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Material politics of plastic at the Environment Agency Austria

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Acknowledgments

Conducting and writing this master thesis has been a professional and personal journey for me. I travelled from the natural to the social sciences and have explored my own personal character as a social science researcher. As in every journey, there were difficult times, when you believe the least in yourself and cannot see beyond that moment. Through this journey there were people who supported me in the good times, the bad times and all the in-between.

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How plastic are *your* realities?

Contents

1. Introduction

This thesis tells a story about the material politics of plastic at the Environment Agency Austria, a story in which materiality and politics are intertwined. Perhaps when one sees the words environment and plastic in the same sentence the first image that comes to mind is plastic pollution in the sea. In the past few years there has been an increasing awareness of plastic items and plastic fragments in the world's oceans. Multiple pictures of bottles, toothbrushes, bags and fishing nets, entangled with fish, birds, seals and turtles. Plastic pollution in the ocean becomes a problem and I would only need to show a picture "to prove" that; I doubt that anyone would disagree. On a political level, plastic pollution in the aquatic environments has been discussed through multiple campaigns and initiatives targeted at tackling this issue. However, no matter how important the issue of environmental pollution is, there is so much more in the world of plastic. Plastic is an integral part of our contemporary economy, a valuable material, which has its own socio-material history. Therefore, plastic is not *just* a material, but it has and creates its own socio-cultural meanings as it circulates in the material world.

Plastic has a short history of a bit more than a century, but it has taken over almost every aspect of living. Just think of how much plastic you encounter in a day, in the workspace, in the bus, in your kitchen, your bathroom, in the kindergarten, in the hospital, at a bar, in the supermarket or your local store. Your phone, your shoes, your fridge, your clothes, your pens, your glasses, your car and your bike all contain some parts made of plastic. Is this not striking? Is it not striking that it is hard to imagine a wold without plastic? Can you imagine a laptop without plastic? The world without plastic existed not so long ago, but it is the pervasiveness of plastic that has made it ubiquitous. Initially, plastic was made to mimic other materials, such as ivory, but it was after the Second World War that plastic expanded. Electronics boomed with plastic. Similarly, kitchen appliances, telephones, and cameras were all made with plastic. Plastic became part of everyday life the way we know it today, in what has been named as the 'Plastic Age' (Yarsley & Couzens, 1945).

Therefore, plastic is not just pollution in the environment, but at the same time it is a valuable material of industrial societies, which is very intertwined with how we experience and live our lives. Modern western medicine cannot be imagined without plastic, and it is the same plastic that is found on a beach. The durability of plastic makes it an excellent material to use, but it also challenges its degradation. In the past years, there have been many discussions about how we want to live with plastic and these discussions have strong regulatory implications. If we want to rethink how to live with plastic, we need new regulatory frameworks that restrict this material to the places and uses that we deem beneficial and desirable. The EU Plastics Strategy (European Commission, 2018a) published in January 2018 reflects the

ongoing regulatory discussions on plastic and the urgent need for action. But what needs to be regulated about plastic? Do we regulate objects, chemicals, and or waste? What does it mean to regulate a material?

In order to understand what plastic is and what plastic can do, Science and Technology Studies (STS) scholars (De Wolff, 2017; Gabrys, Hawkins, & Michael, 2013; Hawkins, 2010; Liboiron, 2016) have engaged in research on this material with a particular focus on the materiality of plastic. It is through its materiality that plastic challenges conventional conceptions of regulation. The materiality of plastic is being described as a *process*, which therefore is not stable, nor a fact, but is negotiated and enacted in a given setting with different actors (Gabrys et al., 2013). This means that plastic is not singular, but multiple. The realities of plastic are created through the socio-material gatherings of human and nonhuman actors. Therefore, the material politics of plastic are the ways in which plastic becomes political in these gatherings through the negotiations of its materiality. Plastic becomes political not only because it becomes a subject in human politics, but also because it participates, it becomes political through its material existence which is enacted in unpredictable ways (Hawkins, 2009a, 2010). Plastic becomes a matter of concern (Latour, 2004b).

In Austria, plastic in the environment became an issue of concern after a study identified plastic particles in the river Danube in 2014. The issue created media and political attention and the Federal Ministry of Agriculture, Forestry, Environment and Water Management asked the Environment Agency Austria (EAA) to take up this issue of plastic in the Danube and report on the current state of the environment and further recommendations for appropriate steps to address the issue. The EAA is an organization that works on policy consultancy, but at the same time has research projects on certain topics, such as microplastics. In other words, the EAA can be described as a boundary organization (Guston, 2001) working at the intersection of science and policy. Although plastic in the Danube was the initial point of work of the EAA on plastic, they have since expanded their projects dealing with plastic to multiple aspects. They do not work only locally in Austria, but actively participate and organise further dialogue on plastic at the European level.

This thesis asks *how does plastic become a matter of concern in the EAA?* This means exploring how this material is problematized, discussed and negotiated in the work of the EAA, in their practices from their work in the laboratory to their policy recommendations and stakeholder discussions. I follow plastic, in this thesis, through the theoretical lens of post-Actor Network Theory (ANT) to approach reality as enacted and performed; reality does not exist somewhere independent of us and the materials around us, but it is done in the practices of relating humans and nonhumans (Law, 2008; Mol, 1999 and for an overview Michael, 2016). This theoretical framing has shaped this thesis, both conceptually but also practically. It did not only change how I conceptualised plastic, but also how I followed and researched plastic in practice.

It allowed me to focus on the materiality of plastic and follow it as it was being enacted as a matter of concern at the EAA.

To follow plastic in the work of the EAA, I conducted four interviews with people working at the EAA on plastic and discussed their work and the different practices they engage in, from writing reports to rethinking laboratory techniques. Additionally, I analysed reports that the agency published on the topic of plastic and microplastic. All materials were analysed with Situational Analysis (Clarke, 2003) which provides tools to bring together materials from different sources, but also to place nonhumans and humans together and draw their relations through mapping techniques. By engaging with the material politics of plastic at the EAA and by following the materiality of plastic, this thesis not only contributes to current normative and scholarly debates on plastic, but it also pushes the way to approach plastic further in its complexity and to think of new ways of living and regulating plastic as a material of our contemporary societies.

This thesis is structured in seven parts: the (1) introduction, (2) the state of the art, (3) research questions, (4) theories and sensitising concepts, (5) methodology and materials, (6) empirical results and (7) conclusions. The state of the art outlines the three larger areas of scholarly discussions that this work relates to but is not limited to academia. The first part of the state of the art is dealing with what it means to live with plastic and it begins with a historical perspective on plastic, in order to sketch the background on which this work unfolds. Subsequently, I describe the current approaches to plastic from an STS perspective, which is the core body of literature this thesis is situated within and hopes to contribute towards. The next section of the state of the art explores the question of categorisation, as it matters a lot in the context of exploring plastic as an environmental issue. It deals with what categories mean and what classification practices do from an STS perspective, but also with the current debates on the classification of plastic and microplastic in natural science literature and policy. The last part of the state of the art discusses the regulation of plastic. It outlines the current regulatory actions on plastic mainly within the European Union (EU), but it also positions what it means to regulate plastic as a material in relation to STS literature on regulating chemicals, objects and materials. This last part of the state of the art also discusses how I perceive the EAA as an organisation theoretically and why it matters for this thesis.

After the state of the art, I outline my research questions (Chapter 3) and following, I discuss the theoretical and conceptual underpinnings of this work (Chapter 4). I give a short overview of ANT and its initial departure points, its criticism, but most importantly its development to late ANT, or post-ANT, and how this theoretical focus helps me to explore the materiality of plastic at the EAA. I also discuss the concepts of what is a matter of concern and how the concept of multiplicity is used for this thesis. Additionally, I discuss what it entails to do research on the material politics of plastic and what political

means for this research. Chapter 5 describes the materials I used for this thesis, the methodology for analysing the materials, and also the ethical implications of my research.

In Chapter 6 I present my empirical results. I start by telling the story of plastic in the EAA, but also beyond, through the EAA in the broader European discussions. After, I engage with the multiplicity of plastic following its material properties. I describe the different *gatherings* of plastic, or what I call *sites of concern*: the environment, the cosmetics industry, the waste management, the plastics industry and the economy. These are socio-material arrangements in which the material properties of plastic are enacted as matters of concern in the relations formed between human and nonhuman entities. I continue with discussing the need for a definition of microplastics, its importance, but also how the materiality of plastic is complicating this definition. In the last subchapter of my results, I describe how plastic becomes a concern because it is visible and invisible at the same time. I discuss how plastic becomes visible pollution, but through its small size and ability to mimic other materials becomes invisible to the human eye, raising concerns about where it could potentially end up but cannot be seen. The conclusion (Chapter 7), discusses these results and connects them with the debates outlined in the state of the art, and also includes discussions on a theoretical and normative level. I discuss the implications of living in a multiple world with plastic and what the practical implications of acting and regulating in a multiple world mean, but also how can others practicing multiplicity inspire STS in practice.

2. State of the Art

In this state of the art, I provide the reader with an overview of the current scholarly discussions on plastic in society and the environment. This literature review is based on social science and Science and Technology Studies (STS) literature woven together with literature from the natural and environmental sciences. Additionally, the current regulatory discussions on plastic are discussed considering the provided social science perspectives for the unpacking of plastic in society. I open this chapter by reflecting on what it means to live with plastic and I give a short history of plastic in the development of the 'Plastic Age' (Yarsley & Couzens, 1945). In the next paragraphs, I do not aim to provide a linear nor complete history of our plastic age, but rather a precedent for understanding the historical socio-cultural existence of plastic which is crucial in order to situate plastic in the present. I continue with how STS scholars have approached plastic and how they have studied plastic from a social science point of view. The following subchapter deals with the classifications of plastic and microplastics, by rendering together key STS literature on classifications practices with current discussions on the categorization of plastic and microplastics. The last subchapter discusses the importance of regulating nonhuman entities from an STS point of view, as well as the ongoing regulatory discussions around plastic. These strands of literature are important for this thesis

since they outline the debates related to this work and provide a background on which this thesis will unfold and will ultimately contribute to.

2.1 Living with plastic

2.1.1 The plastic age

"Try to imagine a world without plastic. At first it seems easy. Lots of things could be made of other materials . . . few of the objects we use daily would remain unchanged. Some would be impossible. We would inhabit a different world, parallel perhaps, but certainly not the same place." (Meikle, 1995, p. XIII)

We live in a time referred to as the 'Plastic Age'; everyone is acquainted with the terms 'Stone Age', 'Bronze Age' or the 'Iron Age' which refer to the most ubiquitous material used in these prehistoric times (Thompson, Moore, vom Saal, & Swan, 2009). The keyboard I am writing with now is made of plastic, the chair I am sitting on, the bottle I am drinking from, the seats at the tram I used this morning, all have plastic parts; one needs to carefully look around them to realise that plastic is part of our life. Materials like natural rubber have been used since ancient Greeks and Egyptians, but the first material recognised as plastic was celluloid (Bijker, 1987). This material was made from cellulose, a compound extracted from plants, such as cotton, and processed with other chemicals to make celluloid. Celluloid was made at the end of the 19th century and in its initial steps, it was a material of imitation and an excellent substitute for natural materials such as ivory. In contrast to such natural materials, celluloid was easily melted and able to take different shapes and colours. Interestingly, at that time, celluloid was not marketed as an innovative new material, but rather as a perfect mimic of other natural materials (Meikle, 1995).

The first fully synthetic plastic was Bakelite. Celluloid was not a fully synthetic material, since its base was cellulose which is extracted from plants. Bakelite, also referred to as the first plastic, was named after the chemist Baekeland, who invented it in 1907. Bakelite was the first plastic made solely with the tools of chemistry and initially was also used as a substitute for natural materials, such as hard rubber (Meikle, 1995). Bijker (1987) describes *The Social Construction of Bakelite*, in other words, by seeing Bakelite as an innovation. In this text the author discusses the choreography of social groups and historically situated technological frames that orchestrated the making of Bakelite. The histories of plastic materials have strong ties to the manufacturing industry. Baekeland, for example, was an industrial chemist, and indeed most plastics[1] were manufactured in the industrial context. More importantly, they were also promoted by the industry in ways that reflected the socio-cultural position of plastic at the time (Bensaude-Vincent, 2007).

[1] The plural plastics, instead of the singular plastic, is used where I want to refer to many types of plastic or many items made of plastic.

Although both materials -Celluloid and Bakelite- were initially used as substitutes for natural materials, it was after 1920 that the promotion and advertising of these plastics changed. There were not just the cheap alternatives of natural materials- they were an innovation. They "signified greater human control over nature" (Meikle, 1995, p. xiv). John Kimberly Mumford (1924) writes in the *Story of Bakelite,* "It is not sufficient to say, as chemists do, that "Bakelite is a resin formed from equal parts of formaldehyde and phenol, in the presence of a base, by the application of heat." It is more than that. It is a wonder-stuff" (p.7). Plastic adhered to the desires of the modern man and woman; it provided thousands of possibilities, shapes and colours. It was not just a substitute for natural materials; it was an improvement over the natural (Meikle, 1995). Plastics were promoted as democratising consumption. They were cheap and accessible, and at the same time, helped in the conservation of nature by using less natural resources (Bensaude-Vincent, 2007). They were an industrial success, which indeed shaped the 20th century but also the world as we know and experience it today.

The post-war era signified the mass production of plastic items used in everyday life. Plastic could be molded and could give shape to items beyond natural materials for which they were meant to substitute. Yarsley and Couzens (1945) write about the future 'plastic man' that lives in what they call the 'Plastic Age': "As he grows he cleans his teeth and brushes his hair with plastic brushes, clothes himself within plastic clothes, writes his first lesson with a plastic pen and does his lessons in a book bound with plastic." (p.149). Perhaps this sounds too familiar for us now, since we indeed live in the 'Plastic Age'. It was in 1979 that the polymer material industry in the U.S. announced the entering into the 'Plastic Age'. 1979 was the year when the annual production of plastic overtook the production of steel. Plastic played an essential role in industries such as automotive and electronics by replacing wood and metal, helping to lower energy demands (e.g. plastic parts in aeroplanes are lighter) and due to its excellent electrical insulation properties, plastic played a crucial role in the development of electronics and telecommunication devices (Meikle, 1995).

Indeed, today it is not hard to see and experience the ubiquity of plastic. "[M]ore than a substance, plastic is the very idea of its infinite transformation; as its everyday name indicates, it is ubiquity made visible." (Barthes, 1972 [1957] p.92). The plasticity of plastic was what made it such a successful innovation, when compared to firm and inflexible natural materials. Plastic not only took over other materials, but it also multiplied the items an everyday person would use and posses. Together with this plethora of items, and epitomized by plastic, the "culture of the disposable" arose as a "characteristic of the second half of the twentieth century" (Bensaude-Vincent , 2007, p.5). Around mid-century the accumulation of plastic became visible and during the 1970s environmental concerns about the issue emerge. This was the time when the first reports about plastic in the digestive systems of seabirds and marine animals were published, and concerns over the chemicals contained in plastic were voiced

(Thompson, Swan, Moore, & vom Saal, 2009). Since the 1970s, the production of plastic has almost tripled and the environmental concerns about them have also grown, making them a true matter of concern.

There is a paradoxical feature of plastic. It is a success and a threat at the same time. This paradoxical feature is captured in the personal story written by Jody Roberts (2010). The author describes themselves as a 'plastiphobe', a person who is aware of potential harms and toxic properties of plastic and actively avoids encounters with this material in everyday life. Roberts tells a story about their efforts to protect their unborn daughter from the toxicity of plastic. Surprisingly, it is the encounter of their newborn daughter with plastic that saves her life, in the form of tubes and plastic containers, since she was born with a respiratory issue. Although plastic embodied a potential hazard, at the same time it also saved their daughter's life. In my opinion, this story says much about the role of plastic in contemporary societies. On the one hand, through their *plasticity* they are a material and industrial success, but on the other hand, because of their *non-plasticity* (Davis, 2015) they accumulate in landfills and oceans, raising concerns about human and wildlife health and becoming a top environmental concern.

2.1.2 Approaching plastic

"[N]ew encounters, practices and natures emerge through material entanglements with plastics." (Gabrys et al., 2013, p.209).

Plastic can materialise in a myriad of objects, which have diverse chemical compositions and a variety of uses. Plastic has become invisible; one needs to carefully look around them to realise that plastic is part of our lives. There is a multiplicity of plastic, from the household to the workplace to the deep oceans; plastic has conquered our worlds. This multiplicity is very interesting from a social science perspective since it provides a range of cases in which to explore plastics' multiplicity. Furthermore, the materiality of plastic has drawn much attention. STS scholars have approached plastic as objects, as chemicals or as pollution in order to understand how this material is reconfigured in practice. To understand "when and how plastics as materials *become* political" (p.5, emphasis original) or in other words to unfold the *material politics* of plastic (Gabrys et al., 2013).

To approach materiality in such a way entails rethinking materiality and material properties as flexible, neither fixed nor stable. Materiality is being reconfigured in the practices and entanglements between humans and nonhumans[2]. Gabrys, Hawkins, & Michael (2013) describe the materiality of plastic as a *process*, which can be enacted and performed in diverse environments or as Shove (2015) puts it "the qualities of a material are not fixed or inherent: they are an outcome of the various product- or object-encounters through which the material is known." (p.39). Plastic is approached not as ontologically fixed

[2] This will be discussed further in the theories and concepts, chapter 4.

nor stable but enacted, which implies that plastics are not just objects or just materials, but they carry with them all of the sociocultural understandings of what plastic is and what it can do. There are many ways to study plastic: as a specific chemical, as an object, as the chemicals added on the plastic or as pollution in natural environments. In the next paragraphs, I will outline the different ways that STS scholars have approached plastics by exploring their *processual materialities*[3] (Gabrys et al., 2013).

Gay Hawkins has explored the *material politics* of the plastic water bottle to give accounts of how the plastic bottle is rendering the political, not as a passive entity, but through its material participation in markets and everyday life. Hawkins (2009) argues that the practice of drinking has been medicalised and politicised through and with the emergence of the plastic bottle, exemplifying the *politics of bottled water*. Looking at the plastic bottle as a form for packaging, Hawkins (2011) explores how the bottle participates in the creation of markets and publics from the petrochemical industry to advertisements. However, beyond the plastic bottle, other studies have also approached plastic as objects, such as plastic bags and plastic food packaging (Hawkins, 2001, 2009b, 2010, 2018), to unfold the socio-material underpinnings of plastic. Joe Deville explores the socio-material life of the credit card, whose plasticity, meaning its material arrangements, becomes entangled with the very idea of credits and dept. In a captivating account, McKay and Perez (2018) describe that when objects are made out of plastic they also carry the sociocultural connotations that accompany plastic. The object they follow is a backpack, the "the *pasiking* backpack" (p.2), made by indigenous Filipinos usually by materials such as rattan. The *pasiking* backpack is recognised as a form of indigenous art. The authors explore the making of this backpack with plastic or, to be more precise, with plastic waste. By using plastic, the identity of the object shifts from one that challenges hegemonic masculinities, through its bright colours, to one that comments on class and the local/global divisions. This shift happens with and through plastic as a material, which creates in the object its own "cultural potency" (p.16).

However, when plastic is approached by its specific chemical composition, new possibilities for researching this material arise. For example, the common plastic bottle is mainly made of polyethylene terephthalate or in short PET. The PET bottle is almost a symbol of single-use plastics, and as Hawkins argues, its disposability is not just happening after it is used, but it is inscribed in the form and chemical composition of the bottle (Hawkins, 2013; Hawkins, Potter, & Race, 2015). The PET bottle was "*made to be wasted"* p.50, Hawkins, 2013, emphasis original). The material properties of PET were crucial for the bottle to become "*made to be wasted".* The afterlife of the bottle was already inscribed into the material that the bottle is made of. Other scholars have also focused on the chemical composition or type of plastic rather than the object. In a more historical account, Susannah Handley (1999) writes about nylon in clothes

[3] Processual materiality is the understanding of materiality as a process

industry and fashion. The author describes that the use of nylon in clothing reconfigured the use of clothes in everyday life. It opened the possibility of owning many different clothes, but also wearing certain types of clothes and colours to specific events. Nylon enabled and rendered everyday clothing and fashion as we know it today. Another work that follows the chemical composition of plastic is that of Andrea Westermann's (2013) on vinyl. Vinyl is also known as PVC or polyvinyl chloride, and it is used in various applications, including food packaging. Westermann gives a historical perspective on vinyl in post-war Western Germany. The author describes how the material properties of vinyl, such as its malleability, enabled the creation of consumer democracy in Western Germany. On the other hand, due to the health risks it posed, it enabled the emergence of consumer activism, which actually challenged the very notions of Western Germany's consumer democracy.

PET, vinyl or nylon are all names that refer to what plastic is made of, its core polymer structure. However, most of the properties of plastic are due to added chemicals called, plasticizers, added on to its core polymer structure. Plasticizers give colour, flexibility or harness to plastic. There are thousands of plasticizers used nowadays, and most plastic manufacturers have formulas on their combinations of plasticizers used for different plastics and items. Although this thesis does not focus on plasticizers there is considerable work exploring these chemicals and their material relations to bodies, consumers, and also to regulatory agencies. Perhaps the most well-known plasticizer is Bisphenol A or BPA, which, due to its ability to mimic hormones, can be an endocrine disruptor. The use of BPA, and other endocrine disruptors, has triggered questions about human health and chemical exposure though everyday plastic objects, such as bottles (Andrady & Neal, 2009). Sarah Vogel (2012), by studying the discussions and entanglements of science, regulatory agencies and the industry, unfolds the difficulties of defining if, when, and to which degree is BPA safe. In addition, Brewer and Ley (2014) have focused on the positions that public actors take in controversial scientific discussions over BPA. So far, most of the literature approaches plastic as objects or chemicals, and always studying plastic in use, or plastic 'in place'. However, what about when plastic becomes "matter out of place" (Douglas, 1966): when it becomes pollution?

As described, it was not until the 1970s that environmental concerns about plastic arose (Meikle, 1995). Plastic is a very durable material -which is one of its successful features- but at the same time, it poses problems due to its accumulation in landfills, oceans, rivers or soil (Barnes, Galgani, Thompson, & Barlaz, 2009). Plastic can be found in places where it 'does not belong' such as the intestines of animals or the bottom of the ocean, which triggers questions about its use and end life. Plastic becomes a 'matter out of place' (Douglas, 1966); there are places where it belongs and places it does not. The famous anthropologist Mary Douglas describes that dirt is cultural; shoes with mud on them do not belong on the kitchen table but the floor. They become dirt on the kitchen table, because they are not 'in place'. Similarly, plastic in the form of a keyboard in a seminar room at the STS library of the University of Vienna is 'in

place', but plastic found in the stomach of a sea bass caught by a fisher on a Greek island is 'matter out of place', it is a matter of concern.

STS scholars such as Max Liboiron and Kim De Wollf have followed plastic as pollution in the ocean's gyres. They have both separately travelled with expeditions to the heart of the ocean's gyres to experience and witness plastic pollution. They ethnographically approach plastic pollution and with their work challenge existing conceptions and patterns. Liboiron (2013, 2016) describes the microplastics spread in the ocean as a plastic smog and advocates to move away from the linear way of understanding pollution to a more complexity driven approach. The scholar suggests that microplastics *forces us* to rethink how we understand and define pollution. Some scientists see plastic in the ocean as 'matter out of place', and therefore in need of removal with no further ado, while others define harm only through empirical measurements, which will ultimately, define the effects of and appropriate solutions for plastic. The author proposes a new mode of pollution called *miasma*, which corresponds to the complexity of the relations between plastic, microplastics, plasticizers and the environment. In this way, new environmental policies can be made which capture the complexity of the entanglements with plastic and microplastics (Liboiron, 2016).

De Wolff challenges the view of plastic in the ocean just as 'matter out of place": "Gyre plastic is not simply human-made 'matter out of place' (Douglas, 1966); it is also a matter of life (and death) as bodies come to live, travel and die with plastic, and with plastic inside them." (De Wolff, 2014, p.180). For De Wolff, understanding plastic only as a 'matter out of place' is not accounting for the lives of the entities that live with plastic. The author proposes that we should approach plastic by embracing its complexity and capacity to transform and create new worlds, rather than simplifying them as a 'matter out of place'. In the previous subchapters, I have gathered stories told about and with plastic and I have categorized them as stories about objects, about chemicals or pollution. These were my classifications, which as all categories render certain things visible or invisible, and also create particular worlds (Bowker & Star, 1999).

2.2 Plastic as a category

2.2.1 What is plastic?

"Plastic itself, by its very nature, complicates efforts to think about it. Able to assume many degrees of shape, texture, hardness, density, resilience, or color, the myriad varieties are united only by a word—plastic—that has defied most attempts to promote specific trade names." (Meikle, 1995, p.3)

What is plastic? Evidently, it is not easy to give one definition of plastic. The Oxford dictionary defines plastic as a "synthetic resinous substance that can be given any shape". Plastic as a category includes several polymer based synthetic organic materials used in a range of applications by taking different forms

(PlasticsEurope, n.d.). These polymers are made from oil, natural gas or coal, which combined with several chemical additives called plasticizers, can result in plastics of different colours, hardness or resistance (American Chemistry Council, n.d.). Although this is a current definition of plastic, it has changed historically.

Etymologically, the word plastic comes from the Greek word 'Πλαστικός' which means 'Able to be molted'. Meikle (1995) describes that the first time that the word 'plastic' as a noun was introduced in a dictionary with a description resembling the current use of the noun was in 1910. The plural 'Plastics' was adopted later in 1925 by the homonymous trade magazine. Interestingly, since the singular word plastic never referred to one material for very long, up until the post-war era, there was confusion regarding what plastic was and was not. The author attributes this confusion to the strategic marketing of the plastic manufacturing industry, which instead of promoting each different chemical type of plastic separately, encompassed and promoted all synthetic polymer materials under one name: plastic. The categorization and naming of plastic were heavily based on the industrial aspects of the material since they were describing the manufacturing process rather than the material itself. Back then the categorization of plastic was dominated by the industry, which produced and marketed the materials, but later when plastic entered multiple fields of everyday life, their categorization expanded to laboratories and policy offices. One example of a current category of plastic is microplastics[4]. These categories are not only crucial for analytical purposes, but their materially shape the world we experience, by defining issues and solutions from laboratory practices to policy papers.

2.2.2 Making Categories

"A classification is a spatial, temporal, or spatia-temporal segmentation of the world. A "classification system" is a set of boxes (metaphorical or literal) into which things can be put to then do some kind of work-bureaucratic or knowledge production. (Bowker and Star, 1999, p.10)

A starting point for unfolding classification systems and the making of categories is the work of Foucault (1971) *The Order of Things*, where through an archaeological investigation of the natural sciences Foucault focuses on the process of taxonomy, or the process of classifying living entities. Foucault asks, "according to what grid of identities, similitudes, analogies, have we become accustomed to sort out so many different and similar things?" (p. xxi). The author rejects the conception that categories are *a priori*, that categories are a natural fact, but rather investigates the historical epistemic discourses that brought

[4] When referring to microplastics, I refer to small plastic particles that are perceived as pollution. This separation if not a definite one, it steams out of the literature in which this separation exists as a procedural categorization. I am not referring to microplastics as a clear-cut category but rather as a category that I recognise is being used and, most importantly, as a category that gives rise to new realities, new practices, new policies and new worlds to be formed.

these categories into existence. Bowker and Star's (1999) book *Sorting things out* is a point of reference for STS work on classifications and standards, and in turn, their point of reference is the aforementioned work of Foucault. Bowker and Star bring the study of classifications and standards a step further by not only exploring the socio-cultural texture of classification systems but also by asking, "how these properties inform social and moral order via the new technological and electronic infrastructures?" (p.5). They focus on information and its infrastructures through their main empirical case, the International Classification of Diseases. The authors illustrate how classifications deem certain aspects visible and others invisible by ordering the world. They do not see categories as good or bad, but they argue that categorization is ultimately an ethical decision.

For example, when an object becomes pollution is not only a matter of scientific classification, but it is situated in the cultural and political meanings of pollution. When does plastic become waste and what does this classification do? O'Brien writes: "[A] used bottle that is reused by refilling it is not waste (it has been 'recovered'). The same bottle in a bottle bank that gets crushed and is reused later for a different purpose is waste according to the EPA [Environmental Protection Act]." (O'Brien, 1999, p.284). Through this classification, different actions can be followed. Recently there was a call from scientists to classify plastic waste as toxic (Rochman et al., 2013). "With a change in plastics categorization, numerous affected habitats could immediately be cleaned up under national legislation using government funds." (Rochman et al., 2013, p.170). It is evident that depending on the classifications, different political actions can be actualised. The classifications of plastics are not only based on their chemical and physical properties, but are embedded in complex sociocultural systems.

When understanding the social life of materials, there is a constant need to produce knowledge about them. In order to assess the performance of these materials, they have to go through "classification, measuring, modelling, testing and adjusting" (Harvey & Knox, 2010 as cited in Barry, 2013, p.14). Although Bowker and Star (1999) focus on information and knowledge, they acknowledge the role of materiality in the making of categories. The authors describe classifications as *materially textured;* they "have material force in the world" (Bowker & Star, 1996, p.3). When classifications are conceptualised as *materially textured*, then we can analyse the structures and durability of these classification systems in the making. In the case of plastic, not only do the categories have material force, but also the classification of the material itself becomes a highly contested and negotiated field, in particular in the case of microplastics.

When interested in classifications, the question that follows is where are they made? Which places, actors and material forces are assembled for a category to be created? One place is the laboratory; especially for the categorization of material objects or entities. Latour and Woolgar (1986), in their monumental ethnographic work *Laboratory Life*, state their interest "in the way scientific order is constructed out of chaos" (p.33) and how scientists "are also confronted with the task of constructing an ordered account out

of a disordered array of observations" (p.34). Classifications are a way of ordering the world, and more precisely are a way to order the world in the laboratory. Through the processes of classifying the "uncoordinated plurals of our actual world" are represented as an "ordered set of pluralities" (Dewey, 1989 [1925], p.49). The processes of classifications can function as 'black boxes', which become invisible (Bowker & Star, 1996).

An early example of making categories in research practices is the account of Latour (1999) who followed scientists in the Amazonian rainforest and studied how they represent and classify their study objects. Latour describes that only certain parts of the rainforest are classified, such as the plants, and other parts, such as the ants or the soil, are not. Therefore, the selection of which materials are categorized is a process that ultimately makes only certain aspects of the rainforest visible. Julie Sommerlund (2006) also writes about classificatory practices in research but in the field of Molecular Microbial Ecology. The author describes how two different classification systems for categorizing bacteria can co-exist. The author shows that classification systems can be *multiple* in practice without antagonising or overtaking each other. This concept of co-existing classification systems contradicts the initial *status quo* of what a classification is, which Bowker and Star (1999) established. They describe that "categories are mutually exclusive" (p.10), and Sommerlund's empirical work challenges this assumption by unfolding the apparent multiplicity of classification systems, which is a useful tool in exploring the categories of plastic. Although, as described, certain classification systems stem from the laboratory, categories are created, negotiated and become relevant beyond. Classifications shape and are shaped by our understandings of the world both explicitly and implicitly, and in the case of plastic and microplastics, these categories are not yet in place but are in the making, contested and negotiated in the networks of actors from the laboratory to the Environment Agency's offices and back.

2.2.3 Defining plastic and microplastics

Plastic materialises in different shapes: bottles, bags, pens, and boxes, which enable us, humans, to do certain things. However, their form is not stable. Plastics transform throughout their lives; a plastic bag can become thousands of small plastic pieces travelling with the waves of the oceans through the world. Recently scientists identified that plastic in the oceans break down into small plastic particles which they named microplastics (Thompson et al., 2004). Since then, microplastics have been found in practically every ocean and also lakes, rivers and soil (Driedger, Dürr, Mitchell, & Van Cappellen, 2015; Lechner et al., 2014). Plastic accumulates and breaks down in places where we do not want it; it becomes pollution. However, "Plastics do not simply break down in ocean environments; rather, they enrol humans and more-than-humans in new processes and practices of working through and with these natures in the making." (Gabrys, 2013, p.212). The process of degradation is not only a purely physical or chemical process but is

embedded in its sociopolitical skin; it creates new realities. Microplastics have enrolled human, nonhuman and more than human[5] actors in creating new networks from microorganisms that hitchhike microplastics to fishers that are paid to fish plastic out of the sea, to new policies aiming to remove microplastics from the oceans (Gabrys, 2013).

Interestingly, what is striking about microplastics is their classifications. At first, the ways that microplastics are classified might seem straightforward; but it is not. For example, they can be categorized according to their source into primary and secondary microplastics. Primary microplastics are microbeads and come from commercially available products such as scrub creams or toothpaste. Secondary microplastics are coming from the mechanical breakdown of larger plastic parts (Cole, Lindeque, Halsband, & Galloway, 2011). There are several ways that microplastics can be classified: by size, shape, color, type or degradation stage through visual classifications, but also by chemical and physical characteristics with the use of specific technologies (Hidalgo-Ruz, Gutow, Thompson, & Thiel, 2012). In an ethnographic account, the STS scholar Kim De Wolff (2014) followed scientists and science-based NGOs as they sorted out plastic and microplastics captured in the Pacific ocean, describing the material challenges of their work. The author narrates how scientists untangle plastic from plankton by physically separating plastics by colour or size and labelling them into categories. Once again, the multiple ways and challenges of classifying plastic and microplastics unfold, but also their importance since these categories not only define the ways microplastics will be quantified, but also how the problem can be potentially tackled.

Although classifications seem stable at first, when going deeper one can see that these categories are discussed and contested in the scientific literature. The authors of a highly cited paper on the methodology used for classifying microplastics state "The number of categories used to classify microplastics depends on the criteria of the respective authors, which can vary widely" (Hidalgo-Ruz et al., 2012, p.3067). Not only can the categories vary, but they can also be debated. For example, what should be classified as microplastics? Currently, the broadly accepted size limit is 5mm, but this has been contested depending on the context and use case. The importance of the size classification is that different sized particles might have different effects on different organisms and they will need different technologies to be measured and captured, but also different policies to regulate them (Lusher, 2015). Microplastics have been identified in the digestive system of marine animals such as birds, fish, turtles and mammals (Lusher, 2015) which has raised concerns about their potential impacts on human and animal health. Even though the exact hazards posed by microplastics are still unclear and debated in the scientific literature (Galloway, 2015), microplastics have been named as one of the emerging environmental concerns of the 21st century (UNEP, 2011).

[5] Bacteria, for example

These different material classifications are to a large degree constructed in laboratories, but their impact goes beyond by shaping the ways we think about microplastics to the ways we make policies. One example is the case of microbeads. Microbeads are primary microplastics used in consumer products. Some countries have banned (U.S., U.K.) primary microplastics in products such as toothpaste or face creams (Department for Environment Food & Rural Affairs UK, 2018). In the U.S., the Microbead-Free Waters Act (U.S. Government Publishing Office, 2015) is in place to restrict the entrance of microbeads in the aquatic environments by prohibiting the use of microbeads in consumer care products. In a policy document there is the need to define what an object is and in this case a microbead is: "the term `plastic microbead' means any solid plastic particle that is less than five millimetres in size and intended to be used to exfoliate or cleanse the human body or any part thereof" (U.S. Government Publishing Office, 2015). In order to define plastic microbeads, they use the solidity and size of plastic particles, and in particular, they use the 5mm size limit that was first introduced to describe secondary microplastics and categorize them separately from other types of plastics. As mentioned before, this size limit is still debatable in the scientific literature since it is still unclear why this is the best limit to describe microplastics and what are the reasons for using it. Nevertheless, this classification has already made its way into policy. Plastic microbeads with the size of 4mm are banned, while plastic microbeads with the size of 6mm are allowed. That is one example of how classifications order the world around us. They have a performative and active role on how policy is made and thus, exploring how the categories of plastic and microplastics are conceptualised and negotiated in the EAA will add to our understanding of how the 'plastic problem' is understood, and also how current and future policies are envisioned.

2.3 Regulating plastic

2.3.1 Regulating the nonhuman

There is a reoccurring need to regulate technology and its by-products, from self-driving cars, new medical devices, care products, Genetically Modified Organism (GMOs), to materials like plastic. Questions about risk and benefits, but also about democracy and citizens, are all renegotiated and reconfigured in the era of technological development. STS scholars have explored debates about regulating technologies by showing their cultural context, such as the nation-state context. Jasanoff (2007), by studying regulations of biotechnology in three different nation-states, the U.K. the U.S. and Germany, shows how each national context regulates reproductive technologies and entities such as embryos, DNA, or cells, differently, which stabilizes a form of nation-building through the regulation of these technologies.

Research in biotechnologies has a considerable history in STS research. Foucault's interest in Biopolitics (1997) is a starting point for STS scholars: from reproductive technologies and embryos (Jasanoff & Metzler, 2018), GMOs (Lezaun, 2006) to exploring the 'politics of life itself' and the 'biological

citizen' (Rose, 2007). The governance of gene editing technologies, with the most recent example of CRISPR, has been a key field of STS research pursuing questions of risks, future visions and participation (Jasanoff & Hurlbut, 2015). There has been much discussion in the field of STS on governing emerging technologies (Felt et al., 2007), with nanotechnology being one of the many examples (Kaiser, Kurath, Maasen, & Rehmann-Sutter, 2009). However, plastic is neither an object of biopolitics nor an emerging technology.

Although there is considerable work in STS on the living nonhuman, such as organisms or cells, there is much less on the non-living nonhuman, such as chemicals and materials. Admittedly, this is a very arbitrary differentiation with speculative boundaries, but it is less about drawing clear boundaries between living and nonliving and much more about drawing attention to materials and chemicals beyond their relation to the living, as a category that requires separate attention and study. That is something that Barry (2017) in his *Manifesto for a Chemical Geography* highlights, and argues that the apparent absence of chemicals' connection to the living is one of the reasons for chemicals being overshadowed as a study object. Barry wants to bring back the importance of exploring the chemical. The author describes that "the idea of chemical geography is founded on the recognition that the chemical compositions of atmospheres, landscapes and bodies have become critical sites for politics, government, and everyday experience" (Barry, 2017, p.13). And plastic is no exception.

2.3.2 Current plastic regulatory discussions

Plastics are materials that are difficult to tame. Humans are trying to categorise and restrict plastics, but they escape into rivers, lakes, oceans or soil. They change shapes; they transform and challenge our assumptions about what materials can do and where they belong. They form new realities and challenge practised nature-culture dichotomies (De Wolff, 2017). On the other hand, in a very normative way, plastic and microplastic pollution is becoming a challenge for humans. In recent years, there have been several initiatives against plastic pollution and an urgent need for new policies that will ultimately tackle the issue of plastic in the environment.

Regulating plastic as chemical pollution has been one way of looking at this material. For example, Fortun et al. (2017) discuss the regulation of plasticizers, the chemicals added in plastic, as chemical pollution and the authors propose a way to rethink pollution as a *slow disaster*. Sarah Vogel (2012) traces the regulatory history and debates over BPA, a commonly used chemical in plastics production, and asks what is considered safe? This is an important question to ask when making regulatory frameworks on BPA. The answer, according to the author, cannot be addressed solely by science. In other words, I would argue that how and when BPA or other chemicals are safe is not a matter of fact, but it becomes a matter of concern (Latour, 2004b). From a chemicals' regulatory perspective, topics such as the toxicity of plastic

becomes crucial, but once again this is a partial view on plastics' regulation with a focus on the additives used rather than the material itself.

Another way to approach the regulation of plastic is as objects. By following the life and afterlife of the plastic PET bottle, Hawkins (2011) explores the complex regulatory processes around this plastic object "from technology transfers, to failed trials with other plastics, to diverse government regulations controlling everything from packaging safety standards to patents" (p. 9). Plastic bags have also been a plastic object of regulatory focus. Currently, several countries in the world have banned, restricted and or regulated the use of single-use plastic bags (Figure 1). In the European Union (EU) the European Parliament (EP) adopted a legislative directive in 2015 to restrict the use of plastic bags, and since then several member states have taken action, such as adding a price tag on the plastic bags (European Parliament and Council, 2015). Other single-use plastic objects such as straws, plastic cups and plates are currently in the focus of ongoing European regulatory discussions (European Commission, 2018b).

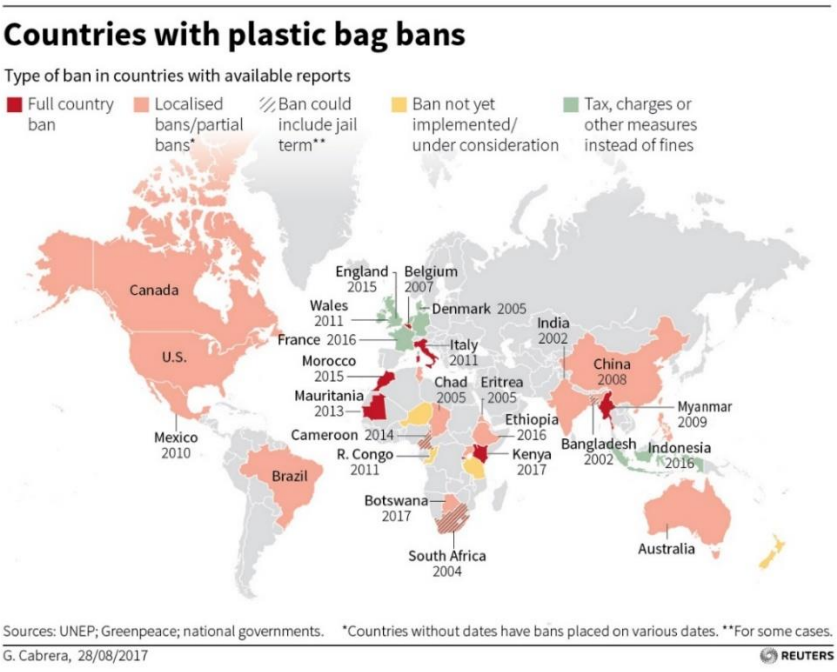

Figure 1: Image retrieved from Ndiso, 2017.

In January 2018 the European Commission (EC), as part of the EU Circular Economy Plan, published the first worldwide strategy with plastic as its primary focus. In the European Strategy for Plastics in the Circular Economy or for short, EU Plastics Strategy, they discuss a plan to rearrange plastic in society and the economy by setting ambitious goals such as all plastic packaging being recyclable as of 2030 (European Commission, 2018c). This plan was published the same month that China -one of the biggest

importers of plastic waste from the EU- issued a ban on the import of plastic waste (Boffey, 2018). Different actors and organizations published their recommendations and comments on the EU Plastic Strategy before its publication. The Interest Group Plastics (IG Plastics) is one of them. The IG Plastics is part of the EPA network (Network of the European Heads of the Environment Protection Agencies), and it published a Position Paper on the EU Plastics Strategy in which they set their priorities for further steps required on a European level in order to regulate plastic, and also prevent plastic pollution. Not all European countries are members of the IG Plastics, but interestingly the Environment Agency Austria (EAA or Umweltbundesamt in the German language) has an active role in this group as one of the founding members. The formation of this group once more highlights the current importance and efforts for regulating plastic on a European level.

A recurrent theme of this thesis and literature review is the different ways to approach plastics as chemicals, as objects, as pollution or as a material. This recurrent challenge is not one that only I as a researcher have encountered, but one that is also evident in the scientific and regulatory literature on plastic. Therefore, what needs to be regulated in the case of plastic is not clear; in fact, it becomes an empirical question connected to the ontology of plastic. Regulating plastic can mean many different things, but what I have chosen to place in focus is the material itself, not the chemical additive nor the object, but the material.

2.3.3 Environment Agency Austria as a boundary organization

The EAA can be conceptualised as a boundary organization (Guston, 2001) since they work at the intersection of science and policy. On the one hand, the agency is active in policy advisory, and on the other hand, they run their laboratories on specific issues, such as analysing environmental samples. They engage in what Miller (2001) calls 'hybrid management' by negotiating the boundaries of science and policy, but aiming to advance both. They involve people from both communities, but at the same time have a distinct role that would be difficult or impossible for organizations in either community to have. In a way, one can witness the co-production of the social and scientific orders (Jasanoff, 2004) in such an organization. This thesis does not focus on the role and position of the EAA in the European or Austrian arenas, but by using the EAA as an empirical site of research, it unfolds how the materiality of plastic becomes a matter of concern inside the EAA. Therefore, conceptually positioning the EAA will provide a background upon which my research unfolds.

The EAA has research facilities that explore and measure the impacts of microplastics in the Austrian context (Umweltbundesampt, n.d.). In the literature, authors distinguish this research conceptually from academic research in universities. Not because the one is better than the other, but because the structures that the research is embedded in and the goals differ. The scientific work of an Environmental

Agency, such as the EAA, is described as *regulatory science*, because it is often used for regulatory and advisory purposes (Jasanoff, 1990). Regulatory science has been accused in the past for not being objective enough, with the assumption that political agendas influence it, in contrast to academic research. From an STS perspective, objectivity is understood as contextual, rather than an overarching value. A great example is the work of Daston & Galison (2007) highlighting the multiple *modes of objectivity* since the 17th century. What this entails is that different places and times practice different types of objectivity, or in other words, what is perceived as being objective is not universal nor ahistorical but embedded in the situation. Therefore, from this perspective, regulatory science is not conceptualised as less objective, but understood as another type of objectivity called *regulatory objectivity* which is "based on the systematic recourse to the collective production of evidence" (Cambrosio, Keating, Schlich, & Weisz, 2006, p.189). This term has been mainly used to describe practices of objectivity in biomedical research, but in a more broad sense explores how *The practices of objectivity in regulatory science* (Jasanoff, 2011) become a site of importance for research on negotiations over the boundaries between science and policy.

Therefore, place matters when exploring the entanglements of humans, plastic and the environment. Place, meaning in which organization discussions happen, but also place as a geographical location. Regulatory science is embedded in a national context which is essential to consider when thinking about the intersections of science and policy (Jasanoff, 1990). In the case of plastic, it is interesting that most of the discussions about plastic are focused on the impacts of plastic in the ocean and marine life. It might, therefore, seem odd that Austria is interested in this topic, as a country without a sea shoreline. To answer the question of how and why the EAA became interested in plastic and microplastics is an empirical question. However, what makes this thesis interesting is that studying plastic in the context of the Environment Agency Austria can provide a unique opportunity to understand the issue from a different perspective, which allows aspects to unfold that are overshadowed by topics related to the aquatic environment. And conceptualising the EAA as a boundary organization provides the tools to explore how plastic is enacted and how materiality matters in the negotiations of science and policy.

3. Research Questions

In this thesis, I have chosen the Environment Agency Austria as a case to follow plastic and explore its material politics. Although the materiality of plastic has been researched through different objects such as bottles or credit cards (Gabrys et al., 2013) or as plastic in the oceans and its study in laboratories (De Wolff, 2017; Liboiron, 2016) the role of plastic in organizations, such as the EAA, in an institutionalised form of working with plastic and negotiating plastic, has not been explored. Conceptualising the EAA as a boundary organization allows us to address questions at the intersection of science, policy and how plastic is being problematized in the in-betweens. Research in boundary organizations, such as Environmental

Agencies, has a strong co-productionist approach (Jasanoff, 1990), which to some extent does not place materiality at the center of attention. Therefore, by applying a post-ANT perspective to study plastic at a boundary institution, a fresh approach is provided which allows us to address the materiality of plastic as they travel in formal organizational structures.

The main question of this thesis approaches plastic not as a matter of fact but as a matter of concern, which is enacted in diverse settings. It therefore asks:

How is plastic enacted as a matter of concern in the Environment Agency Austria?

With this main research question, I explore how plastic is enacted in the work of the EAA and how plastic is negotiated and problematized. It is important to highlight that this does not address plastic as one matter of concern, but rather the opposite, it allows the exploration of the multiplicity of plastic and its multiple enactments as matters of concern. When, where and for whom does plastic become a matter of concern and which practices and actors gather to enact this matter of concern? The aim is through the empirical exploration of the work that the EAA is doing on plastic to explore the spectrum of enactments of plastic as matters of concern. In particular, I also focus on the role of the EAA as a boundary organisation, and how plastic is negotiated as matter of concern between science and policy. When and where does it become a matter of politics and when and where a matter of science? With the following sub questions, I aim to approach different aspects of the main research question in more depth and detail:

How is the materiality of plastic enacted?

This question is of great importance for this thesis. It highlights not only the interests, but also the theoretical underpinnings of this work. Materiality is understood as a process (Gabrys et al., 2013) not as a stable and fixed entity. Therefore, this question points to the practices of enacting the material plastic- not the object, but the material. It is about following the material properties of plastic and exploring how they are reconfigured in the work of the EAA, in the making of plastic as matter of concern. This question addresses materiality directly by following the material in the EAA and exploring how its materiality matters for plastic enacted as a matter of concern.

How is plastic made political through the work of the EAA?

Here the political is understood as Andrew Barry describes it "The political need not be only associated with the control of political institutions, the activities of the state or the formation of social movements. Instead I take the political to refer to the ways in which artefacts, activities or practices become objects of contestation" (Barry, 2001, p.6)**.** Therefore, this question directly addresses the material politics of plastic. It is not about the politics that deal with plastic, but about the material becoming the nucleus of

the political contestation. This question unfolds the politics of enacting as a matter of concern and rendering plastic as political matter.

How do the human and nonhuman actors relate to each other in the networks of the EAA?

Plastic is enacted as a matter of concern in the *gatherings* of human and nonhuman actors. It is the practices of relating these actors that enact plastic as a matter of concern. Therefore, exploring the networks in which the EAA is entangled and how the human and nonhuman actors relate with plastic enables us to explore the multiple realities of plastic and the different ways that plastic participates in the work of the EAA. It is important to remember that all of these questions are answered from the perspective of the EAA. This means that they do not aim to understand all the different networks in which plastic participated but explore how plastic is enacted in the EAA. There is no such assumption of an 'objective' description of the situation, but an exploration into how the work of the EAA enacts and gathers actors, plastic and matters of concern.

4. Theories and sensitizing concepts

4.1 From Classical ANT

Central to my work is the conceptualization of plastic as a nonhuman actor capable of enacting and being enacted. ANT, and especially its latest developments, provides tools to explore the heterogenous relationships between humans and nonhuman actors. A starting point for ANT was the work of Callon (1984) with his work on St Brieuc Bay, in which they[6] describe the relations between marine biologists, fishermen and scallops through the approach of 'generalised symmetry'. Callon conceptualises human and nonhuman actors as equals in the web of relations of the network. In other words, the nonhuman scallops were shaping the social as much as the human biologists. The conception that the social is not only formed by human activity was a radical one in the 1980s, which drew many supporters and critics of ANT together.

Although ANT has developed much since the 1980s, the conception that the world is build in socio-material relationships is still at the very core of ANT, but also of STS in one way or the other (Law, 2017). By looking at these socio-material networks, scholars have described the hybridity of entities that exist between nature and culture, between the human and the nonhuman. They are not either or, they are hybrids of both. Mike Michael (2016) discusses hybrids and gives an example from Law (1994) "As Law has noted, remove a manager's technologies whether 'high' (mobile telephone, computer, smart printer, data projector) or 'low' (desk lamp, desk, chair) and she is no longer a manager" (p.42). A manager becomes a hybrid through the radical human and nonhuman relations. Another example of hybridity is the story of the

[6] 'They' is used when referring to a single author as a gender neutral pronoun as a way to resist defining ones gender by their names.

door closer by Bruno Latour (as his alter ego Jim Johnson), writing about how artefacts are not passive objects, but rather are moral and social. Social relations are shaped through the delegating competences between humans and nonhumans and the constant inscriptions and prescriptions between them (Latour (Jim Johnson), 1988). It is therefore through the relational negotiations of the human and the nonhuman in which agency and social realities are enacted and mobilised. It is through the hybridity of the human and the nonhuman, of nature and culture that socio-material worlds are enacted. Plastics are, from this perspective, hybrid entities of nature and culture, which through the socio-material relation between humans and other nonhumans, become pollical and the center of moral and political contestations.

Although on the one hand Latour (Latour & Porter, 1993) describes these hybrids entities, the author devolves further to argue that modern societies engage in, what Latour calls *purification work*. The moderns take these hybrid entities and *purify* and separate them. Through the work of *purification*, moderns enact dichotomies in which hybrids are split into nature or culture, science or the social, humans or nonhuman, scientific or political. This kind of work creates certain social meaning and categories for what fits where. What Mary Douglas describes as 'matter out of place' is in part an enactment of a dichotomy of what belongs where, of what belongs to nature and what belongs to culture and at which time and space. This *purification* work in relation to plastic is in action and it becomes a very interesting one. Plastic emerges as a nature/culture hybrid through the relational associations of humans and nonhumans. It is in constant negotiation of dichotomies: of nature and culture, science or politics. Where does science end and politics begin when it comes to plastic? This is a dichotomy, a boundary that is enacted in specific situations and is present in my case; I follow this purification work and the making of dichotomies through the work of the EAA as a space in which plastic is in constant negotiation.

4.1.2 Criticism and agency

The early ANT through the years has collected several criticisms (for a overview see Law, 2008; Michael, 2016). Although I do not aim to cover all the different criticisms, I will discuss two main points that become relevant to my own work, namely the issue of agency and of normativity. The former addresses the question: Do nonhumans have agency as humans do? The latter point criticizes that ANT excludes larger forces and power relations that might be outside of the described networks. In other words, critics have argued that ANT becomes blind to it's own contribution to politics, or more bluntly put, that ANT becomes of "middling utility at best and politically useless at worst" (Rudy, 2005). The contribution and relation of ANT to normativity and politics will be discussed in the next subchapter in regards to the development of ANT to what has been named as post-ANT, which takes up large parts of these critical points.

The issue of agency is an important one in relation to my work. I have described that I conceptualise plastic as active matter that participates in shaping realities. What does that mean in practice? And how can nonhuman plastic be active? Very often agency is equalised with intentional action, which tends to attribute agency only to humans who are able to act intentionally. In contrast, I argue against this equalization since agency is not formed in an intentional action of one actor, but through the radical relations formed between actors. Therefore, agency is not attributed to an individual, but it is rather distributed. "This distributive version of agency can also be seen as 'flowing' or circulating amongst different elements of network (or collectif) – or rather as enacted in the relations 'between' entities. The agency of nonhumans 'enables' the agency of humans which enables the agency of nonhumans and so on." (Michael, 2016, p. 68-69).

However, what does this mean practically? "As a more general descriptive rule, every time you want to know what a nonhuman does, simply imagine what other humans or other nonhumans would have to do were this character not present." (Latour & Johnson, 1988, p.299). This is a thought exercise that indeed unfolds the position of nonhumans as active, and it is when they are removed from the network of the relation that one sees their active role. In the case of plastic, it is not only its absence that reveals its activity, but it is also its presence. I believe no one would intentionally want plastic to be in the deepest of the oceans or in the stomachs of fish, but plastic acts beyond the human. It breaks down into small tiny pieces and creeps into the waters, soil, air; plastic accumulates on organic pollutants in the sea and becomes toxic in ways which humans could have never predicted. In this way, the material, the plastic, becomes active beyond human intention and that action and forces human to act, to actively engage with its materiality, to remove plastic or to regulate plastic. This is how the distributed agency of plastic emerges; plastic is not just a background on which humans act upon, but it participates, it escapes, and it demands attention.

4.2 To post-ANT

The early or classical ANT mainly emerged and was built on studies of laboratories as places where knowledge is produced. Scholars followed and unpacked how facts and knowledge are constructed through the work of human scientists and nonhuman technologies (Latour & Woolgar, 1986). In other words, early ANT asks questions about the epistemic, about knowledge production and fact making. On the other hand, post-ANT jumps on the 'ontological turn' train and shifts the questions from episteme to ontology. It asks, "what is it"? Or "how are things enacted?" (Michael, 2016. p.115). The early ANT work looked into how facts are constructed, how reality is constructed through the co-construction of the scientific and the social. In contrast, post-ANT approaches reality(-ies) not as constructed but as enacted. It moves from epistemology to ontology.

> We are no longer dealing with *construction*, social or otherwise: there is no stable prime mover, social or individual, to construct anything, […] Rather we are dealing with *enactment* or *performance*. In this heterogenous world everything plays its part, relationally. […] Buyers, sellers, noticeboards, strawberries, spatial arrangements, economic theories, and rules of conduct – all of these assemble and together enact a set of practices that make more or less precarious reality. (Law, 2008, p .151)

Reality is not perceived as singular and stabilised, which the analyst needs to discover, nor socially constructed, but as enacted in socio-material *practices*. This work is not the first STS research that approaches plastic from a post ANT perspective. On the contrary, it is a common axis for STS research on plastic (Gabrys et al., 2013; Hawkins, 2010). This research applies this post ANT perspective to study plastic in a formal institution such as the EAA, as a matter of concern in the making regarding not just the use but also the regulation of plastic. Further, I describe two concepts: the matters of concern and multiplicity, which are positioned in the wide framework of post-ANT. These concepts were central to my analysis and approach towards my materials and research.

It is interesting to highlight that some authors, such as Law (2008) use the words enactment and performance interchangeably, while others such as Mol (2002) argue that the word 'perform; has too many connotations; it is associated with a theatrical configuration, in which the true reality is in the 'backstage' and the performance happens at the front stage and therefore prefers to use the term enactment. "I don't want those associations to interfere with what I want to do here: to shift from an epistemological to a praxiographic inquiry to reality. So I need a word that doesn't suggest too much. A word with not too much of an academic history. The English language has a nice one in store: *enact".* (Mol, 2002, p.32). In this work I also prefer to mostly use the word enactment, mainly because the word enactment gives the opportunity to not presuppose a specific actor that is enacting. Therefore, it draws the attention to the relations between the actors, to the gatherings and its practices rather than the single unit.

4.2.1 Matters of concern

Following the move from the early classical ANT to a post-ANT perspective, Latour suggests a new form of thinking about politics, which they call *Dingpolitik* (Latour, 2005). This form of politics requires positioning the object at the center of the discussion; it also requires us to stop talking about 'matters of fact' and how they circulate but rather engage with 'matters of concern' and how they gather (Latour, 2004b).

> The mistake we made, the mistake I made, was to believe that there was no efficient way to criticize matters of fact except by moving *away* from them and directing one's attention

> *toward* the conditions that made them possible. But this meant accepting much too uncritically what matters of fact were. (p.231, emphasis original)

Latour suggests attending to *what is* rather than the conditions that made it. An object is not anymore, a matter of fact, but a matter of concern because objects are so entangled with actors, practices, spatial arrangements, moral understanding and discourses. They are no longer matters of fact, but instead they gather around them actors, discourses and practices that render them into matters of concern. They become 'things' and "a thing is a gathering" (Latour, 2004, p.235). In order to break down what this means Latour gives an example from Ian Hacking's discussion about rocks and dolomites, claiming that rocks could be treated as a matter of fact, but the dolomites cannot. "Dolomite is so beautifully complex and entangled that it resists being treated as a matter of fact. It too can be described as a gathering" (Latour, 2004, p.234). Similarly, plastic cannot be treated as a matter of fact, whenever and wherever plastic appears it carries with it all the sociocultural understandings of what this material is and what it can do. It has its own socio-material histories, which cannot be disentangled from what this material is.

Therefore, when placing plastic in the middle and thinking them through as things, not objects, one can attend to the *gatherings*, which enact them as a matter of concern. "*Gatherings* is the translation that Heidegger used, to talk about those Things, those sites able to assemble mortals and gods, humans and non-humans." (Latour, 2005, p.13). *Gatherings* are sites in which the materiality of plastic becomes a matter of concern through *gathering* of humans, nonhumans, discourses and practices. Plastic becomes 'things' circulating in the Environment Agency Austria which becomes "a site where nature-objects are assembled, a site for a politics of things" (p.100) through 'assembling practices' (Asdal & Hobæk, 2016).

4.2.2 Multiplicity

What is reality? A question that has been asked in the Western philosophical circles many times. It is often imagined that a singular reality exists; one of knowns and unknowns, one that we can have different perspectives on- a reality that can be discovered and described as one entity. The 'ontological turn' brings a radical change to the answer of this question, namely that "reality is itself multiple" (p.74 Mol, 1999). Reality does not exist somewhere in depended of our actions, but rather it is practiced. Reality is enacted through the practices that make it and therefore "if reality is *done*, if it is historically, culturally and materially located, then it is also multiple. Realities have become multiple." (Mol, 1999, p.75, emphasis original,). It is important to understand that multiplicity is not a set of different perspectives, but multiple practiced realities.

An example of how multiple realities are practiced and are enacting different worlds is the work of Annemarie Mol (2002). In their work *The Body Multiple*, the author uses an account of empirical philosophy

to trace the ontological multiplicity of atherosclerosis in the practices that enact it. Mol describes how through the material practices happening at different parts of the hospital, atherosclerosis is enacted as multiple. It is not the perspectives about atherosclerosis that change, but it changes what atherosclerosis *is.* Although this example and most of my theoretical concepts refer to the field of STS, the ontological turn has also influenced other academic fields. Perhaps understanding a disease, such as arteriosclerosis, or a material, such as plastic as multiple and enacted is not very intuitive. I want to therefore bring an example from gender studies to demonstrate that the idea that reality is a set of practiced enactments or performances is one reaching beyond the border of STS. Gender studies scholars, such as Judith Butler (1988) have described gender as performative, meaning that what gender is, is the set of practices that enact it. In this way, the ontology of gender is the enactment of it through the practices. Reality does not just exist, but it is practiced. In a similar manner, what plastic is- the realities of plastic- are enacted through the practices of working with and regulating plastic.

The scholar Gay Hawkins gives a great example of the enacted realities of plastic. The author follows the plastic bag in three different settings: in say-NO to plastic bag campaigns, in everyday household use, and in the scene of the movie American Beauty in which a plastic bag flows in the wind. The focus is "the performativity of plastic: the ways in which its distinct materiality is realised in diverse arrangements" (Hawkins, 2010, p.121). Although the material properties of the plastic bag are shared in the three different settings, it is the performance of the material properties that enact different politics, ethics and different plastic bags. In this example, the enactment of the materiality of the plastic bag creates a new reality in the different gatherings that the scholar followed. However, in my work I am interested in the enactment of the materiality of plastic, not as one object, but as a material.

4.3 Material Politics

"Matter itself is to be conceived as active, forceful and plural rather than passive, inactive and unitary" (Lemke, 2015, p.4). So far I have talked about objects, a disease, a plastic bottle and a plastic bag- but what about the material? How can we include the material in political thinking? What is the difference in theoretically discussing an object or the matter that builds it? What does it entail from a theoretical perspective to follow the call of Andrew Barry (2017) to attend to the chemical, to the material?

Many authors do not separate the object and the material. Stories of materials are told through the stories of objects. An example is the work of Gay Hawkins on the plastic PET bottle (Hawkins et al., 2015). However, my interest is a focus on the material, not the object. I want to take a step back from the object and discuss the material itself, its materiality and material properties. The theoretical move to the 'material turn' has placed a focus on technologies and objects, but in this case the focus is on the material itself. Plastic allows and guides the attending to its materiality. "Plastic complicates this turn, however, for it is

not just the world of objects that is defamiliarized, but also the material properties that constitute those objects. Plastic draws attention to the materiality of objects *and* the shifting properties of those materials." (Gabrys et al., 2013, p.3 emphasis original). It is the enactment of these shifting properties of plastic that make it political, that draws the attention to the material politics of plastic.

Matter is not perceived as stable, sharply defined or ontologically fixed, it is not the background on which politics happen, but "materials *become* political" (Gabrys et al., 2013, p.5). Attending to the material politics of plastic means to attend to "how the properties and behaviour of organic and inorganic materials […] themselves participate in such controversies. […] material objects should not be thought of as the stable ground on which the instabilities generated by disputes between human actors are played out; rather, they should be understood as forming an integral element of evolving controversies" (Barry, 2013, p.12). It is the properties of the materials that become the center of political contestation; the material properties are enacted as the matters of concern.

This conceptualisation of materiality as nonstable but enacted and negotiated changes the theoretical approach towards the materials. Jennifer Gabrys, Gay Hawkins and Mike Michael (2013) in exploring the material politics of plastics describe the materiality of plastic "as *process"* (p.3). When discussing materiality as a process, its enactment and fluidity unfolds rather than its stability or fixation. The authors call this materiality of plastic as its "processual materialities, or *plasticity*." (p.2). Therefore, plasticity of plastic refers not only its ability to be molded into multiple objects, but also to the enactment of its materiality in diverse gatherings. With this theoretical lens I also followed plastic in the Environment Agency Austria and explored its processual materialities.

In conclusion, positioning this work and approaching plastic from a post-ANT perspective, not only allows for exploring the multiplicity of the materiality of plastic, but also allows for a new form of political thinking, a new form of critique. This critique is not oriented at deconstructing matters of fact but at stepping back and shifting the focus towards matters of concern and towards constructing new realities (Latour, 2004b). It enables us to explore how realities are enacted but also to ask and reflect on how a vision of a 'common world' can be constructed in which different realities can co-exist (Latour, 2004a). Adopting this theoretical framework enables us to approach plastic in its multiplicity and reflect on how we can live with multiples of plastic in contemporary societies.

5. Methodology & Materials

To answer my research questions, a qualitative research framework was adopted since the aim of this work is not to conclude in any numerical data representation, but to understand processes of meaning making (Jensen & Laurie, 2016). In this chapter, I will first outline my case study by providing some background information about the EAA and then discuss my field access. I continue by describing my

materials, the qualitative interviews and documents used, and contextualise them theoretically as methodology for qualitative research. Then I provide an outline of Situational Analysis, the methodology used to analyse my materials. I end this chapter by reflecting and discussing the ethical aspects of my research process.

5.1 The case study

For my case study I used the Environment Agency Austria. Above, I described how I approach and conceptualise the EAA as a boundary organization working at the intersections of science and policy. In this part I aim to give a short description of the EAA as an organization, with its history, structure and legal status.

The EAA was founded in 1985 through the Environmental Control Act. In 1999 its legal status changed to a limited liability company (GmbH in German) owned by the Republic of Austria under the Ministry of Sustainability and Tourism (named as such in 2018 from Federal Ministry of Agriculture, Forestry, Environment and Water Management). The EAA is funded mainly by the Federal Ministry through projects, but they also receive project requests from other sources, such as private industrial companies, NGOs or even individual citizens. For example, their laboratory works on the analysis of microplastics in the environment and they can have samples for projects related to the Federal Ministry, samples from private industrial clients, and also samples brought in by individual citizens.

The EAA employs more that 450 people working in 55 different disciplinary fields. It is considered to be Austria's leading expert institution for the environment. Their consultancy expertise expands to many fields related to the environment and society, from stakeholder dialogues to mobility management (see Figure 2).

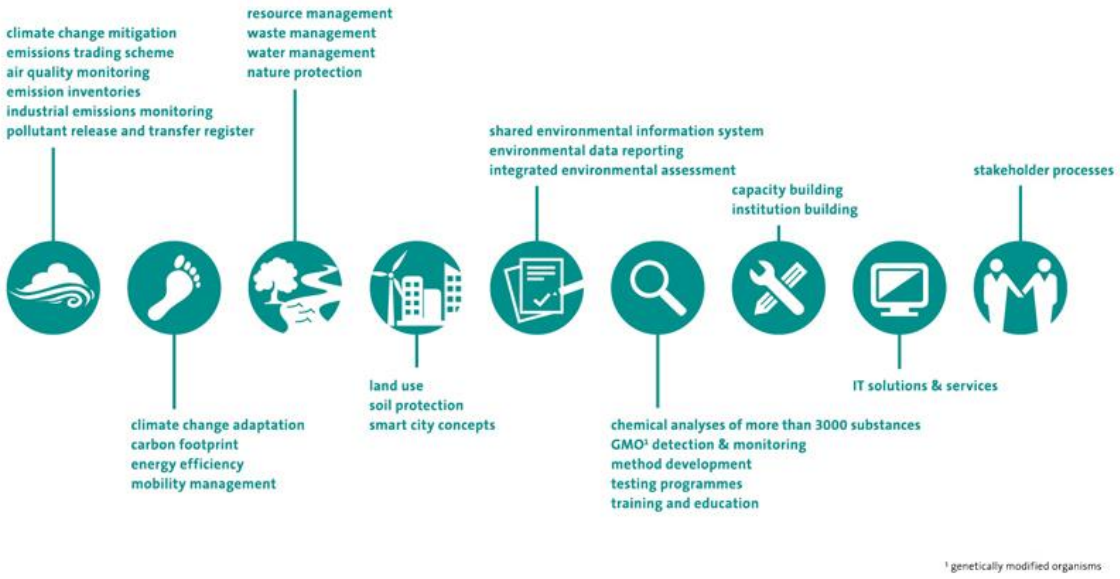

Figure 2: The "Fields of expertise" by the EAA (Umweltbundesamt, n.d.-c)

There are 24 departments operating at the EAA, each of them having a different focus from International Relations to Air Pollution Control. The focus can differ, depending on the issue addressed but also depending on the type of work that the particular department does. There are two Managing Directors of the EAA and a Supervisory Board consisting of 7 Members. These members are from the EAA, from the Ministry of Sustainability and Tourism but also from the Ministry of Finance.

Internationally the EAA participates in "over 200 networks and committees" (Umweltbundesamt, n.d.-b). For example, they participate in twinning projects, in which they partner up with another country in order to address a pressing environmental issue. These projects aim at cooperation and knowledge exchange between different countries. They have many ongoing collaborations with EU member states, but also non-EU Eastern Countries. In the EU they are active through many networks, doing work associated with the European Commission and the European Parliament. The specifics of their work on plastic and microplastics, also their relation to the EU networks on these topics, will be described later as part of my empirical analysis, drawing on the materials analysed for this master thesis.

5.2 Field Access

I became interested in the work of the EAA because of their active and multilevel work on plastic and microplastics. My initial contact with the EAA was in December 2017. I had already started reading about the work of the EAA and I was interested in getting more information about their work and structure. I got a contact of a person working on microplastics at the EAA and got back a quick and structured reply

providing information on their work, but also redirecting me to the coordinator of the microplastics topic to further discuss potential field access.

I met with the coordinator at the end of February to discuss their work and also my research. From the discussion, it became clear that they[7] (the coordinator) were interested in my research, but it was also highlighted that access to the field could only be granted by the higher management. In other words, it is not the coordinator's decision if I would be able to conduct research there or not. I wrote a proposal directed to the management of the EAA to request access. I explained my research aims and provided samples from the questions I would ask the interviews. I also provided the informed consent any potential participants would sign.

Time was also an issue. I wanted to conduct interviews with employees of the EAA and this would take time from their work. It was clear that their time was limited and precious; wasting their time was not an option. I would be able to interview four different experts from different departments that have worked or are working on the topic of plastic. I did not choose directly whom I interviewed, but the coordinator indicated the experts on the topic and I was internally given contact to these experts after the higher management accepted my proposal. It was very interesting that I was not the one who directly chose my interviewees, but this was arranged internally. Therefore, this selection was part of my empirical work, since it outlined, from their perspective, the different departments and aspects in which the EAA works with plastic.

5.3 My materials

The materials I analysed were the four interviews conducted with the experts from the EAA, one full report published by the EAA on plastic in the environment, and the summaries of two other reports from the EAA: one on waste in Austria and the other on microplastics in the environment. These two reports were not analysed in full because they were written in German and only the summaries were in English. Analysing these reports was beyond my language skill capacity and translating them was an extra analytical step I did not want to add to my analysis.

My research endeavour with plastic started in March 2016 and it extended beyond my master thesis, since I also worked on plastic related projects. What this entails practically is that I have extensively read and followed the debates on plastic beyond the purposes of my master thesis, which has implicitly and explicitly informed my own research. In the section on 'Contextualising my empirical materials' I describe how many other sources of materials on plastic and microplastics have informed this work. In this subchapter, I also describe my materials and discuss how I theoretically conceptualise them. Further, the

[7] A gender-neutral pronoun is used in order to first protect the anonymity of the person and second resist gender binaries.

issue of researching enactment and practices by conducting interviews and analysing documents will be discussed. I place this work in relation to the literature that has approached enactment in a similar methodological fashion and conclude with where I see the limits of my approach from a methodological point of view.

5.3.1. Qualitative Interviews

The main materials analysed for this thesis are the four interviews I conducted with the experts from the EAA. Each interviewee was from a different department of the EAA[8], working on plastic from a different angle. Interviews were arranged individually but were all conducted within a month between April and May 2018 over three separate dates. They were all conducted at the EAA buildings in Vienna in different offices and/or meeting spaces and each interview lasted for a bit more than one hour. With the written permission of the interviewee, the interviews were audio recorded and late transcribed all together.

I conducted semi-structured interviews with open-ended questions. This way both structure and flexibility were combined. The 'semi-structure' means that I had a questionnaire prepared before hand, but I also navigated the interview situation by asking questions on topics that came up during the interview situation (Jensen & Laurie, 2016). A semi-structured interview approach was very helpful since there were many topics discussed, which I did not anticipated beforehand. My questionnaire was focused on questions about describing their work, from day to day practices to how they see their work in relation to policy making and knowledge production. How deso plastic matter in their work, in which ways and what are the challenges that they perceive? The aim was to understand their own individual perspectives on their work and its context (Silverman, 2006). I often asked for specific examples from their work practice in order to get a descriptive account of their own practices and challenges in a concrete rather than an abstract way.

The questions were open-ended; meaning that there were no questions demanding a yes or no answer. I was rather asking questions that require a descriptive answer or an explanation. When making the questionnaire, I reflected on the wording of the questions, especially in terms of using words that framed plastic as, for example 'pollution' or 'a problem'. This framing was avoided to let my interviewees unfold their own perspectives without directing the discussion into one particular orientation. Due to the semi-structured way the interview was conducted, many questions arose during the interview situation. It was significantly more difficult to phrase on the one hand open-ended questions, and also take care of the wording of the questions while being in the interview on the other hand. To the extend that it was possible, I did so.

[8] For purposes of privacy I have decided not to mention the particular department my interview partners are working at. This issue is further discussed in the section of ethical considerations.

These interviews functioned in my research process on two levels; they provided expert information on a specific topic and the co-constructing of social meanings and enacted aspects of plastic in the EAA. There were many facets of the work of the EAA on plastic that I was not aware of due to many reasons, one of them being the field access situation. These interviews provided me with information and references to other sources in order to understand and contextualise the work that the EAA does. At the same time, they acted as a performance of the realities of plastic and the people working with plastic in the EAA. In other words, these interviews did not "simply describe the world as it is, but also enact it." (Law & Urry, 2004, p.391). Through these accounts in the interview situation meanings, practices and plastic were all woven together to enact new meanings, practices and, indeed, new plastic- to enact new realities.

Until now I have referred to my interview partners as 'experts'. Who is an expert and who is not an expert is a highly problematized issue in STS. The word expert holds authority and enacts power. Framing my interviewees as experts was not initiated by myself, but by them. They were presented to me as experts in their field of work and there were times during the interview when they referred to their own expertise or expert opinion. Although I respect their expertise and their own identification, in my work I do not perceive them just as experts giving me information about plastics. I see them as people who work with plastic, and through their work and during the interview, provide me with information, enacting and performing a reality with plastic. During the interview they enact and re-construct their own expertise, work, practice and opinions with plastic and they create not only sociocultural meanings, but also participate in the enactment of certain realities. Approaching my interview partners less as experts and more as people who work at the EAA on plastic, is not meant to devalue their work nor their expertise but allows me to see the connections rather than the differences in their account and relate them to one another.

My research focus is to understand how plastic becomes a matter of concern in the EAA and how the materiality of plastic becomes important. To a certain extent, my research is interested in exploring these questions in the practices of the work of the people in the EAA. It is very common to assume that practices are only, or better researched by participants observation, but there are researchers who have looked into practices by conducting interviews. Frank Heuts and Annemarie Mol (2013) employ interviews in order to research the valuation practices that deem what is a good tomato. They describe that participant observation "wasn't easy to achieve in *our* practice." (p.128), and they employ interviews in order to answer their research questions, but interviews that have a particular focus on the description of practices. Mol (2002) has described earlier in her work a method called *praxiography* in which the researcher understands the topic of research and its practices *enacted* together. In the case of exploring what is a good tomato the researches positioned the interviewees as "their own praxiographers" describing their practices. In a similar fashion, in my interviews I focused on my interviewees' work and work practices, by asking direct questions and follow up examples of their everyday working practice with plastic.

Heuts and Mol (2013) describe that interviewing is a "a helpful enough proxy" (p. 128) of participants observation, implicitly creating space for seeing participants observation as 'better' in comparison to interviewing for exploring practices. Neither doing practice nor talking about doing practice is unproblematic; neither is representing reality better, but they enact it differently (Atkinson & Coffey, 2003). Therefore, I do not see this work as deficit, or lacking a participant's observation, but rather as giving a different perspective. Although I have not observed the practices through the interviews, I have been able to participate in the discussion about practices, which gives opportunity to the participant to draw and *gather* meanings, discourses and actors to their practices and reflect upon them. It allows for reflection on their practices and gives them space to "take a fresh look at their own practices." (Heuts & Mol, 2013).

5.3.2. Documents

Documents can be found in many different forms and are integral parts of a diverse range of practices. In my research, I have analysed parts of three reports published by the EAA. In these reports they present their work and relate their work to further recommendations or discussions around policy actions. The first report I analysed is titled "Plastic and Microplastic in the Environment" and was published in 2015. It is written entirely in English, which is not usual practice, meaning that this report intended for an international audience. The report is 27 pages long and it is split into five chapters: a general introduction, materials & methods, results, lessons learned and outlook. The content of the report is about the study which the EAA conducted at the river Danube, giving a context of plastic and microplastics in the environment (general introduction), a description of the methodology used (materials & methods), reporting on the main findings of the study (results), giving recommendations for science and policy for further development (lessons learned) and giving an international outlook of the work on plastic and microplastics pollution on an EU level (outlook).

The other two reports were titled: "Mikroplastik in der Umwelt" (Microplastics in the Environment) and "Kunststoffabfälle in Österreich Aufkommen & Behandlung" (Plastic Waste in Austria Generation & Treatment). They were written in 2015 and 2017 respectively and, as their titles suggest, they were written in German. Each of them has an English summary of 2-4 pages long. The summary presents the main points of the reports. The report on Microplastics in the Environment is an overview of the issues related to microplastics, what is known so far, which aspects are problematized, and the potential sources. It also highlights, in the end, the "Need for Action". This report is related to the work of the laboratory of the EAA on the analysis and detection of microplastics in different samples. The other report on Plastic Waste in Austria, is very different in the way that it was written to monitor the generation and treatment of plastic waste in Austria in the year 2015 as requested part of the EU Circular Economy Action Plan. The structure of the report is similar to the others, first discussing the results of the study and the different shares of plastic

waste in Austria and concluding with recommendations for further development and policy making. The colours, style and structure of all three reports is very similar, which makes it visually recognisable that were all written by the EAA and highlights that writing these reports is a common practice within the agency.

My materials for this research were qualitative interviews and documents. Although, these materials were analysed together, they also differ. Interviews are materials produced with me as a participant while the reports are produced by the EAA without my involvement. The reports pre-existed my research whereas the interviews as materials were co-produced by the interview partners and myself. All materials are analysed by me, but I was not part of the production of both. What I want to highlight is that even though these reports were produced independently of my research, they are not seen as more 'truthful' than the interviews. "Paperwork does not simply *describe* an external reality 'out there': Documents also take part in working upon, modifying, and transforming that reality" (Asdal, 2015, p.74). In this way, both types of materials are performative. They both enact different socio-material realities. This does not mean that they are the same; they have a very different function and material existence. For example, documents are not only produced but they also travel and modify realities by drawing connections and relations.

"Texts do not stand in a random relation to reality but are already part of reality, and textual work helps different actors renegotiate and modify that reality" (Asdal, 2015, p.88). Asdal suggests that documents, especially bureaucratic documents, are not passive agents, but they do what they call 'modification work'. In other words, "documents specify desired connections among people, objects, times, places, and events and thus constitute a structure of relevancies for discourses about organizational practices" (Shankar, Hakken, & Oesterlund, 2017, p.71). As such, these reports not only provide information about the work of the EAA, but they actively connect actors and objects, modify issues and concerns, and render certain things as visible. In a way they *gather* actors, issues, practices, discourses, things and concerns and enact a particular reality. In order to understand these *gatherings* and connections that documents create, not only should the content of the document be considered, but also "How it is produced, how it functions in episodes of daily interaction, and how, exactly, it circulates" (Prior, 2007, p358). Interestingly, all three reports were discussed during the interviews, their context, content, circulation and purpose. In this manner, through the interviews, but also through the contextualization work I did, I explored their circulation, by whom are they read and in which networks they flow.

5.3.3 Contextualising – field notes, memos and messy research

So far, I have described the main materials of my research, which were coded (discussed below). Additionally, I read numerous other materials on which I took notes, and even wrote seminar papers about.

As I said, I started reading about plastic a year before conducting my interviews and this research was for purposes beyond this thesis. I have done extended literature searches on social sciences journals and books, and also followed debates on plastic and microplastics in news medias and regulatory realms. I followed closely the discussions on the EU Plastics strategy, read the strategy and all related documents, and read responses to the strategy and the voluntary commitments published by the industry afterwards. I followed the campaigns launched by the European Commission on Plastics, their roadmaps on single use plastics and read the responses and comments from diverse actors. I watched videos from the ECHA explaining microplastics and their definition, read conference programmes, and watched minutes of discussions about plastic and microplastics on YouTube. Using the WISO database to search for newspaper articles in the so-called 'German speaking world', I searched for when newspapers articles began talking about plastics in Austria, and what were they citing or referring to and what the debates about. I wrote two seminar papers on plastics, and for one of them I conducted participant observation and an interview in a natural science laboratory working on plastic and microplastics pollution. I had numerus discussions about plastics in my work and with friends, colleagues, and family to the extent that everyone started texting me or sending me emails about any plastic related texts that they came across.

All of the above experiences, some directly others indirectly, informed and contextualised my work to a large degree. Perhaps it is not as easy to say how, but it is through this research that I decided to write my master thesis about the EAA in the first place. During this time and after my interviews, I kept field notes and memos in written and also recorded forms. I made notes about what surprised me, what questions I have and what is not clear yet. All of this 'other' research not only contextualised my work, but also changed how I see plastic in and out of my research. This contextualising work is perhaps the most messy part of my own research, which I kept messy, attending to what Law (2004) calls for, and tried to find my own creative way through this messiness.

5.4. Methods of analysis

5.4.1 Situational Analysis

The methodology used for the analysis of the materials was Situational Analysis (SA) as elaborated by Adele Clarke (2003, 2005). According to Clarke, SA is an effort to push grounded theory analysis to the postmodern turn. Grounded theory is a widely used method of qualitative data analysis first described by Glaser and Strauss (1967) based on coding and memo writing methods. Although SA is based on these methodologies, it is an effort to further develop data analysis both conceptually and methodologically. Clarke (2005) argues that grounded theory still holds several modernist underpinnings such as reducing complexity, not reflecting on the conditions of power and in some occasions, even holding positivist understandings of objectivity. The author sees SA as a way to move grounded theory to the postmodern

turn and open it up to the complexity and reflectivity of the situation analysed and of the position of the researcher. Clarke proposes the methodological use of mapping as a technique, not as an end-product, but rather as a way to open up the data and be able to map what is visible and what might stay invisible through other analytical methodologies. They describe three cartographic approaches:

> ❖ Situational maps that lay out the major human, nonhuman, discursive, and other elements in the research situation of concern and provoke analysis of relations among them;
>
> ❖ Social worlds/ arenas maps that lay out the collective actors, key nonhuman element, and the arena(s) of commitment within which they are engaged in ongoing negotiations, or mesolevel interpretations of the situation; and
>
> ❖ Positional maps that lay out the major positions taken, and not taken, in the data vis-à-vis particular discursive axes of variation and difference, concern, controversy surrounding complicate issues in the situation. (p.554, Clarke, 2003)

In this work I used Situational Maps; specifically, I used messy situational maps and applied a relational analysis as described by Clarke (2005), remaking them into relational maps. I did not use social worlds/arenas maps because this methodology has a strong focus on discourses, which would change the focus of my interest. I also chose not to use positional maps due to their strong focus on human actors through the mapping of specific opinions. As my interest was on materiality, situational mapping offers a great approach to the multidimensional issue I am approaching.

Particularly, SA offers tools to explicitly approach materiality and the nonhuman, something that classical grounded theory lacks, and most importantly something that I am particularly interested in. SA is designed in such ways for "explicitly including all analytically pertinent nonhuman (including technical) elements along with the human in situational maps . . . Nonhuman actants structurally condition the interactions within the situation through their specific material properties and requirements and through our engagements with them" (p.63). It is this focus of SA that eventually, not only allowed me but also directed me in my research to explore the enactment of the material properties of plastic while at the same time relating to broader discourses. The particular situation I explored in this project is the processes through which plastic becomes a matter of concern in the EAA through the enactment of its materiality.

Mapping with SA requires data that was coded. I transcribed all four interviews using the program 'Express Scribe' in a verbatim manner, meaning that I transcribed everything that was said, the way it was said. After, I did an initial coding by switching from line to line and incident by incident, coding as described by Charmaz (2006). I first coded the interviews, and then I moved to the reports; by doing this, the coding of the reports was heavily influenced by my coding of the interview, which meant that practically there

were some codes that I used from the interviews to the reports. Through the process of coding I had already identified some codes that I thought were very interesting and I decided to include them in my mapping.

I first started with the messy situational map, in which I included all human and nonhuman actors, discursive elements, material elements, and also the codes that I found interesting from the initial coding. It was very important at this stage that I included the material properties of plastic discussed in the interviews and reports in the maps. I continued with the relational maps, which allowed me to see how these codes related to each other but also to the other elements of the map. I made several relational maps, in which I placed material aspects in the middle and thought through their relations to the other elements on the map. Clarke describes that when making situational maps "*The key question is what the nonhuman things really "matter" in this situation of concern*" (Clarke, 2003, p.563, emphasis original). The situational maps really helped me reflect on the position of plastic and its material properties and then through the relational maps I was able to create connections and position them in the debate. These mapping techniques provide a special opportunity for placing human and nonhuman actors together to explore their relations.

"It is important to note in making situational maps that the maps produced are not necessarily intended to form final analytic products. They are meant to open up the data, stimulate thinking, generate codes, make memos based on analytical work and recognise sites of silence" (Clarke 2005, p.108-109). The constant writing of memos through the process of mapping is what Clarke sees as the intermediate to the steps of the analysis of the materials and writing up the results. Indeed, reflecting on relations, positions and the role of the nonhuman in my memos was key to being able to write about my results. I wrote memos from the very first step of my research, reflecting on my ideas and impressions of my interviews to the transcription, coding and mapping the materials.

5.5. Ethical Considerations

"Qualitative research is saturated with moral and ethical issues" (Brinkmann & Kvale, 2005, p.157) and it is only through the practice of doing qualitative research that one really understands and gets confronted with this saturation. During my research, I followed the legally binding ethical aspects of conducting qualitative research, such as providing a detailed informed consent, but as Markham (2004) describes "Reflexive ethics is a stance that views ethics as a dialogic process rather than a set of values or principles" (p.50). And by following this stance I will discuss the main issue that has come up in my research, a common issue, namely that of anonymity.

In this thesis I have made an explicit choice, which is to use the actual name of the agency as it is. This choice is to some degree an act of exposure. Perhaps because that during the access negotiations and discussions with my participants, some of them were worried about what I would write about them, and how they, their work and the agency would be presented in my work. I guaranteed personal anonymity and

discussed the details. This anonymity means that there is no direct link between the quotes to the person. To further protect the anonymity of my interview partners, considering that I have already used the name of the agency, I decided not to specify the department each interviewee works at in order to protect their identity. This decision has influenced the way I present my results and, in some ways, places some restrictions. However, following the reflexive ethics that Markham talks about, I made the decision as an analyst about my ethical stance *in practice*.

6. Empirical Results

Before starting my research, I had already been reading for more than half a year read and followed the debates on microplastics (meaning the smaller plastic pieces mainly from the break down of larger plastics) in STS but also in the media. My Facebook newsfeed was full of microplastics stories and what threats microplastics pose to the marine wildlife and environment. I followed the discussions on the impacts of microplastics in the marine environments and wildlife and the difficulties and uncertainties of how to calculate such impacts. A lot of the discussions were focused on the marine ecosystems and the environmental concerns posed. Additionally, the research and methodology needed to identify and calculate the amounts and impacts of microplastics were discussed[9], which instantly drew my attention because it unfolded the complexity and depth of the issues of microplastics in the environment. There were many scientific groups advocating for different methodologies for how to capture microplastics, and how to identify different types of microplastics at different sizes and calculate the amount of microplastic marine pollution.

Although, as I mentioned, I followed these debates closely, I did not come across the work of the EAA in scientific literature but rather, mentioned in the news. I later learned this is a structural issue and requested output of the work by the EAA, which requires published reports and not scientific papers and therefore these reports are considered gray literature rather than classical scientific literature cited in academic journals. These reports, which are the output of their work, are different from typical scientific papers. In their reports, they are not only discussing the methodology and results of their research, but they are further discussing what these results mean for future policy making. It immediately drew my attention that the EAA was not only discussing scientific methodology in detail, but also discussing regulatory measures; they were bridging the scientific aspects with policy recommendations. As a trained biologists and social scientists, I was used to reading scientific papers and it was unusual to me to read such a report. Additionally, their work was not focused on the marine environment, which most of the literature was referring to, but on the river Danube. Therefore, it was these interesting aspects of the EAA work that

[9] See the section of the state of the art for more information on these debates.

captured my attention. I started doing background research on the work of the agency on microplastics and I found that they run a laboratory specifically working on the analysis of microplastics. One could send them samples and they could analyse different parameters, such as size, number, and chemical composition. I also collected the two publicly available reports on microplastics in the environment, in which they present and discuss their work on microplastics in the Danube river and further steps to tackle the issue of microplastics pollution in the Danube. At this point, I was sure that this was a really interesting topic for my thesis; it's going to be about microplastics and the EAA.

I contacted the EAA via email explaining my work and interests and I was redirected to a person coordinating the work of the agency on microplastics. I was able to get a first informal meeting with this person in order to further discuss my research interest and practical steps. From my first meeting at the EAA I felt at times confused; are we talking about plastics or microplastics? I thought that we were talking about microplastics, but then the discussion drifted fast from microplastics to the plastics industry, to pellets, to bioplastics[10]. The confusion did not steam from a deficit of information or lack of knowledge, but the opposite, it was the overwhelming amount of (what at the time I understood as) different topics that created confusion. This *multiplicity* of issues also occurred in my interviews. My initial interest was on microplastics and for some time I was so fixed on this idea and I could not see what my interview partners were showing me; that we cannot talk about microplastics if we don not talk about plastic more broadly. Meaning that we cannot talk about microplastics as an environmental concern without addressing all the other issues that surround plastic as a material. Microplastics are made of plastic, or to put it in chemistry terms, out of carbon-chain polymers, and microplastics are not the only matter of concern about these polymers. Microplastics are perhaps the largest environment concern of the 'plastic problem' and judging from my own initial interest, are also a very publicly visible one, but my interviewees showed me that this is only one aspect of the discussions on plastic. From the Danube, to recycling, to waste treatment, and to plastic production and bioplastics, plastic gathers entities around it in networks that cannot be easily disentangled. I was so fixed on my idea of holding the perfect master thesis topic that initially I could not see the webs that plastic brought to me.

Perhaps my fixation on microplastics had to do with the assumption that the EAA is dealing with environmental issues in the singular way. I was therefore confident that microplastics would have been the major issue of concern since it has been framed as an emergent environmental issue. Again, through my fieldwork, my participants showed me that an environmental concern is never just an environmental

[10] What is bioplastic, as discussed later in my results, is not always clearly defined. It mainly refers to plastic produced by plant materials, such as straw, but sometimes it is confused with biodegradable plastic and therefore instead of the term bioplastics sometimes the term bio-based plastic is used to point to the material used to make plastic. Not all bio-based plastic is biodegradable and vice versa.

concern; it is an issue that gathers many different concerns and relates to other aspects, such as economic aspects. The issue of plastic is not singular, but *multiple*.

In each interview I conducted another plastic appeared on the scene and was discussed to the degree that I was not really sure if we were talking about microplastics. How can I make sense of this complexity? Until I started my analysis, I was not sure what I would write about. I wanted to write about microplastics, but then I got confronted with so many *different* plastics; *different* issues; *different* concerns. I had to engage with the multiple realties that plastic enacts and is enacted in. *"You have social problems, environmental problems, you have problems or challenges in trade, economy, it's of course a very big field in this complex material"* (Interview 2). My participants were aware of the complexity and multiplicity of plastic, perhaps not in the theoretically informed way that I describe it in this thesis, but in their practice and work with plastic. One participant described how they organised discussions with other stakeholders on bio-based plastics (bioplastics), to talk about future developments and their discussions kept ending up on issues such as recycling, which was beyond the scope of the initial planned topic of discussion. This is an example showing how my participants have experienced through their work the multiple connections of the networks that plastic creates. My initial focus on microplastics was not only narrowing my scope, but it also did not allow me to navigate all the connections that my participants were drawing during the interviews. Their perspective on the different aspects and networks of plastic showed me different *gatherings* of humans, plastic, institutions, methodologies and issues.

When I started making my situational maps I started to realise the different *gatherings* in which plastic was entangled and the relations and connections drawn. It was then that I realised the diversity of topics in my materials beyond microplastics. Microplastics were discussed in particular ways and in relation to particular entities. Microplastics were discussed in relation to the environments, the marine environment, the Danube, in relation to fish and birds, but also in relation to human health and commercial products. In this process, my main focus transformed from microplastics to a description of a material property of plastic, namely its size. It was the realisation that what was problematized about microplastics was their size, and this allowed me to ask which other material properties of plastic are being discussed? I started following the material aspects of plastic, such as chemical composition or solubility, discussed in my materials and then mapped the relations of these properties to different entities. In other words, I placed not only the material plastic in the center of my research, but its different material properties as separate entities in the gatherings of the networks that enact plastic as a matter of concern. I was able to then map their relations with human entities, nonhuman entities, more-than human entities, concerns and issues. Soon I realised that here were specific *gatherings* in which microplastics were discussed, in which the size of plastic was a matter of concern and there were others that the size of plastic was absent as a concern. These different *gatherings* I describe here as *sites of concern*, inspired by Latour (2005) who wrote that *gatherings* are

"sites able to assemble" (p.13). Therefore, these *sites of concern* are sociocultural, spatial and material gatherings in which specific material aspects of plastic become a matter of concern through the negotiations of their materiality. *Sites of concern* are the multiple realities that plastic enacts and are enacted in, through the relations of human and nonhuman entities. In each *site of concern* there are different actors involved, different institutions, politics, spaces and research; and it is in these *sites of concern* that the material properties of plastic become political through constant relations and negotiations between entities.

In the first part of my results (6.1), I follow plastic in and out of the EAA to the Danube and into European policy making arenas in an attempt to give a (hi)story of the relationship between plastic and the EAA. In the second part (6.2), I map the complexity of plastic through its material properties and describe the *sites of concerns* in which different material properties of plastic become matters of concern. I use the help of diagrams to map out this complexity, which helps visually the reader at the risk of giving the illusion of fixation and stability. These diagrams are performative the same way as my empirical materials are, they don't represent a fix and stable 'truth', but they perform one understanding of what it means to work with plastic and how the plasticity of plastic is enacted. Additionally, it is important to note that I made these visuals therefore it is part of how I enact plastic. My active role as a researcher is shown through these visuals as one who is organizing and enacting plastic in my own research.

In the third part (6.3), I discuss the definition of microplastics as an example of how different *sites of concern* relate to each other, but also how plastic through its materiality complicates and resists a uniform definition. In the last part of my results (6.4) I describe the matter of visibility and invisibility of plastic and how both visible and invisible plastic is perceived as problematic depending on where they are found and where they belong to. Additionally, the issue of who is rendering plastic visible is discussed as a way to order what is plastic and what is not.

6.1 Following plastic

6.1.1 In the Danube

The Danube so colourful: A potpourri of plastic litter outnumbers fish larvae in Europe's second largest river. This was the title of the article published in Environmental Pollution Journal reporting for the first-time numbers of plastic items in the river Danube. The study was conducted by scientists from the University of Vienna and the University of Natural Resources and Life Sciences (BOKU-University) in Vienna and the samples were collected at the site between the city of Vienna and Bratislava at the region of the "Danube Alluvial Zone National Park" (Lechner et al., 2014). The sampling for the study was conducted in the years 2010 and 2012 and it was published in the early 2014.

On 6 of March 2014 the German newspaper *Spiegel* reported on the abovementioned study. "*In der Donau schwimmt mehr Plastik als Fisch" ("There is more plastic than fish in the Danube",* my translation*)*

by picking up the language used in the aforementioned research paper. Plastic in the Danube became not only a visible issue, but was turned into a matter of concern. As one of my participants described, when asked when the starting point of their work with plastics was: *"The initial starting was April 2014 when an international, a scientific publication on plastics in the Danube river was issued, which caused tremendous echo in the media, also on the political level in Austria. So the ministry was much concerned that they asked Umweltbundesamt to deal with this issue, to have this project on elaborating facts on the transport of plastics in the Danube river." (Interview 1)*

This first study identifying plastic in the Danube River had a political impact. The Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW) - which after January 2018 was named Federal Ministry for Sustainability and Tourism (BMNT) – requested from the EAA to conduct a further study on plastic in the Danube river and to report on recommendations for further policy making. That was the initial point for the EAA to start working with plastic in the environment. In 2014 their laboratory for analysing microplastics was set up, in which the analytical work of the samples from the Danube River was done. This laboratory functions today as an analytical laboratory for microplastics. Samples from different sources can be sent there for analysis, from industrial sources to consumer products.

In 2015, the EAA published their reports on plastic and microplastics in the Danube river (in English and in German) in which they report on the details of their study, but also conclude with further recommendations and future steps. The study concluded that 40 tones of plastic are passing through the Danube River every year. The number 40 tones soon became a headline of newspaper articles in Austria and Germany, but it also reached the British newspaper *Guardian*, reporting on the plastic in the Danube (McGrath, 2016). As they *Guardian* wrote, the Danube is the world's most international river, meaning that it flows through 10 different European countries starting from Germany and all the way to the Black Sea. This also explains to a certain degree why plastic in the Danube found in Austria is featured on international news rather than just local news.

Later in 2015, Andrä Rupprechter, the former minister of Agriculture, Forestry, Environment and Water Management, presented the 10-point action programme (Umweltbundesamt, n.d.-a). "Jetzt haben wir aussagekräftige Daten auf dem Tisch. Mit einem 10-Punkte-Maßnahmenprogramm setze ich mich auf europäischer und nationaler Ebene für saubere Gewässer ein." Federal minister Andrä Rupprechter ("Now we have meaningful data on the table. With a 10-point action program, I am committed to clean waters at European and national level." as quoted in Umweltbundesamt, n.d.-a, my translation), This 10-point action program, included 5 steps to pursue on a European level, such as harmonization and standardization of methodologies for the identification of microplastics, but also setting EU wide limit values for plastic pollution. The action program included also 5 steps to be taken on the national level, in Austria, such as raising awareness, initiating stakeholder discussions in Austria and achieving 'green events' such as the

Vienna Eurovision Song contest. Therefore, this 10-point action program highlights that even though the initiation of these discussion in Austria was triggered by finding plastic in the Danube river, the 'plastic problem', and more importantly how it can be tackled, is not only an Austrian issue or a local issue, but it requires actions beyond the borders of Austria to, at least, the European level.

One of the controversial issues about the first paper published in 2014, by researchers at of the University of Vienna and the BOKU-University, reporting on plastic in the Danube, was the amount of plastic that was linked to industrial sources. In this publication they divided the microplastic samples collected into four categories: pellets, flakes, spherules and other (Figure 3). They attributed the first three categories to industrial sources and reported that for the year 2010, 86% of the total load of plastic measured in the river Danube originated from industrial sources.

Figure 3: image retrieved from (Lechner et al., 2014)

This was followed up by the press which put pressure and responsibility on a plastic's production company located at on the Danube river (Werz, 2014). This was a very controversial issue, which also partially led to the decision of the Ministry of Agriculture, Forestry, Environment and Water Management to ask the EAA to study the flow of plastic in the Danube. The EAA used another methodology for sampling plastic and microplastics in the river, seen as an optimised version of the methodology used previously. They report that 4-10% of the plastic load is pellets and the rest comes from other sources, such as littering. It is important to understand that this issue of how much of the overall plastic and microplastics identified in the Danube can be attributed directly to industrial sources has political significance. Depending on the sources of microplastic pollution in the Danube there will be different political actions needed in order to restrict these emissions. It is therefore not only an issue of research and methodology, but also an issue that

shapes the political agenda and the actions that need to be followed in the future. The political action that followed these studies and controversies in the Austrian context was the 10-point action program published by the Ministry of Agriculture, Forestry, Environment and Water Management. As part of the actions to be followed in Austria was that the Ministry must sign the 'Zero Pellet Loss' pact with the Association of the Chemical Industry of Austria. This 'Zero Pellet Loss' pact was a voluntary commitment signed by 21 companies in the plastics industry in Austria. It includes 10 practical steps, such as implementing trainings for workers or new strategic planning, in order to minimise the emissions of plastic pellets, which are the plastic raw industrial material, to the environment. In other words, to have zero loss of these plastic pellets in the environment, such as in the Danube, hence the name 'Zero Pellet Loss' pact ("Pakt & Zero Pellet Loss & - FCIO" n.d.).

These public controversies and discussions about plastic and microplastics in the Danube and the involvement of the industry were building blocks of making plastic in the environments and matter of concern in Austria. These discussions were the trigger for the EAA to initiate their work on plastic and microplastics, but from the very beginning it was clear that these issues were not limited to Austria. They were not local issues that could be tacked locally, but on the contrary they were issues that demanded international and European action. At the same time, even though the starting point of their work with plastic was an environmental concern, namely plastic and microplastics in the Danube, it will become evident that their work later evolved and branched into many other fields of work and interest.

6.1.2 In Europe

In 11th and 12th May 2015 there was stakeholder conference with the title "Eliminating Plastic and Microplastic Pollution - an urgent need" initiated by the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW) and co-organised by the EAA, the Network of Heads of the European Environmental Agencies (EPA Network), the Dutch Ministry of Infrastructure and Water Management, the European Economic and Social Committee, the Latvian Presidency of the Council of the European Union and the EPP Group. This was the first stakeholder conference on plastic and microplastic pollution on the European level, which brought together industryy representatives, national and European policy makers, Environmental Agency representatives and NGO members. The main issue of concern was microplastics pollution and the urgent need for action highlighting how these different actors were *gathered* around this matter of concern. Additionally, it is evident that Austria, starting from the issue of microplastics in the Danube, took an active role in organising and initiating European discussions on plastic and microplastic pollution taking the role beyond Austria's borders and setting the issue of plastic and microplastic as a concern for Europe. The were three objectives identified for this conference:

“

- *bring together policy makers and other relevant stakeholders*
- *take stock of existing knowledge about plastic and microplastic entering the aquatic environment and to address gaps*
- *identify concrete next steps for effectively eliminating plastic and microplastic pollution in the aquatic environment”*

(“Conference Eliminating Plastic and Microplastic Pollution, 11-12 May 2015,” n.d.*)*

It is interesting that at this point the discussions about plastic and microplastic pollution are targeted at the aquatic environments, such as the sea and rivers, and it is later that findings of microplastics in soil and air will change the conceptions of what plastic pollution is, where it originates from and where it can be found. For example, the issue of car tire abrasion which creates microplastics that end up in the soil, but also water, is an issue that appears later in the discussions on plastic pollution.

At the Conference Eliminating Plastic and Microplastic Pollution there were presentations of different stakeholders. From Austria two people from the ministry of Agriculture, Forestry, Environment and Water Management presented; Elisabeth Freytag-Rigler, who is Head of EU Coordination, and director at the Ministry and Andrä Rupprechter, Minister for Agriculture, Forestry, Environment and Water Management in Austria. Additionally, Karl Kienzl the Deputy Managing Director of the Environment Agency Austria presented at this stakeholder conference in Brussels, which once again highlights the interest of Austria in the issue, the involvement of the EAA, but also the political significance that Austria gave to the issue of plastic pollution and its actions to bring it into the European discussion.

The conference was split in three parts, the first was to *“frame the challenge of eliminating plastics from the environment”* (European Network of the Heads of Environment Protection Agencies, 2015b) in which stakeholders form the Austrian Ministry, the Latvian Ministry of Environment, the Environmental Commission of the European Parliament, the United Nations Environmental Programme (UNEP) and the OSPAR (organization for the Protection of the Marine Environment of the North-East Atlantic) presented. The second part was about *“improving the knowledge base”,* with presentations from Environmental Agencies of Austria, Germany, Iceland, Sweden, Finland and Norway. These presentations were about the specifics of each country in terms of plastic and microplastics pollution to give overviews of the different issues and actions in each country. The presentation of the EAA was on their study on the Danube River, and they presented their methodological approach, but also the results of the study. In this conference the issue of plastic in the Danube, expanded as an issue of not only plastic pollution in Austria, but in Europe.

The third part of the stakeholder conference was *“A Stakeholder Dialogue with European Commission”* on *“taking further action to eliminate microplastic pollution”*. This session was opened by

Karmenu Vella the European Commissioner for Environment, Maritime Affairs and Fisheries, a prominent figure in the plastics discussion in the European Union, who is also one of the main actors for preparing the EU Plastics Strategy released in 2018. This session was followed by different stakeholder positions. Some from the plastics industry such as PlasticsEurope, the representative association of plastic manufactures and plastics industry in Europe, and from Borealis, one of Europe's biggest polyolefins (a plastic type) producers in Europe with its headquarters in Vienna and production sites in Austria, Germany, Netherlands and other countries. The association Cosmetics Europe, which is the trade association representing the cosmetics industry in Europe and the EurEau a European federation representing public and private provider of drinking and waste water were also positioned in this session. Additionally, the Marine Litter Policy Officer of the Seas at Risk association, presented in the stakeholder conference. There was a diversity of actors brought together in order to discuss plastics that once again exceeded the framing of plastic as an environmental concern and showed the complex actor networks that enact plastic. It shows how many different connections and relations, between human entities, institutions, policy organisations and plastics are formed in order to enact plastic as a matter of concern.

One of the next steps suggested in the conclusion paper of this Stakeholder Conference in Brussels in 2015 was that *"The members of the EPA Network having been present at the conference asked the Austrian EPA (Environment Agency Austria, "Umweltbundesamt") to continue the initiative for plastics/microplastics with support of other EPA Network members and stakeholders"* (European Network of the Heads of Environment Protection Agencies, 2015a). This illustrates the central part that the work of the agency has on the European level and highlights the connections between the EAA to the European discussions on plastic and microplastics. On the other hand, it also maps in a way the group of actors participating in the discussion on plastic and microplastics in Europe and once again illustrates the important role that the industry has in all its different forms.

Another next step following this conference was the establishment of an interest group as part of the EPA Network that would work targeted on plastic. The Interest Group Plastics (IG Plastics) was established in 2016 and it works as a group of experts and representatives from Environmental Agencies of certain EU states. Austria, Denmark, Finland, Iceland, Germany, Netherlands, Norway, Portugal, Romania, Scotland, Slovenia, Spain, and Switzerland are the states participating in the IG plastics with Germany being the chair and Austria the co-chair of the Interest Group. *"It was established to specifically work on plastics as one of the major topics of the EU Circular Economy Action Plan. This was agreed with the Interest Group Green and Circular Economy, to which it is thematically closely related. The focus of the IG Plastics work lies on land-based plastic inputs into the environment, as it is assumed that large amounts of plastics ending up in the oceans stem from land, however with significant regional differences"* (IG Plastics Discussion Paper). The interest group has a specific focus on plastic, namely on plastic as a concern

for the environment. By naming their focus, they are separating themselves from other Interest Groups such as the Interest Group Green and Circular Economy. At the same time, they also separate plastic as a matter of concern; plastic as part of the circular economy and recycling is a matter of concern in the Interest Group Green and Circular Economy and plastic in the environment becomes a matter of concern in the IG Plastics.

The IG Plastics wrote a discussion paper titled *"Recommendations towards the EU Plastics Strategy"* (IG Plastics, 2017). This discussion paper was written as a commentary and feedback on the Roadmap[11] of the EU Plastics Strategy published in January 2017. In this framework the IG Plastics provided the discussion paper with a cover letter addressed to the Commissioner Karmenu Vella with targeted recommendations for the development of the EU Plastics Strategy, which was eventually published in January 2018. This highlights the important role and influence that the IG plastics group had in the policy realms, but at the same time, the importance of the EAA, which co-chairs this group in the European policy discussions. Starting from the issue of plastic in the Danube river in Austria, to then leading discussions on plastic pollution in Europe to finally participating in European policy recommendations, the EAA becomes a central actor in Austrian and European arenas. It highlights that how plastic becomes a matter of concern at the EAA, is not only relevant for Austria but also beyond to how plastic is conceptualised in the European arenas.

The IG Plastics was established as a group to work on Plastics in the environment, plastic as an environmental concern. By doing this there is a move to disentangle plastic from other concerns and create plastic in the environment as a separate issue. Although this is the focus through the discussion paper it becomes apparent that it is impossible to purify plastic as one matter of concern, to make it singular. The recommendations, although targeted at solving the issue of plastic in the environment, touch upon recycling, biodegradable and bio-based plastics and waste management, fields that exceed plastic as an environmental concern and enter into other concerns regarding the economy or the plastics industry. These different *sites of concern* will also be discussed further in more detail.

Plastic gathers and creates relations and connections between many different actors in the European context, actors from the industry, policy makers, NGO advocates, seas, rivers, and fish. In these connections, plastic is enacted and performed as a *matter of concern*. It becomes the connecting tissue of these actors and gets reconfigured as a different *matter of concern* in different discussions and sites. In this section I illustrated the position and role of the EAA in the European discussion as a background on which this thesis unfolds. Although positioning my work and the work of the EAA is important, the main focus of this thesis is how plastic is enacted in the work of the EAA; how plastic becomes matters of concern and how its processual materialities come to matter is the focus of the next subchapters.

[11] A roadmap is on the one hand informing on work of the European Commission on a specific topic and on the other hand inviting for feedback from stakeholders.

6.2 Multiple materiality and sites of concern

6.2.1 Multiple material aspects of plastic

In my interviews, plastic appeared in many forms. We talked about plastic particles in the Danube, plastic bottles, plastic in landfills, bio-plastic, bio-based plastic, bio-degradable plastic; about plastic fibers and clothes, about polyethylene, polypropylene, PET or plastic in paint, in cables, about nano-plastic, plastic bags, or plastic pellets. There was a diversity of ways in which plastic materialised and how different material aspects of plastics became a matter of concern in different *gatherings*. As mentioned above, I call these gatherings, *sites of concern;* namely the sociocultural, spatial and materials arrangements in which the materiality of plastic becomes a matter of concern as a separate issue. I will discuss the sites of concern in more detail later, but first I want to outline the specifics of the material aspects of plastic that become matters of concern in the work of the EAA.

There are many different material properties of plastic that perhaps a chemist or a material scientist would describe. The purpose of this subchapter is not to create a list of all the possible material properties of plastic, but to illustrate that some of them become the center of discussion and contestation. I describe here seven different material aspects of plastic that become matters of concern in the work of the EAA: size, solubility, mass, chemical composition, degradability, primary recourse and shape (Figure 4). Empirically, I arrived at these material properties through the mapping and ordering of my materials. In my interviews, my participants were talking about many different plastics in different situations, and when I started coding I asked myself: what was the issue discussed? As soon as I started my mapping I realised that there are aspects of the material properties of plastic that were discussed and problematized in the interviews. I therefore asked which is the material property that becomes the issue of concern, when and where? Who and what is involved? I followed the material properties through my interviews and documents to understand the specifics. Later, I placed these material properties in my situational map in order to understand their relations with other human and nonhuman actors. Again, this does not mean that these are the correct material properties that one needs to follow or that there might not be others that are important, but these aspects were problematized in the situation I was empirically following.

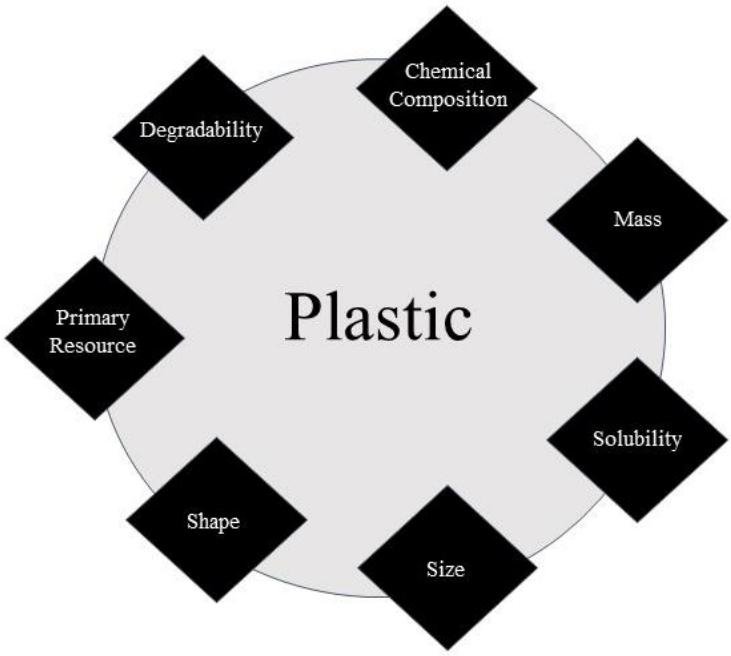

Figure 4. Visual representation of the material properties of plastic enacted in the EAA.

One of the most frequently discussed material aspects of plastic, and especially microplastics, is their size. The size of plastic particles becomes very important. In fact, when talking about microplastics there is already a focus on the size, on the micro. The working - and most commonly used- definition of microplastics is plastic particles under 5mm, which once again indicates how size matters when talking about plastic. Solubility refers to the ability of plastic to be soluble in liquid. It is important to think about the chemical state that the plastic is at, especially when defining plastic. In everyday interactions with plastic we are used to interacting with plastic in a solid form, but what about when they are liquid? Are they still plastics?

The mass of plastic refers to the amount of plastic; in other words, how much plastic is in a certain area? It is about the volume of plastic objects, fragments and items in, for example, a river or a trash system or a container. The chemical composition refers to the specific polymer type of plastic. For example, PET is one chemical composition of plastic. There are many different types of polymer structures that plastics are made of which are important since they inscribe and enact different ways that plastic interacts with the environment. For example, the polymer structure might determine if this specific type of plastic can be recycled or not. The degradability of plastic is its ability to be degraded. Degradation is a term that can mean many different things and in fact it is highly debated in many different ways. How and when can a plastic material be considered degradable is contested. In theory, all plastics are degradable at some far point in the future, in hundreds of years, but that does not qualify them as degradable materials. Therefore, what is the time span in which degradation is accepted as degradation? I will, unfortunately, not give a

definition of what degradation is, but here the term is used *in vivo;* I use the term as my participants describe it without giving it a fixed definition. Furthermore, the primary resource of what plastic is made of becomes a matter of concern. Plastic is mainly made from fossil fuels, such as crude oil. This is the 'traditional' primary source of plastic, but there are other resources that can be used to make plastic. There are the, so-called, natural materials, such as sugar cane. Once again, the definition of what counts as nature and what not originates from my participants rather than me applying a prefixed definition on my materials. One could ask why oil is less natural that sugar cane? This dichotomy of natural materials versus fossil fuels exists in my empirical materials and therefore once again I use these terms *in vivo* following the definition and dichotomies my participants enact. Finally, the shape of the plastic matters. Is it a bottle? Is it a cable? Is it a fiber? A granule? There could be countless examples of the shapes that plastic can take, since its ability to be molded into myriads of shapes is one of its success features. Although all the intentional shapes of plastic are included in this category, the unintentional ones, such as a fragment of a plastic chair are also included that bring new shapes and challenges into the networks.

This is not an exhaustive list of the material aspects of plastic, but these are the aspects that through my empirical analysis were enacted as matters of concern. An example of an obvious absence is that of plasticizers (chemical additives in plastic), which was not extensively discussed as a matter of concern. This does not mean that this is an aspect which the EAA deems as unimportant, but rather that they either do not directly work on this aspect, since also in the study they conducted at the Danube river they are not engaged in any toxicological analysis, which is where plasticizers are mostly problematized; or it could also be that this issue was missed in the interviews due to the specific focus of the discussion. Either way, it shows that there are obvious and perhaps less obvious absences, which might be important for further reflection. Plastic is a complicated material and I have no aim to map all the potential material aspects of it, but rather understand these material aspects as performative and follow how they are enacted and become matters of concern in the Environmental Agency Austria.

6.2.2 Multiple sites of concern

The material aspects described above are enacted differently in diverse *gatherings*. They are negotiated and become matters of concern in different *sites of concern. Sites of concern* refer to the sociocultural, spatial and materials arrangements in which particular material aspects of plastic become matters of concern through the negotiations of their materiality. Each *site of concern* has different entities gathered, humans and nonhumans creating new relations between them that enact an ontologically different plastic. *Sites of concern* are the multiple realities in which plastic becomes political. I describe five *sites of concern* in which the materiality of plastic is negotiated, namely the environment, the cosmetics industry, waste management, the plastics industry and the economy (Figure 5). Empirically, these *sites of concern*

emerged through my relational maps. When I started relating actors to each other there were clusters of relations and these clusters were the *sites of concern* I describe here. It is important to point out that these are the *sites of concern* enacted by my participants working at the EAA. They do not represent all aspects of plastic and its material relations in the world, but in the specific situation of the work of the EAA. These *sites of concern* are very heterogeneous and not easily comparable to each other, but my purpose is not to compare them, but rather to understand how the enactment of diverse material aspects of plastic in these sites make them a matter of concern.

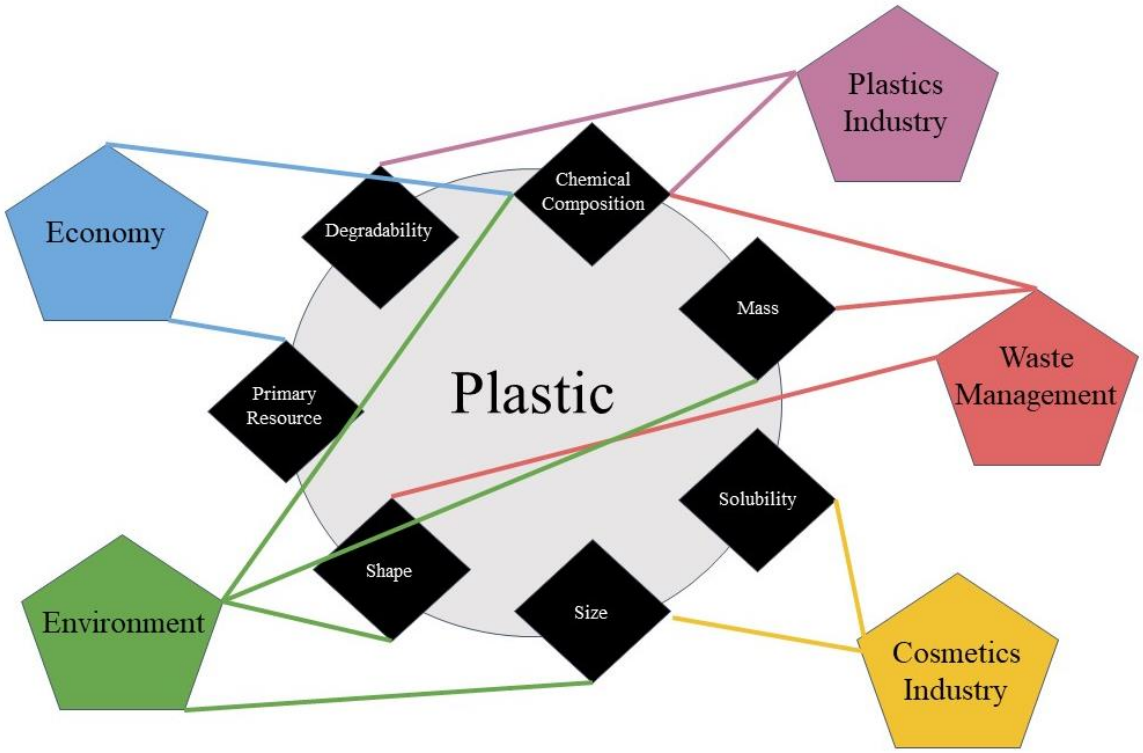

Figure 5: Visual representation of the sites of concern and different material properties of plastic enacted through them.

6.2.2.1. Environment

Environmental concerns about plastic and microplastics are very broadly known, and as I described above, my own interest started from this *site of concern*. Plastic in the river Danube was the initial point of work for the EAA and in these discussions the size of the plastic is a material aspect that becomes a matter of concern. Microplastics have been framed as a top environmental concern because of their size. It is hard to imagine talking about microplastics without thinking them as an environmental concern; the actual name 'microplastics' is directly connected with environmental concerns. Microplastics become political entities when they are found in the environment, in places where they do not belong. Their size becomes part of the problem because they cannot easily be cleaned up, but also because they can be swallowed by organisms.

It is therefore through this material aspect that specific concerns materialize, such as the animal digestion of plastic, and it again depends on the size of the plastic if this particle will stay trapped in the digestive system of an organism or of it will be secreted.

A question that is hard to answer is which material aspect of plastic is a problem for the environment? Which material aspect of plastic should be a matter of concern? *"Does the mass of plastics give a burden to the environment, or is a potential danger to the environment, or is it the number?" (Interview 2).* The answer depends on whom and for whom the concern is about. There are different techniques with which plastic in the environment can be analysed. One set of techniques can give you answers about the mass and chemical composition and another about the number, chemical composition and size. Both are relevant in order to answer different sets of questions.

The number and size of particles becomes relevant in relation to organisms, for example fish or birds in order to study and understand the biological effects of plastic and especially microplastics since they can be swallowed by organisms. *"If you think of organisms of like sea animals and so on if my jacket is floating around in the open ocean I don't think that a sea bird is going to swallow my entire jacket, but if there are smaller pieces floating around this makes it different and for some problems it is important to know about the number" (Interview 2).*

The mass becomes important when trying to understand where the plastic comes from and although it is discussed as an environmental concern, it is mostly attributed as a waste management concern (which will be discussed later in more detail). *"Sometimes the mass is more important thinking of for example, if you look at the effluent of waste water treatment plant, how many million of particles there is, it's difficult to have a feeling what that means, but if I tell you it's one gram per year or it's hundred tons of plastic per year, you can asses the problem in a more tangible way" (Interview 2).* Interestingly, measuring the mass of plastic also reflects the kind of policy that could be applied. For example, when measuring mass and enacting mass as the matter of concern then policy directed to value limits can be applied. Meaning, over which amount of plastic does plastic become a burden to the environment? Is it a kilo, two kilos, one tone?

The chemical composition of plastic becomes a matter of concern in two ways. First, the chemical composition is used for distinguishing plastic from everything else. It becomes the final certification of whether or not a particle is plastic. The chemical composition analysis is the one that will distinguish if a particle is sand or plastic. Additionally, the chemical composition together with the shape of a plastic particle can give information about where the plastic particle comes from. *"If you find lots of PET for example, you can think of a source that is plastic bottles. Many plastic bottles are made from PET. If you add visual information, like the particle shape to it, like fragments seem to be from a bottle also yeah, you can track back a potential source" (Interview 2).*

In this site of concern, the size, mass, shape and chemical composition of plastic become matters of concern and are enacted differently as issues to be addressed. In other words, asking what the plastic problem in the environment is could be viewed through these different material aspects. The problem is enacted through the materiality of plastic and at the same time the materiality itself emerges as the problem. Is it the number, the size or the mass of plastic that becomes a problem for the environment? Is the problem where does the plastic come from? The material aspects of plastic become the center of contestation, they become the matter of concern through the enactment of their materiality and show what plastic can do.

Additionally, in contrast to the other *sites of concern* this is the most publicly viewed one. There are many public groups that hold a strong interest about plastic in the environment such as NGO's, media, and citizens. This is the site where the work of the EAA on plastic was initiated and there is a strong demand for answers, for solving the concerns related to the environment. This demand has also created pressure for the people working in the EAA to give answers and to propose actions. This *site of concern* in many ways is present as the most prominent aspect of the discussion on plastic and to a certain degree it becomes equivalent to the 'plastic problem'. This, in a way, equates and fixes plastic as an environmental concern, which overshadows and does not account for all the other realities that unfold with plastic.

6.2.2.2. Cosmetics industry

Plastic participates in the cosmetics industry as small plastic particles used for the enhancement of the effects of a certain product. Evidently there are many more uses of plastic in the cosmetics industry in the form of plastic bottles or containers, but it is the intentionally added small plastic particles that become a matter of concern. These plastics are also called microbeads and they are added to enhance a certain product such as make-up products, body creams, soaps and toothpaste. The intentionally added microplastic in the cream, not the container of the same product, becomes the matter of concern and it is therefore the size of the particles that is problematized. These particles can be washed through the water system directly to lakes or oceans and they therefore become a concern for their possible environmental impact. When they are in the product they are a concern of the cosmetics industry, but when they are washed down to the lake they become an environmental concern, even if the particle itself is not changing the *site of concern* is. Similarly, to the previous site of concern, the environment, the size of the plastic once again becomes a matter of concern. It is the size of the microbeads that it is problematized, since due to their small size they escape the filters used in water systems and get released into the environment.

Additionally, the solubility of plastic becomes a matter of concern illustrating how many diverse material aspects plastic has which are enacted in specific arrangements, *"for example, if I am a producer of a certain product and […] let's say, I have a water soluble powder and I put it into my water, I stir it and it's gone. The molecules are still there but there are no particles. And then the question is […]: are there*

microplastic particles in there?" (Interview 2). This quote illustrates how the solubility of plastic could define if there is plastic or not in a product. Is plastic only plastic in solid form? Or is plastic a matter of concern only in the solid form? Is it a problem when plastic is in liquid form and released into the environment?

My participants described that in this *site of concern,* the size and solubility are the matters of concern. There is an evident relation of this *site of concern* to the previous one about the environment. For example, in both the size of the microplastic particles is important, but plastic is reconfigured differently in this *site of concern*. What matters here is the intentionality and its potential prevention. Although there are similarities, this difference triggers another way of thinking about plastic and policy making in this *site of concern* than in the environmental *site of concern*, which ultimately conceptually separates them. Specifically, the European Chemicals Agency -a newly founded agency that consults the European Commission - has an ongoing working project on intentionally added microplastics in consumer products. They target only the intentionally added microplastics, not the unintentional microplastics from the break down from larger plastic objects or other plastic leakages. Their work is on finding a definition of microplastics in order to restrict the use of intentionally added microplastics in commercial products. This is an example of how the policy-making path is very different regarding this *site of concert* with different institutions and actors working on the matters of concern that the material aspects of plastic enact. The matter of finding a definition for microplastics will also be discussed later and how tensions of what comes to matter arise through searching for a definition.

6.2.2.3. Waste Management

Another *site of concern* is waste management where mass, chemical composition and shape are the material properties becoming matters of concern. Waste management includes all the arrangements of humans and nonhumans that need to gather in order to practice waste management, in this case in Austria. Therefore, the question in this *site of concern* is how does plastic become a matter of concern in these practices and relations? As mentioned above, measuring the mass of plastic is important for waste management. In other words, waste management is concerned with the amounts of plastic waste produced at a certain place at a certain timeframe. For example, in the study that the EAA conducted on plastic on the river Danube they identified that 40 tons of plastic are passing through the Danube every year. Then the work of waste management is to understand: *"How much waste has been treated in the same time, how does defining of 40 tones, maximum of 40 tones in the Danube per year, how does that compare to the overall plastics, which has been processed in waste treatment in Austria?" (Interview 4).* The mass of plastic becomes the matter of concern, how much plastic is being treated in Austria and how much of this

is 40 tons? Is it one percent, ten percent or fifty? The amount of plastic enacts concerns and raises questions about its treatment and end life.

Measuring the amount of plastic in environments such as the Danube is one place in which the mass of plastic becomes a matter of concern, but there is another one. Austria, under the request of the EU Circular Economy Package, needs to calculate the amount of plastic waste for the year 2015, a task given to the EAA. This calculation of mass is targeted at waste that has been treated or even recycled in contrast to the plastic that is found in the Danube. *"To examine […] how much plastic waste is generated in Austria for the reference year 2015 [...] we also want to collect data regarding all these waste streams, they include different shares of plastic …" (Interview 3).* Therefore, the place changes from the river to trashcans, waste treatment plants and recycling systems.

A waste stream is a waste fraction; for example, bio-organic waste is one waste stream. The categorization of waste streams, waste types and waste codes can be different in the EU and on the nation state level. In Austria plastics do not have their own waste code, but they are different shares of plastic in different waste streams. *"We collect in Austria bio-organic waste, which is separately collected in this Biotonne, and some people collect it at home in normal plastic bags and they put the full plastic bag with the bio-organic waste into the Biotonne, so you have in this waste stream there is also plastic inside. It shouldn't be, but it is in the reality" (Interview 3).* Plastic exists in almost every waste stream, even at places where they 'do not belong to', such as bio-organic waste.

In order to calculate the overall mass of plastic waste one needs to disentangle plastic from other waste. There are 6 types of plastic waste according to the EAA in order to classify them into working categories:

"(1) "pure" plastic wastes (plastic wastes in the narrower sense, such as polyolefins, plastic films, plastic containers and containers, etc.) [KS-Abfall]
(2) Solid waste containing plastics (waste types with different share of plastic such as substitute fuels, end-of-life vehicles, etc.) [KS-h-Abfall]
(3) Paints and varnishes [F&L]
(4) Cured paints and varnishes [F&L ausgehärtet]
(5) Plastic sludges [KS-Schlämme]
(6) Plasticizers [Weichmacher]" (Report 3)

Pure plastic waste is made of 100% plastic, such as a plastic bottle. The solid waste category includes items such as a laptop, which is made from plastic, but also by other materials. Plastic sludges are coming from wastewater treatment processes and plasticizers are chemical additives used in the process of

producing plastic in order to give them specific properties or colour. These different categories give an idea of the diverse states, places and items in which plastic can be found in waste management. In order to calculate the mass of plastic, there needs to be a disentanglement of plastic from other materials. How much plastic is on a varnished wooden board? How much plastic is on a cell phone? The disentangling of plastic requires a particular kind of work that attends to the materiality of plastic in comparison to other materials. Plastic can be found in so many different shapes and forms, which complicates the calculation of its total mass.

Beyond the mass, the shape and the chemical composition also become matters of concern in waste management. The chemical composition of plastic becomes a matter of concern in relation to recycling plastic. Recycling is part of waste management and it is this part of waste management that intersects with the economy. Recycling is a way to turn waste into economically valuable goods that can be recycled back into the economy. An example of the role of the chemical composition in waste management and recycling is that of the PET bottle, which is seen as a successful example of a product in the circular economy. *"A PET bottle it's collected separately in Austria and going to recycling, so you have some recycling companies who make flakes of it. So, you have then these small pieces and then there are other companies who produce new bottles and they want to buy these flakes. So, this is I think a good example for circular economy" (Interview 3).* In this example, recycling gives value back to the PET bottle. The key is that not every bottle or every plastic can be recycled, but it is the chemical composition of the bottle that enables it to be recycled in the economy.

The combination of shape and chemical composition of plastic becomes the matter of concern for waste management and recycling. Plastic in the form of paint, in the form of a bottle or a cable is problematized differently because of its shape and its entanglement with other materials. It is the orchestration of the chemical composition and the shape that make the PET bottle a successful example. *"When you make flakes from another kind of material like I don't know PP or PS then, and you make flakes and you make then, I don't know, in the first stage it was shampoo bottle and then you make flakes and make then some chairs, yeah plastic chairs then it's a kind of recycling but it's down cycling" (Interview 3).* For the recycling to be successful, chemical composition and shape must be preserved and recycled back into the economy.

6.2.2.4. Plastics Industry

The plastics industry is a very large *site of concern* and here it is important to highlight that the EAA is not part of the industry, but their work can be related to the industry. For example, they have stakeholder meetings, in which they discuss parts of their work with industrial stakeholders or analyse samples provided by industrial companies for their internal industrial assessment. The plastics industry can

be divided in two parts. The plastics production industry; the ones that produce plastic flakes of a certain chemical composition from, most commonly, fossil fuels (oil) such as polyethylene flakes. The second part is the plastics converter (plastics treatment) industry; they combine plastic with other materials or chemicals, such as plasticizers, in order to produce certain products.

The plastics industry is one of the biggest stakeholders in the discussions about plastic at all different levels. They hold a very strong interest in plastic due to their economic relations to this material. Nevertheless, plastic becomes a matter of concern in theses industry negotiations differently than at other *sites of concern*. My participants discussed that the chemical composition of plastic is important. Plastic producers are defined by the particular type of plastic they make, and this also gives them access to different markets. There are certain chemical compositions of plastic that are used for specific purposes. For example, plastic packaging is mainly made out of polyethylene while nylon is mainly used in clothing. Therefore, specific chemical compositions also indicate different markets. In other words, the chemical composition becomes a matter of concern for the plastics industry in relation to the value and market share of each type of plastic.

Additionally, the ability of plastic to degrade becomes a matter of concern. The degradability is closely related to the chemical composition of plastic, but it is differently enacted as a concern. As one participant described *"you might have heard about the oxo-plastics, well, manufacturers say they degrade within a certain period of time and they do nothing else than breaking into smaller chains and producing microplastics" (Interview 4).* Can a plastic product degrade? Where and after how long? The aspect of degradation is a concern in relation to the plastics industry since there is an emergent need to address the issue of plastic in the environment. For example, oxo-plastics were initially thought of as a solution to the issue of non-degrading plastics. Oxo-plastics can be made when adding specific chemicals to conventional plastic that helps them degrade faster. However, later oxo-plastics were seen as problematic since they accelerate the break down of larger plastics into microplastics and this was not seen as the desirable degradation process for plastic in natural environments, since it added to the increasing amounts of microplastics. Therefore, ultimately the question is: what is degradation and in which timeframe should it happen? This is an empirical question that I cannot answer in the spectrum of this thesis, but it becomes evident that degradation is a material aspect that becomes a matter of concern in the plastics industry.

6.2.2.5. Economy

The last site of concern is the economy. The economy is of course a very large term and in relation to plastic there are many different economies described, such as the new plastics economy, an initiative lead by Ellen MacArthur Foundation to find new more circular ways of plastic in society and economy; the circular economy, an industrial economic system which the European Union is highly endorsing; or the

bio-based economy, an economic system that places biotechnology as the driving force to change industrial and societal processes. These are some examples of the divergent economic systems plastic is discussed within. What I want to describe with this *site of concern* are the negotiations in which plastic participates in relation to trade and the economic system. Although this *site of concern* is very interconnected with the plastics industry, there is a difference between them since the economy is a larger concern in which nation states or the European Union hold a strong interest. In other words, the plastics industry *site of concern* could be seen as a part of the economy, with the latter including more aspects.

In the economy, the chemical composition of plastic is problematized. It becomes very important especially in relation to recycling. If and to what extend can a material be part of the circular economy depends heavily on its chemical composition. As discussed before, the example of the PET bottle is one that is illustrated this relationship. The flakes that are made from the recycled PET bottle have value in the economy since there is demand for them. This describes the circle of the bottle based on its chemical composition. It is because the flakes are out of PET that makes them valuable.

Additionally, the primary source of the plastic material becomes a matter of concern. Plastic is mainly made from oil or other fossil fuels, but other primary sources used to make plastics are being developed and considered. It is common that the shift to other primary sources, such as sugar cane, is viewed as a more environmentally friendly option, but my participants also pointed out that beyond that there is an economic concern enacted through the primary source of plastic. *"If you are dependent on fossil resources you have political dependencies [...] You have import dependencies, dependencies on trade. So one positive effect if you use bio based material to produce plastics is that you are independent from fossil resources" (Interview 1)*. Plastic is enacted in political dependencies; oil in Austria, but also majorly in the EU, needs to be imported and therefore a trade dependency is created. Plastic's primary source becomes a matter of concern in the economy through these trade dependencies.

In a way, there is a whole new set of concerns that are created in relation to the economy beyond and independent of the environmental concerns. The EAA has been working on a project on bio-degradable and bio-based plastics and although the environmental concerns are always in there, a new set of concerns in relation to the economy arise, *"So the aim of this project was to reduce, or the main aim, was not to reduce release of plastics in the environment, it's also one aspect, but the main aspect is, to use bioplastics to reduce the, or to be independent from fossil resources" (Interview 1).* This does not mean that the environmental aspect is not considered important or it is not a concern, but rather highlights that beyond the environmental aspects, plastic participates in the economy and their material properties matter, because they become matters of concern that create political dependencies.

The above *sites of concern* are presented as the multiple realities in which plastic is enacted. Each of them tells another story of plastic through its material properties relating plastic to different institutions,

actors and policies. Plastic's materiality becomes a matter of concern in each of these sites and even if it is the same material aspect, it becomes a concern in different ways. For example, the chemical composition in the environmental site matters in order to understand where plastic is coming from. The same material property in the site of concern 'economy' becomes important in relation to the processes of recycling and which plastic's chemical compositions are being recycled, for which ones there is demand and which ones are downcycled.

The environment and economy as *sites of concern* are larger and more abstract than the other ones. Interestingly, most concerns about plastic relate to one of them, plastic as an environmental concern or as an economic concern. Since plastic was made at the beginning of the 20th century this material has become a vital part of the current capitalist economy and it was not until the 1970s that plastic became an environmental concern. In the work of the EAA plastic enters as an environmental concern – as plastic in the Danube- and through this it unfolds its complexity and becomes an economic concern. Plastic is both an environmental and an economic concern at the same time.

6.3. Defining microplastics

6.3.1. Importance of a definition

What is microplastics? This is a question without one answer. Talking about microplastics and not about plastic already assumes their small size, but how small? As mentioned before, it is often stated that every plastic under 5mm of size is microplastics. Although this is the most commonly used definition of microplastics, as the report of the EAA states*: "There is no legally binding or internationally standardized definition of the size and composition of microplastic" (Report 1).*

It is clear that size is an important material aspect to consider for the definition of microplastics, but the next question is, what else is important to consider? Or in other words, is the size the only important material aspect of microplastics? What about the chemical composition? What about biodegradability? *"So the questions are many fold, and we had those open questions on very different levels. So the first is the definition of microplastics. What is it what we are really talking about? [...] what is the definition of microplastics? What has to be included? Is it just solid particles or can they dissolve? What about biodegradable plastic? Is it still microplastics? What is the size range we are talking about? Is it micrometers? Or also millimeter? [...] it's nanoplastics microplastics? Are we talking about the same thing?" (Interview 2).* There are many different aspects of the material properties of plastic that could be considered in defining microplastics, therefore it is not a matter of fact which material properties plastic has, but it is about which material aspects of plastic has become a matter of concern for the definition of microplastics.

Defining microplastics becomes important. Although there is not one definition of microplastics, finding a definition is perceived as an important step for tackling plastic and microplastics pollution. *"In order to take effective measures to reduce plastic and microplastic pollution in the environment, several pre-requisites are needed [...]:A uniform definition of "microplastics" including a sub-categorization of size ranges" (Report 1).* Finding a dentition is one step, if not the first step, in order to tackle microplastics pollution. The definition will not only answer the question if 'we are talking about the same thing', but it will also frame the issue, frame the problem. The need for a definition is not only an issue reflected by the EAA, but also something discussed more broadly in relation to microplastics. This is also reflected in the work of the European Chemicals Agency (ECHA), which is currently working on finding a definition for microplastics. The ECHA, after the request of the European Commission, is gathering information for defining intentionally added microplastics used in consumer products in order to propose a framework for the restriction of intentionally added microplastics in consumer products. However, before being able to propose a restriction there needs to be a definition.

Interestingly, the need for defining microplastics is two-fold; on the one hand a definition of microplastics is needed for further research, but simultaneously the same definition is crucial for policy making, *"here for this risk analysis and for this exposure studies and so on, the definition again comes into play because which materials should be tested for their effects on organisms? as long as we don't really know what microplastics is, it's difficult to choose" (Interview 2).* The definition of microplastics is needed in order to decide which materials should be tested and evaluated for their potential risks to animals and human health. The definition becomes a passage point for any future research on microplastics.

The definition is also important for policy making, *"when it comes to restrict the use of microplastics, like this intentional use you have to have a definition what is restricted, and unless you have that you can't restrict anything" (Interview 2).* There needs to be a definition for any restriction or policy to take place. Defining objects is not a new practice for research or policymaking. Microplastics are not the only plastics that cannot be defined; bio-plastics suffer from the same lack of definition, *"we had to make, to make clear a definition on what is bioplastics, because this is, some experts talk about bioplastics in a very limited way because this is focusing on their work on biodegradability on issues like that for- in terms of waste for instance. On the other hand, there is bio-based plastics, very different origin, very different issue, they have a very small overlap, not everything that is biodegradable is necessarily bio based and vice versa" (Interview 4).* Different definitions are important for both research and policy making because they are defining issues. A definition is not only about defining the object, but at the same time defining the issue, the problem, and its potential solutions. Interestingly, plastic through its materiality complicates these definitions and enacts multiple realities in which plastic exists not as one, but as ontologically different entities.

6.3.2 Resisting a definition

Finding a uniform definition of microplastics becomes complicated. The materiality of plastic complicates this definition. Microplastics resist to be defined. As discussed above, there are different material aspects of plastic that become matters of concern in different *sites of concern*. Finding a definition of microplastics requires answering the question of what needs to be addressed in relation to which concern? Which material aspects are creating which issues? The material aspects of plastic become matters of concern in the process of finding a uniform definition for microplastics. There are three different material aspects of plastic that on the one hand show the contradiction between *sites of concern* and at the same time enact three different issues.

When the issue is the fish in the Danube river, the size of microplastics becomes the material aspect that needs to be defined, *"also for fish, let's say fish in the river Danube, again huge pieces of plastics […] won't really influence them as long as it's still huge […] But after weeks and years and so on, maybe this huge piece breaks down into smaller pieces and then becomes relevant to the fish" (Interview 2).* In this case, the entities that are needed to be cared for are the fish, and particularly the fish in the Danube River. The size of plastics is enacted as the matter of concern when the issue is the faith and welfare of the fish in the Danube.

If the question is, where does the plastic found in the environment come from? then the chemical composition and the shape are the material aspects that become the matter of concern and need to be included in the definition, *"If you find lots of PET for example, you can think of a source that is plastic bottles. Many plastic bottles are made from PET. If you add visual information, like the particle shape to it, like fragments seem to be from a bottle also yeah, you can track back a potential source" (Interview 2).* In this instance, the chemical composition and the shape become the matters of concern because the issue is the origin of the microplastics. And although we are still talking about microplastics, meaning small plastic particles, the size is not enacted as the matter of concern for identifying the sources of microplastics, but instead the chemical composition and shape become the matters of concern. This is not because the size is irrelevant, but because the issue is different.

And last, when the issue is the restriction of microplastics in the cosmetics industry the solubility of plastic becomes a matter of concern distinct from the others. *"for example, if I am a producer of a certain product and […] let's say, I have a water-soluble powder and I put it into my water, I stir it and it's gone. The molecules are still there but there are no particles. And then the question is […]: are there microplastic particles in there?" (Interview 2).* In this instance, first the issue of restricting microplastics in consumer product then the solubility becomes the matter of concern.

If we think about one single microplastic, it has a certain size, a chemical composition and it could be soluble in certain conditions, thus it seems as one entity. But, through the enactment in these three different ways, of the different material properties in relation to what is the issue, microplastics become different entities. Through this enactment they become multiple and therefore resist being defined as one entity. Defining microplastics is not an act of matters of fact, there is not a definition of microplastics that *per se* exists somewhere but defining microplastics is a process that includes sociocultural understandings of what the problem is concerning microplastics, and how they can be restricted. And plastic, because of their own multiple socio-material existences, resist and complicate the efforts to enact them as one uniform entity.

6.4 Invisible/visible plastic

Plastic with its multiple materiality becomes matters of concern. One aspect which is yet not discussed is how plastic becomes visible, but yet invisible at times. This visibility/invisibility is strongly related to the size of the plastic, but also to the accumulation and use of plastic in everyday life. Who can see plastic? Where does it become an aspect that creates concern among the public(s), but also among people working with plastic?

6.4.1 "It's an indicator of pollution"

We all encounter plastic in our everyday life, sometimes we realise that our table is made of plastic, but most of the times we do not. Plastic becomes invisible in everyday life and interaction. However, through the emerging concern about plastic in the environment, more and more pictures of plastic in the ocean, in rivers or in sand appear, making plastic visible. This makes plastic visible pollution. Due to the durability and materiality of plastic, it accumulates in places where it does not belong and – in contrast to other chemicals and materials- plastic is visible. Plastic becomes an indicator of pollution, *"For me it's an indicator of pollution because you can see it. You can't see the dissolved components and pollutants and plastics is very well visible" (Interview 4).* This visibility of plastic creates concern. Everyone can see a plastic bag floating in the Danube, but not everybody can see what chemicals are in the water, *"You can see plastics in the environment. This is different to other pollutants they are dissolved you can't see them. You can compare of course with the load of plastics compared with the load of lead that flows down the Danube river at the same, but that doesn't say anything" (Interview 4).*

Even if the impact of plastic in certain environments is unclear, their existence in these environments is visible and it becomes a concern. The problem becomes visible through the visibility of plastic materials in environments, even if there are many questions still to be answered. *"We can see there is a problem that's not deniable, or we can see, find plastics but we don't- also and that's the next, that bring*

me to the next challenge, currently we don't know what that actually means for the environment and for human health, and environmental health because the effects of plastics on organisms has been studied for these like sample organisms but not for humans for example" (Interview 2). Therefore, plastic's pollution is a concern because it is a visible matter out of place, it is not the systematic research that creates the concern, but it is the other way around. Plastic in natural environments is a visible concern and the research will determine why and how it affects wildlife, ecosystems or even humans. The concern is initiated by the visibility of the material, which triggers research to explore the risks and interactions.

One interesting aspect of plastic is that in some ways, it feels easy to relate to this material. Because of its visibility and materiality, it is not an abstract chemical, but a material we can touch, see and feel. It is a visible material which we use everyday and when the same material becomes pollution it is one we can relate to, *"Plastics is used everywhere, everyone knows what plastic is, it's not abstract, and it's a product which is present and therefore I think it's of main interest of everyone" (Interview 1).* Plastic becomes of interest to everyone: of science, of policy making, of public(s) through its visible materiality.

The visibility of plastic makes it easy to relate to, which in a way makes it easier for the non-expert to be able to see pollution. Theoretically, everyone can see a plastic bag in the sea and this creates the impression that plastic can be found everywhere, in beer, in honey, in creams, in toothpaste, in water. Plastic started to become visible in many different places, which initiated concern and pressure to know more about plastic, and especially microplastics, in order to find solutions, *"I find it challenging that there seems to be a huge interest of the public on knowing of the environmental burden of microplastics in their, like in Austria for example, or in the river, or in their garden" (Interview 2).* It is interesting that this visible pollution creates the idea that it could *visibly* go away. Or in other words, it creates the impression that everyone will know and see when the plastic pollution is over since it will be visible in clean oceans, clean rivers, clean gardens, clean beer. This visibility distinguishes plastic from other invisible pollutants; it makes plastic an indicator for pollution, but what about when plastic becomes invisible?

6.4.2. "Just because you can't see it doesn't mean it isn't there"

"Just because you can't see it doesn't mean it isn't there". This is a quote form the poster of a campaign by the European Commission for an initiative to clean up the seas from plastic (Figure 6). The visibility of plastic makes it an indicator of pollution; a material that everyone can relate to, every visually-abled person can see plastic, and everyone uses plastic in many different ways.

Figure 6: Brochure from the campaign of the European Commission

However, plastic also becomes invisible. What if plastic is in our bodies and we cannot see it? What if it is in our food, in our beer or our water? What about the plastic we cannot see? *"So particularly when it comes to contamination of food, it's not the huge particles that are the problem because the huge ones you can see, if there is a piece of foil on your chicken or whatever, you can remove it. The question is, are there smaller particles you cannot see" (Interview 2).* The size of plastic again becomes the matter of concern. A visible large piece of plastic enacts a different concern than a small invisible piece of plastic.

Although the small size of plastic and its invisibility can be a concern, such as in food contamination, a small and invisible plastic particle can also be beneficial in a specific context, for example in the cosmetics industry, *"This is a discussion that is also relevant for intentionally added microplastics, so were you enhance the functionality of products by adding certain plastic materials. And very often these are not particles you can feel, like in a facial scrub but there is so small that they change, they have different functions. For example, there is wrinkle cream where the particles sit in the very fine wrinkles, you can't see them because that's also the idea of make up that you don't see that everything is like… being made up, but they just sit in the small wrinkles and they reflect light is a certain way" (Interview 2).* A small plastic particle invisible to the human eye is not a concern *per se*, but it is enacted as a concern when it is in the food on my plate and at the same time this same particle with the same size and invisibility becomes

beneficial in a make-up cream. What I want to illustrate here is that the size renders plastic visible or invisible, and through this material aspect creates different concerns and benefits. The size is not a matter of fact, it is not good or bad, but the material aspect becomes a matter of concern that is enacted as a problem or a benefit in different socio-material arrangements.

6.4.3. Who can say what is plastic?

Plastic becomes invisible through its size and this invisibility leads to the questions: what if there is plastic in places where we cannot see it? What if there is plastic in human bodies? In our food and water? Interestingly, plastic looks like other materials that are not plastic and non-plastic materials look like plastic. As discussed above, plastic as a category is not stable nor clearly delineated, but nevertheless plastic becomes a category through the processes of comparing plastic to other materials such as glass or other organic structures. Drawing on personal experience, when I have to separate my waste for recycling, I always need to stop and think: is this plastic or paper? It sounds self evident, but in practice is not. It is through the comparison with other materials that the category of plastic is outlined.

Recognising what is plastic and what is not sounds intuitive, but many times it is not. After all, plastic was initially made to mimic other materials. Due to its extensive visibility, plastic and microplastics become visible even when they are not there: *"Very often is, oh we found fragments, we found foils, we found fibers. But a fiber itself is not necessarily microplastics. A fiber can also be like a cotton fiber, a natural fiber. Or a fiber can be a hair, sometimes hair, like cut pieces of hair they look like fibers" (Interview 2).* Therefore, it is not only that plastic looks like other materials, but also that other materials look like plastic; disentangling and recognising when and where plastic is present becomes complicated and the human eye is inadequate at identifying what is plastic and what is not, confusing plastic with its lookalikes.

It is when the human eye fails to recognise plastic that the analytical instruments in the laboratories become the experts on separating plastic from everything else: *"So, we had a honey sample, and maybe if you recall the picture you see on the web when you google for microplastics, it's very often the perfectly spherical white or blue or greenish, spheres, particles. And we did an analysis of a honey sample, so we basically we just used a sieve as you have it at home in your kitchen we put in some honey and then washed it through with water and looked at the remaining solids. And what we found was a perfectly spherical white thing. It's ah! that's a plastic granule, and by looking at the it looked so artificial so man made, that if this was, if my naked eye would have been the only technique to identify I would have said ok that's a plastic granule, but then we used our analytical instrument which is able to characterise the material, and I don't need to go into the detail, but like the result from the analysis was bees wax. And that's completely plausible. Where else would you find bees wax than in honey" (Interview 2).* This is an example of how on

the one hand, other materials start to look like plastic, for example bees wax looks like plastic, and it is because of this mimicry that even though the object is visible and recognisable by the human eye, human vision fails to recognise plastic from non-plastic. Therefore, it is not only the size of the object that makes it invisible, but also its ability to mimic and be mimicked by other materials.

Consequently, to see plastic is not a practice that only depends on the size of the object, but also by its chemical composition. And defining the chemical composition is beyond the capacity of the human eye but the ability of analytical techniques and machines in the laboratory. The analytical technique is the one that can 'see' plastic and can define what is plastic and what is not. The analytical technique can make plastic visible. In Figure 7 derived from the report of the EAA on plastic in the Danube it reads, *"some plastic fragments are already visible by the naked eye."* The figure is showing a picture of a dish with 3 colourful circles on it, which indicate the 'visible' plastics.

Figure 7: Original text: "Dried material sampled from the river Danube, mainly of biological origin; some plastic fragments are already visible by naked eye".

If one would have seen this picture without the indicated circles I doubt that it would be possible the see the plastic objects. Perhaps an expert or a trained eye would more easily recognise plastic, but still there needs to be an indication for the 'visible' plastic, otherwise the reader would not be able to see it. Interestingly this also highlights that there might be non-visible plastic particles on the picture, either because they are too small or because they look like other materials on the plate.

These invisible plastics can become visible through the analytical technique called Infrared spectroscopy. *"Plastic fragments larger than 500 µm can be sorted by hand, and categorized according to their shape by the naked eye, e.g. industrial granules, flakes, foam, foils or fibres. The identification of a plastic material based on properties such as colour, stability and texture is possible, but often misleading. A more reliable way to confirm plastic material is infrared (IR) spectroscopy" (Report 1).* The expertise is transferred from the human to the nonhuman, the infrared spectroscopy can show what is plastic, can make plastic visible. The nonhuman analytical technique is the expert and the material property of the chemical composition is the ultimate verification of what is plastic and what is not. Seeing becomes possible through the nonhuman infrared spectroscopy analytical technique, *"To be sure that what we count, what we measure is actually microplastics and that we can differentiate also between different type, polyethylene, polypropylene, and different sorts of plastics and distinguish them from other materials, like natural fibers and organic material like, sand and so on" (Interview 2)*. The naked human eye reaches its limits and, in many cases, becomes inadequate to make plastic visible.

Plastic becomes visible and invisible in different incidents. On the one hand, it becomes visible pollution, an indicator of pollution that humans can easily see, in the ocean or in the river. People can make and share pictures of it to show the visibility of plastic pollution. In other words, plastic becomes an opportunity to show and visually share what pollution is and how what it looks like. We would not be able to see and make pictures of the pollution of the ocean from other chemicals, but plastic provides this opportunity. On the other hand, in everyday life plastic becomes invisible due to its pervasiveness and although we can see it we fail to recognise what is made of plastic. Plastic also becomes invisible due to its size. Small plastic particles are not visible to the human eye and even if they are, one cannot be sure that this is plastic. Plastic mimics other materials and vice versa. Therefore, analytical techniques are needed to make plastic visible to humans. It is interesting, isn't it? The games that plastic plays with our eyes. When we think we see it, it is actually not there and when we cannot see it, we are concerned because it might be there.

7. Conclusions

In this thesis I followed the materiality of plastic and its enactment in the work of the EAA. I used a theoretical lens to put the material in the center of the research and ask how reality is enacted through the practices that make plastic a matter of concern. I conducted research at the Environment Agency Austria, an institution that works at the intersections of science and policy and asked how the material properties of plastic are enacted and negotiated. How do these material properties matter for plastic becoming an object of politics?

Following the material properties of plastic and how they are enacted allows for an approach that takes materiality seriously and explores the socio-material relations that are formed. This theoretical approach helped me position the human and the material as equals in the situation and explore their relations in symmetry. This entails that I explored what humans do, but I also explored what plastic does and asked how the situation would be different if plastic would not be there. What are the material properties that enable plastic to radically change the situation? This work is a contribution to the study of the non-living material world from a perspective that sees reality as enacted. Additionally, this study embraces and wants to bring the theoretical lens of post-ANT into policy making arenas and start asking and navigating how post-ANT could be used in order to study and enact policy making. Although this study did not directly engage with policies, but rather the step before, in the thinking and discussing regulation and policies, it positions itself into this direction. This direction was crafted by other STS scholars (Law & Singleton, 2014), and in my opinion has a lot to offer in not only understanding and describing enacted multiple realities, but also in radically changing them.

On the other hand, adopting a perspective comes with limitations. Following the materiality of plastic so closely positions this research in a particular manner, which could not allow for other elements to be taken into account, such as larger systemic structures. In certain ways, following materiality and what happens in the situation it requires us to assume that everything is happening in this situation without accounting for what happens outside of it. Additionally, what is critical to highlight is that although I describe the situation, I am also part of it. I am also part of the realities I describe that are enacted with plastic. I also enact plastic in this thesis. For example, what is a relation between entities, which actors are important, and which are not, how I describe things these are all parts of the realities I am enacting. And understanding my position as such brings limitations to how much my descriptions can reach beyond my research. Here in this concluding part of my thesis, I try to make such bridges while considering my own performativity. Whether I have succeeded or not is up to the reader to reflect upon.

In my results I first described how plastic as an issue arose in Austria and consequently in the EAA starting from the river Danube. The initial concern was triggered by plastic particles found in the river Danube, which initiated scientific and political discussions. Additionally, I outlined how from the Danube the issue expanded and contributed to the larger EU discussions on plastic in the marine environments and how Austria, and especially the EAA, had a very important role in initiating discussions on the European level and organizing structures for further dialogue on the issue of plastic. This part on the one hand shows the role and position of the EAA in Austrian and European arenas, but it also shows how the issue of plastic, from its very beginning, gathers actors from science and policy making, transforming it into a hybrid scientific-political issue and an issue that requires attention from both sides. When looking at the EAA as a boundary organization (Guston, 2001) negotiating the boundaries between science and policy and

working at both at the same time reveals the important role the agency has in forming the issue at stake. It is through that work that plastic becomes political.

In this thesis, I described how the material properties of plastic become matters of concern, but also how I followed these material properties through the accounts and reports of the EAA. What material aspects matter and where? I showed how material properties and matters of concern are enacted "in one single gesture" to refer to Bensaude-Vincent (2007). The material properties become matters of concern. What is interesting is that this is not a single enactment; meaning that it is not one material property attributed to one matter of concern, but on the contrary the same material property can be enacted as multiple matters of concern at the different *sites of concern.* One example of a contradicting matter of concern is when I describe the size of plastic in the environment and the cosmetics industry. The size of plastic particles is problematized in the environment because the smaller the size there relates to a range of organisms that can swallow these particles, whereas in the cosmetics industry the smaller the size the more invisible these particles are, and for example, in a make up powder this is a beneficial property. Therefore, the size of the particles becomes a matter of concern differently in different *sites of concern*, which illustrates the multiplicity of plastic. It is in the *gatherings* that meanings are attached and attributed. The size of plastic is not a straightforward matter of fact, but it becomes a situated and multiple matter of concern.

In this work I have described and discussed what I call *sites of concern.* These *sites of concern* are socio-material *gatherings* of humans, nonhumans, institutions, cultural narratives and spatial arrangements. There are sites in which plastic is enacted as a matter of concern. What holds a *site of concern* together as a site in which more similarity can be found in the site than out of it, is that in the *sites of concern* plastic is enacted as one. What makes these *sites of concern* a particular type of gathering is that they share something. In the words of Latour (Latour & Porter, 1993) there is one kind of purification work happening inside each *site of concern*; there is a nature/culture dichotomy performed in which plastic is positioned. This makes the *sites of concern* a new reality in which plastic is enacted. It has its actors, institutions, spaces, geographies, practices, concerns and solutions. These *sites of concern* show the multiple realities in which plastic is entangled and how the people at the EAA not only recognise that, but also work with and through these multiple *sites of concern.* They do not call them *sites of concern* of course, but nevertheless they recognise the multiplicity and complexity of the worlds of plastic. From the laboratory work to the plastics industry, they work with the multiple realities of plastic.

What I find interesting is that although in practice they work with the multiplicity of plastic there is still the need to enact plastic as one. Multiplicity is perceived as an error that needs to be fixed. This becomes obvious in the search for a definition of microplastics. The need for a uniform and universal definition becomes obligatory for further scientific and political work on microplastics. But why? This

'why' is not asked because I did not get a convincing answer, but it is a 'why' on a more abstract level. Why do we think it is good and it is also possible to define microplastic as one? Why can it not be that there are multiple definitions that correspond to situated issues, concerns and problems? There can be a multiplicity of categories practiced. Sommerlund (2006) shows how two different systems of classifying bacteria co-exist in practice in a research field. It is not about finding the best universal system that is better than every other, but it is about situating the system in the specific work that it is needed for. It would be beyond my wish and capabilities to answer how this precisely could work with microplastic and I do not aim to argue that I hold the answers. I think the answers come through the practice, and what I want to suggest is to push the boundary of what is considered normal practice. In other words, perhaps finding one definition for objects or materials worked, one way or the other, in the past, but what I describe here is that working with plastic is pushing this boundary and it is perhaps time to rethink the practices of defining plastic and ask why we so badly need the world to be single and one (Law, 2015)?

Looking at the world as one is something that post-ANT scholars have repeatedly challenged (Law, 2015; Mol, 2002). But what does this mean when regulating plastic? I have discussed in this thesis the difficulties of even writing about plastic. STS scholars have written about plastic through objects, waste and chemical pollution, and indeed this difficult question of what *is* plastic? is also prominent in the regulatory realms. What does it mean to regulate a material and not an object? And even more, what does it mean to regulate a multiple material? Regulation of nonhumans is imagined as regulating objects, or a technology, but what about the chemical or the material? Andrew Barry (2017) explicitly wants to bring attention to the chemical and its material politics. How could regulation be imagined if we were to abandon the 'one world' view (Law, 2015)? How could plastic be regulated without defining it as one, and without rejecting its multiplicity, but rather by embracing it? A perspective of a multiple worlds does not offer only theoretical discussions, but in my opinion, it brings together the normative and the theoretical. It becomes theory in practice without separating the normative world from the theoretical one. They become one and ask how could a multiple world be approached in regulation practices? It is the true shift to ontology because the discussion is not about how can we know about the multiple world, but what is the multiple world in the practices that make it. Most importantly this opens up the possibilities to see the different realities and in fact make decisions on which realities enact the 'common world'(Latour, 2004a) we collectively decide to live in. It transforms regulation from a single, inflexible entity that positions authority to an enactment of a common practice (Law & Singleton, 2014).

At this point I want to discuss how this could actually look and I want to shift the focus from plastic to gender. This might sound irrelevant, but I hope I will convince you of the important work that gender studies scholars and activists have done and how this can inspire work in other fields. Perhaps what makes it relevant to me is that while conducting this thesis I was reading the book of Riki Wilchins (2004) on

Gender and Queer theory. Riki Wilchins is a gender and transgender activists and founder of the advocate group GenderPAC. In their book, Wilchins describes that what it means to *do* gender has not only changed the way the author sees their life, but also the way they do politics. Gender activists have for years challenged how gender is defined in regulations, how and when a person can change their gender in official paperwork, what is considered a disorder, how can more than binary gender identities be considered in regulatory realms, in medical insurance coverage, and in marriage or adoption. Evidently, the topic of gender is very different from plastic, and I do not mean to tautologise or relativize, but while reading the book of Wilchins I realised something. These people are doing politics in multiplicity. They embrace multiplicity and think through how this multiplicity can be embraced in regulatory realms. It is not perfect, nor it is universal, it is work in progress, but it shows how much work it requires to move away from a 'one world' world (Law, 2015). And most importantly it shows that it is possible. To me this was an important moment. It was the moment that I really saw that it is possible to discuss policy without reducing or enacting a singular reality.

It is not only a theoretical abstraction to say that the world is multiple, or that plastic is multiple, but it changes how we live and regulate in practice. STS scholars (Law & Singleton, 2014) have started speculating what it would mean to regulate in multiplicity, how would it look and how it would change the way we see regulation on the first place. Top-down regulation requires single definitions, such as the definition of microplastics, and it therefore enacts a single world. It assumes a single regulation for a single reality or as Law and Singleton (2014) write, policy holds "the assumption of ontological singularity" (p. 387). They propose a more fluid version of policy in which there is space for negotiation and exploration of issues and the different worlds that are created. It gives space to ask in which world we should enact and what does this mean and for whom. With the above example of gender, I want to add to their ideas and thoughts that indeed gender activists have done work that can inspire and initiate valuable pathways of thinking about regulation in multiplicity.

However, coming back to my thesis, what would this mean for plastic? I am sure that there are many aspects that could be explored, which reach beyond the work of this thesis, but I want to discuss here one that has to do with language. What does the term plastic do? I have discussed in different parts of this thesis how hard it is to write about plastic. Do I talk about plastic in the singular or plastics in the plural? What difference does it make? What is different if I talk about plastic or about nylon or PET? How we name and categorize things makes certain aspects visible and other invisible. Bowker and Star (1999) wrote that the decisions behind how to categorize things are moral and ethical ones. This means that what becomes visible and what becomes invisible has material impact. Many times, how things are named and categorized seems 'natural', meaning that it feels normal and intuitive. Language not only categorises the world, but it makes certain realities possible. What does the term 'plastic' do? Why do we need to refer to all polymer

materials as plastic and discuss them as one? What would happen if we would stop talking about plastic, and for example, talk about the specific chemical compositions? Perhaps this would allow for a more nuanced and situated approach on polymer materials. My jacket and my bottle would not be both made out of plastic, but out of nylon and PET, respectively. This is a change in the ways we talk and discuss about these materials, but it also affects how we think about it. It materially changes what is seen as possible, desirable and approachable. It enacts the problems and their solutions. This is one way that I see approaching the multiplicity of plastic and navigating what language can do in the negotiations of these realities. Evidently, this is only a speculation, but I am confident that by changing the mindset in which we approach plastic many more ideas will arise.

So far I have discussed much about plastic as the 'stuff of politics' (Braun & Whatmore, 2010), but here I want to discuss a contribution this thesis makes to a more cultural perspective on plastic and its appearance or disappearance in everyday life. Plastic was made initially to mimic other materials such as ivory. Historically it was after the Second World War that plastic expanded beyond its capacity to mimic others. In my empirical results I have described how plastic on the one hand is visible pollution, an indicator of pollution, and on the other hand, how plastic becomes invisible. The size of plastic is one reason for its invisibility; small plastic particles are invisible to the human eye. Additionally, plastic becomes invisible even if it is theoretically visible. In other words, even when we can physically see plastic it becomes invisible because it cannot be recognised as plastic. Its ability to mimic other materials and the pervasion of plastic in everyday life has made plastic visible even when it is not there. We look at bees' wax and think it is plastic. Therefore, it is not only that plastic mimics other materials, but also that other materials mimic plastic. Plastic is seen in objects that are not plastic. Perhaps it is because plastic is an umbrella term form many materials and the name plastic refers to the properties of the materials. Therefore, everything that seems plastic (as an adjective) is perceived as plastic (as a noun). It is only through comparison that plastic, as a category, exists. It is through comparison that plastic is enacted as a uniform category. Adding therefore to the cultural history of plastic, we are at a time when plastic has become so abundant that it feels more natural than ever. A time when plastic is seen even when it is not there, when 'nature' mimics plastic.

In conclusion, this thesis explored the multiplicity of plastic in the work of the EAA. It showed the different worlds in which plastic is part of and how it challenges assumptions about uniform definitions. Plastic poses challenges for STS researches, but also for people regulating and researching plastic and what I have argued here is that we should all attend to these challenges. Take our work with plastic as the initiation for a bigger discussion of how we can live in a multiple world and how this would look like. Plastic provides an opportunity to rethink policy making and it 'forces thought' (Stengers, 2010) about what living in a multiple world means. In my opinion, this is not only a matter of convenience or theoretical fetishism, but it becomes increasingly challenging to balance the humans, the nonhumans and more-than-

humans on this planet and therefore thinking in multiplicity and posing the question of a ‘common world’ (Latour, 2004a) becomes an imperative.

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Appendix

English abstract

Plastic was a success story of the 20th century, a material that revolutionized industry and expanded consumption. However, plastic has become a current top environmental concern since plastic particles found in oceans, rivers, or soil, pose uncertain risks to humans and wildlife. From an STS perspective, the materiality of plastic has been described as a process enacted in divergent environments. This thesis builds on this perspective, and uses a post-ANT lens to ask: How is plastic enacted as a matter of concern in the Environment Agency Austria? In the past years, there have been discussions on how to regulate plastic on a European level which culminated in the EU Plastics Strategy published in 2018. The Environment Agency Austria (EAA) is not only a leading figure on plastic discussions in Austria, but an active actor in major European arenas. The EAA works at the intersection of science and policy; they analyze microplastics in laboratories, but also engage in policy consultancy. I conducted interviews with people working at the EAA on plastic and in addition, analyzed their publicly available reports. I describe the multiple sites of concerns, the gatherings of humans, plastic, discourses, practices, material properties and material arrangements, in which plastic becomes a matter of concern through the enactment of its material properties. I also discuss the importance of defining microplastics and how plastic resists such definitions. Lastly, I explore the instances of how plastic becomes a simultaneous visible and invisible threat. In conclusion, this thesis touches upon issues of what it means to classify, define and regulate plastic in a multiple world and how we could engage in this multiplicity of plastic in regulation in order to explore deeper the material entanglements of plastics, humans, nonhumans and environments in contemporary societies and envision a 'common world' with plastic.

German abstract

Plastik war eine Erfolgsgeschichte des 20. Jahrhunderts, ein Material, das die Industrie revolutionierte und den Konsum intensivierte. In den letzten Jahren wird Plastik zunehmend kritisiert, nicht zuletzt, weil die Risiken von Kunststoffteilchen, die in Ozeanen, Flüssen oder Böden gefunden wurden, ein schwer abzuschätzendes Risiko für Mensch und Tier darstellen. Aus einer STS Perspektive wurde die Materialität von Plastik als Prozess beschrieben, der in unterschiedlichen Umgebungen abläuft. Diese Arbeit baut auf ebendiese Betrachtungen auf und betrachtet das Phänomen durch eine theoretische „post-ANT-Linse": Wie wird Plastik im Umweltbundesamt Österreich als „matter of concern" gehandhabt? In den vergangenen Jahren wurde darüber diskutiert, wie Plastik auf europäischer Ebene reguliert werden kann, was in der 2018 veröffentlichten EU-Strategie für Kunststoffe ihren Höhepunkt fand. Das Umweltbundesamt Österreich (EAA) ist nicht nur eine führende Institution bei Diskussionen rund ums Plastik in Österreich, sondern auch aktiver Akteur in wichtigen europäischen Netzwerken. Das

Umweltbundesamt arbeitet an der Schnittstelle von Wissenschaft und Politik. Sie analysieren Mikroplastik in Laboren, engagieren sich aber auch in der Politikberatung. Ich führte Interviews mit Leuten, die am Bundesumweltamt mit Plastik arbeiten, und analysierte darüber hinaus ihre öffentlich zugänglichen Berichte. Ich beschreibe die unterschiedlichen „sites of concern“, sowie das Zusammentreffen von Menschen, Plastik, Diskursen, Praktiken, und Materialanordnungen, bei denen Plastik auf Grund seiner Materialeigenschaften zu einem „matter of concern“ wird. Ich diskutiere auch, wie wichtig es ist, Mikroplastik zu definieren und wie sich Plastik solchen Definitionen widersetzt. Abschließend untersuche ich die Momente, in denen Plastik zu einer gleichzeitig sichtbaren und unsichtbaren Bedrohung wird. Zusammenfassend geht es in dieser Arbeit um die Frage, was es bedeutet, Plastik in einer multiplen Welt zu klassifizieren, zu definieren und zu regulieren, und wie wir uns mit dieser „multiplicity” von Plastik beschäftigen können, um die materiellen Verflechtungen in modernen Gesellschaften von Plastik, menschlichen sowie nichtmenschlichen Akteuren und Umgebungen tiefer zu erforschen, um letztendlich zu verstehen, wie wir uns eine „common world“ mit Plastik vorstellen.