other layers, such as ecological and economic impacts. Furthermore, case studies can be done to verify the framework's practicality and refine it as needed. By putting this conceptual framework into practice, scholars will be able to obtain practical insight into its efficacy and indicate areas for improvement.

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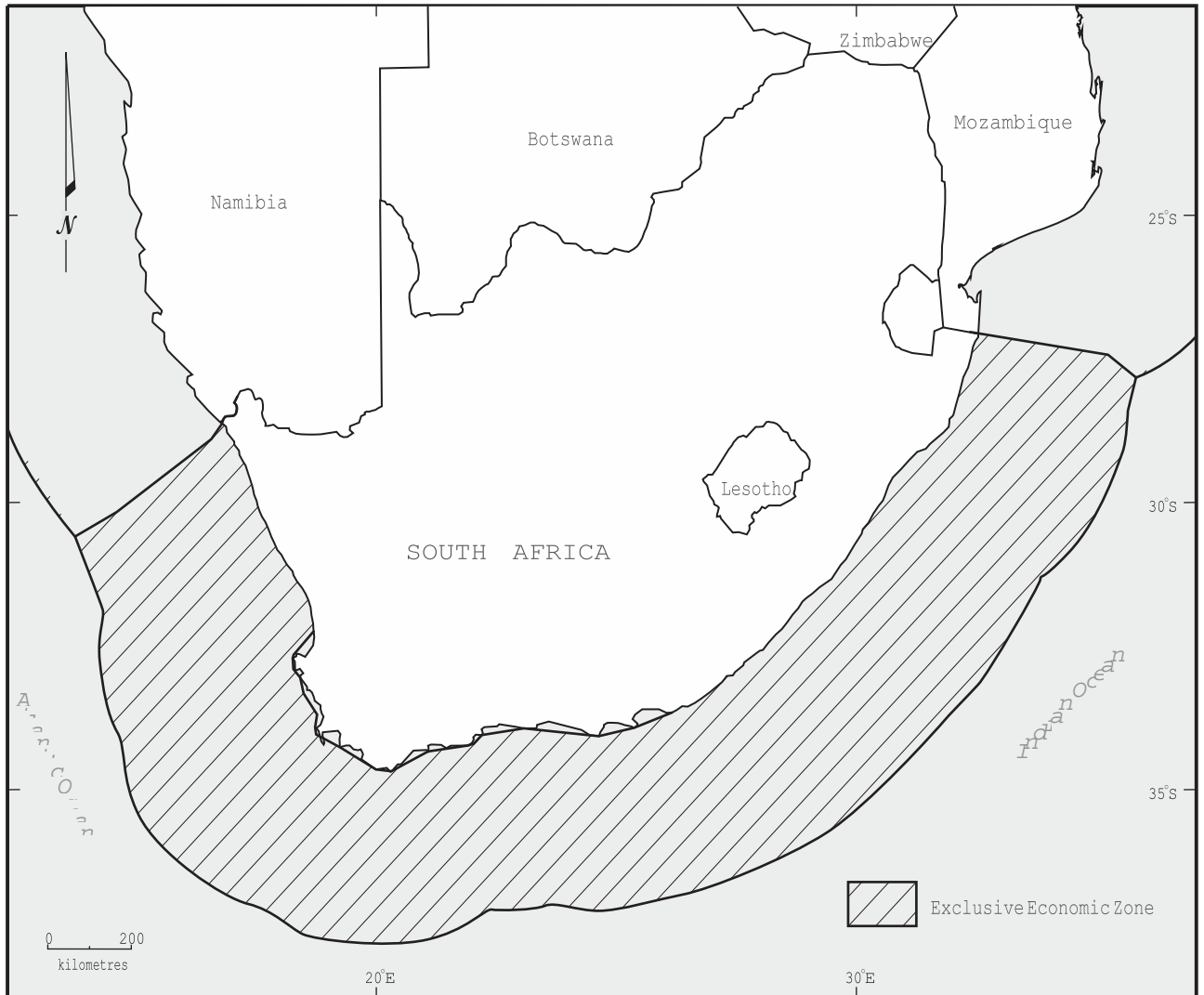
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APPENDICES

APPENDIX 1: SOUTH AFRICAN EXCLUSIVE ECONOMIC ZONE



APPENDIX 2: ETHICAL APPROVAL CONFIRMATION LETTER



Rhodes University Human Ethics Committee
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t: +27 (0) 46 603 7727
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e: s.manqele@ru.ac.za
NHREC Registration number: RC-241114-045
<https://www.ru.ac.za/researchgateway/ethics/>

08/06/2021

Papama Yose

Email: g16y5876@campus.ru.ac.za

Review Reference: 2021-5106-6125

Dear Mr Papama Yose

Title: Marine plastic debris impacts on ecosystem services and the economy in South Africa: Stakeholder perceptions and potential interventions

Principal Investigator: Prof Gladman Thondhlana

Collaborators: Mr. Papama Yose, Prof Gavin Fraser

This letter confirms that the above research proposal has been reviewed and **APPROVED** by the Rhodes University Human Ethics Committee (RU-HEC). Your Approval number is: 2021-5106-6125. Approval has been granted for 1 year. An annual progress report will be required in order to renew approval for an additional period. You will receive an email notifying you when the annual report is due.

Please ensure that the ethical standards committee is notified should any substantive change(s) be made, for whatever reason, during the research process. This includes changes in investigators. Please also ensure that a brief report is submitted to the ethics committee on the completion of the research. The purpose of this report is to indicate whether the research was conducted successfully, if any aspects could not be completed, or if any problems arose that the ethical standards committee should be aware of. If a thesis or dissertation arising from this research is submitted to the library's electronic theses and dissertations (ETD) repository, please notify the committee of the date of submission and/or any reference or cataloging number allocated.

Sincerely,

Prof Arthur Webb

**Chair: Rhodes University Human
Ethics Committee, RU-HEC** cc: Mr.
Siyanda Manqele - Ethics Coordinator

- Marine conservation
- Small scale fisher
- Subsistence fisher
- Commercial fisher
- Recreational user (such as walking on the beach)
- Tourism operator
- Other (please specify):

4. Think about the negative impacts of marine plastic pollution on the marine environment. From the table below state which ecological impacts you aware of by selecting (Yes), (b) think they are not associated with marine plastic pollution by selecting (No) and (c) you not sure or do not know of by choosing (I do not know).

(A) Ecological impacts

Ecological impacts	Yes	No	I do not know
Entanglement of marine species (such as seabirds, penguins, sea turtles, etc.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ingestion of plastic by marine species	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Introduction of invasive species as plastics transport marine animals, plants, and microbes across oceans	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Change of the marine habitat (e.g., composition) for example, by changing physicochemical water quality (e.g., alkalinity, oxygen levels, pH and others)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Reduce species richness	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Decline in biodiversity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Behavioural changes in marine organisms	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Reproductive issues in marine wildlife	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Blockage of intestinal tracts	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Decrease in fish quantity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Death of marine mammals	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Leach of contaminants of plastics to marine organisms	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Any other comments:

.....

5. Please rate each one in terms of the severity at which you generally experience it or perceive it. (Please use a five-point scale: very low (1); low (2); medium (3); high (4); very high (5)) Note: Only rank those impacts you are aware of. Ecological impacts	1	2	3	4	5
Entanglement of marine species (e.g., seabirds, penguins, sea turtles, etc.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ingestion of plastic by marine species	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Leach of contaminants of plastics to marine organisms	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Introduction of invasive species as plastics transport marine animals, plants, and microbes across oceans.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Change of the marine habitat (e.g., composition) for example, by changing physicochemical water quality (e.g., alkalinity, oxygen levels, pH and others)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Reduce species richness	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Social impact	Yes	No	I do not know		
Health complications to humans (e.g., fertility issues and cancer)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Diseases outbreak (e.g., dengue fever, malaria and encephalitis)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Injuries or loss of lives to humans	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Loss of cultural heritage	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Loss of aesthetic or natural beauty	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
May result in loss of livelihood strategies (e.g., fishing)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Decline in biodiversity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Behavioural changes in marine organisms	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Reproductive issues in marine wildlife	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Blockage of intestinal tracts	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Decrease in fish quantity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Death of marine mammals	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Any other comments

.....

.....

.....

7. Please rate each one in terms of the severity at which you generally experience it. (Please use a five-point scale: very low (1); low (2); medium (3); high (4); very high (5))

Note: Only rank those impacts you are aware of.

Social impact	1	2	3	4	5
Health complications to humans (e.g., fertility issues and cancer)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Diseases outbreak (e.g., dengue fever, malaria and encephalitis)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Injuries or loss of lives to humans	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Loss of cultural heritage	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Loss of aesthetic or natural beauty	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
May result in loss of livelihood strategies (e.g., fishing)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

C. Economic impacts

8. Think about the negative social impacts of marine plastic pollution on the marine environment. From the table below state which economic impacts (a) you aware of, (b) think they are not associated with marine plastic pollution and (c) you not sure or do not know of.

Economic	Yes	No	I do not know
A decline in commercial fishing sector	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
High clean-up costs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Adversely affects the recreation and tourism sector	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Any other comments

.....

Please rate each one in terms of the severity at which you generally experience it or heard of it. (Please use a five-point scale: very low (1); low (2); medium (3); high (4); very high (5))

Note: Only rank those impacts you are aware of.

Economic impact	1	2	3	4	5
A decline in commercial fishing sector	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
High clean-up costs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Low recreation and tourism potential	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Any other comments

.....
.....
9. How has marine plastic pollution impacts has affected you or the organisation you work for?

How do you or your organisation cope with the impacts of marine plastic pollution?

10. What form of interventions do you think can be used to address marine plastic pollution impacts?

11. Thinking about the marine plastic debris found in marine environment please choose from the land-based sources below where do you think these plastics come from.

- Landfills
- Harbours and ports
- Private households
- Coastal areas/ Beaches
- Illegal dumping
- Supermarkets
- I do not know

Other (please specify):

Comments

Thinking about the marine plastic debris found in the marine environment, please choose from the marine-based sources list below where you think these plastics come from.

Recreational boats

Fishing boats

Aquaculture

Shipping ships

Commercial fishing

Illegal dumping

I do not know

Other (please specify):

Comments

Section B: RESPONDENT PROFILE

12. Age:

13. Gender: Female Male non-binary Prefer not to say.

14. What is your home language? Choose a language

15. What is your highest level of education?

- None Primary education Secondary education
 post-secondary Tertiary education

Do you belong to any environmental organisation? Yes No

If yes, please state the name

16. What is the biggest source of household income?

- Wage(s) Social grant(s) Private pension(s) Own business(es)

17. Please indicate the broad range of the household income (in Rands)

< R2 000

R 2001- R6 000

R 6001- R15 000

R15 001- R30 000

> R30 000 If you will like any update on this project, please leave an email address:

END OF SURVEY. THANK YOU!!!

APPENDIX 4: LIST OF STAKEHOLDERS REPRESENTATIVES THAT PARTICIPATED IN THE RESEARCH

The names of the stakeholders' representatives have been omitted due to the POPIA Act

	Position	Institution/ Organization
Academics		
	Professor at Rhodes University	Department of Ichthyology and Fisheries Science
2	SARCHI Research Chair in Marine Biology at Rhodes University	Department of Zoology and Entomology RU
3	Professor at University of Cape Town	FitzPatrick Institute of African Ornithology UCT
4	Marine biologist at SAIAB	The South African Institute for Aquatic Biodiversity
5	Associate Professor at UWC	University of the Western Cape
6	Marine economist and Capacity Development Coordinator	University of Wollongong Australia
7	PhD candidate at SAIAB and student representative at SANCOR	The South African Institute for Aquatic Biodiversity
Government officials		
8	Senior Environmental Health Practitioner	Ndlambe Municipality
9	Marine Biologist	Department of Agriculture, Forestry and Fisheries
10	Marine inspector	Department of Agriculture, Forestry and Fisheries
11	Supervisor of a maritime museum	Port Natal Maritime Museum
Civil Society		
12	Marine educator	Sustainable Seas Trust
13	Environmental Specialist	Transnet National Ports Authority
14	Associate Expert, Waste and Marine litter	Undisclosed
15	Senior Consultant Marine ecosystems	Anchor
16	Marine and fisheries scientist / consultant	CapMarine / CapFish cc
17	Marine and fisheries scientist / consultant	CapMarine / CapFish cc
18	Sustainability Manager	Plastic SA
Fisheries		
19	Coastal Seabird Project Manager	Seabirds
20	Executive Secretary of a Fishery Association	Undisclosed
21	Commercial fishing	Undisclosed
22	Commercial fishing	Undisclosed
23	Small-scale fisher	Small Scale Fisheries co-operative
24	Director in fishing co-operative	EkuPhumleni Kenton-on-Sea Corp
Tourism operator		
25	Marketing- Sunshine Coast Tourism	N/A
26	Recreational Boat Cruiser	Recreational Boat Cruiser
27	Own recreational boat cruiser	N/A
28	Charter boat owner	Blackfish Charters
29	Nifty Boating owner	Nifty Boating
Recreational users		
30	Technician	Undisclosed
31	Graphics Design and Development- ICT	Undisclosed

32	Marine Geologist	Undisclosed
33	Academic	University of South Africa
34	Full-time volunteer	Wildlife Rehabilitation Centre
35	Physiotherapist	Undisclosed

To the participants I will be forever grateful for your insight and willingness to participate in this study!!