Contributing to the 'One Health' framework by exploring the emerging environmental dimensions of antimicrobial resistance from a human geography perspective.

Anthony Shenton

Student ID: 14312873

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Abstract

The World Health Organization (WHO) states that antimicrobial resistance (AMR) is one of greatest threats to humanity. Some social science research on AMR has focused on the overuse and misuse of antibiotics in hospital and agricultural environments. However, little research has been carried out to explore how 'environmental publics' (Eden, 2017) make sense of the emerging environmental dimensions of AMR and how scientists imagine lay publics in relation to those emerging environmental dimensions. Without this information, AMR 'action plans' risk failure when put into practice.

This research project addresses this major gap in the existing research by observing and carrying out semi-structured interviews with surfers and open-water swimmers - two of the communities most at risk from AMR in the environment due to being immersed in rivers, lakes and coastal waters - and with scientists working on the emerging environmental dimensions of AMR. This empirical research found that although it was common for scientists to assert that lay publics could participate in research on the environmental dimensions of AMR, it was also common for them to discuss 'lay publics' imagined lack of knowledge about the relevant issues. This position supports the view that the 'deficit model' of the public understanding of science (PUS) (Wynne, 1992) continues to persist. However, it has been strongly challenged by social science research that shows that lay publics are not blank slates that need be filled with scientific knowledge. On the contrary, lay publics possess pre-existing knowledge, values and beliefs that intersect with science. My findings also reveal that both surfers and open-water swimmers draw upon their pre-existing knowledge, values and beliefs about health, healthcare, environmental pollution and globalisation to make sense of the emerging environmental dimensions of AMR and they can use this knowledge to participate in debates about what the issues are and how they should be addressed. In contrast to scientists, they focused more on the structural causes of AMR rather than individuals. Much of the knowledge participants use to make sense of environmental risks, including those related to

AMR, is gained from sensory experience as they carried out their swimming and surfing activities. The joy they gained from being in the water outweighed the risks. Public participation mechanisms need to move more 'upstream' so that 'lay' and 'expert' publics can engage in genuine dialogues with each other about AMR in the environment. This will enable lay publics to not only contribute to the environmental dimensions of AMR, but also help to define and redefine them. These findings could make a valuable contribution to the 'One Health' framework that calls for diverse disciplines to work together to tackle issues connected to the health of humans, animals and the environment, including AMR (WHO, 2017).

Acknowledgements

As I think about all the people who have helped me to complete this research project, I am reminded of the cliché about a PhD being a marathon not a sprint because when I completed my first marathon, I said to myself that this will be the hardest thing I will ever do. I was wrong because nothing really prepared me for the challenges that I have faced over the past 5 years, not least because when I started this project, I had been away from academia for almost a decade and my knowledge of AMR was extremely limited both from a scientific and STS perspective. Thankfully, I have not faced these challenges alone.

I'd like to thank my family for their financial support and encouragement, especially when I felt isolated. I would also like to thank past and present members of my supervision team for taking the time to provide helpful guidance and feedback on my work, including Professor Sujatha Raman, Professor Sarah O'Hara, Dr Thom Davies, Professor Matthew Smallman-Raynor and Professor Carol Morris. I would also like to thank the University of Nottingham 'centre' and the School of Geography for funding this PhD, and the participants who were very generous with their time and energy.

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1.1. Introduction

Since the beginning of 2020 much of the world's focus has been on the threat posed to human health by the Covid-19 pandemic which was caused by the virus *SARS-CoV2* (WHO, 2021). However, according to some of the world's leading scientists, the effects of the antimicrobial resistance (AMR) pandemic are much more insidious. As Dr De Barro, Research Director of the Commonwealth Scientific and Industrial Research Organisation (CSIRO) Health & Biosecurity Risk Evaluation and Preparedness Program Australia asserts: "If you thought Covid was bad, you don't want antimicrobial resistance. I don't think I'm exaggerating to say it's the biggest human health threat, bar none. Covid is not anywhere near the potential impact of AMR'' (Cited in *Guardian*, 2020: 1).

This claim is supported by statistics that were produced by the World Health Organization (WHO, 2015) that estimates that 700,000 deaths related to AMR occur every year and that this could rise to 10 million every year by 2050, which is more than the number of people who currently die from cancer. Analysis carried out by *The Lancet* in 2019 claimed that AMR is already a leading cause of death across the world as more people now die from infections that could previously be treated with antibiotics than from HIV/AIDS or malaria. Although AMR is a term that is used to describe bacteria, fungi and viruses becoming resistant to antibacterials, antivirals and antifungals, scientists, politicians, policymakers and the mainstream media have focused mainly on the risks that antibiotic resistance poses to human health. For example, the former Prime Minister, David Cameron, asserted in 2014 "that If we fail to act, we are looking at an almost unthinkable scenario where antibiotics no longer work and we are cast back into the dark ages of medicine where treatable infections and injuries kill once again" (cited in Walsh, 2014).

England's former Chief Medical Officer, Professor Dame Sally Davies, added: "We really are facing, if we don't take action now, a dreadful post-antibiotic apocalypse" (cited in Pickover, 2017). In order to understand what a "post-antibiotic apocalypse" might look like, this chapter will begin by exploring the impact that the discovery of antimicrobials has had on human health. It will then explore what AMR is and how the overuse and misuse of antimicrobials in humans and animals accelerates the problem, including in relation to the environment. The focus will then shift to how the research aim and objectives can contribute to the emerging debates on the environmental dimensions of AMR that have received little attention in policy documents and the social science literature (Lu *et al*., 2020; Singer et al. 2016).

Although the environment has recently emerged as an important issue in relation to AMR, it has always been at the centre of scientific understandings of disease causation, as will be explored in section 1.2. Why AMR occurs will be explored in section 1.3. In 1.3.1, the focus will be on exploring the overuse and misuse of antimicrobials in human health. 1.3.2, will explore how antimicrobials are overused and misused in animal agriculture. 1.4, will explore how and why the environment has become an important dimension for scientists working on AMR. The risks that AMR poses to human health will be explored in 1.4.1, and how scientific experts believe these risks should be tackled will be explored in 1.4.2. AMR action plans will be analysed in 1.5, to explore how policymakers imagine lay publics in relation to the environmental dimensions of AMR. 1.6, will explore how social science research draws upon a 'One Health' approach to tackling AMR in the environment. My research aim, and objectives will be spelled out in 1.7, and in 1.8, I will make it clear to the reader how my thesis will be structured.

1.2. Antimicrobials and human health

The discovery of penicillin is a complex story that has been explored in detail elsewhere (e.g., Lax, 2005). Here there is only room for an overview of how the 'antibiotic revolution' emerged from ideas about 'germ theory' in the 1930s and

1940s. Germ theory states that infectious diseases are caused by microorganisms, organisms that can only be seen under a microscope, also known as 'pathogens' or 'germs' that are spread from person to person and through the environment. Bacteria and viruses are the two most common pathogens that we encounter. Bacteria are single-celled organisms that are mostly benign and can even contribute to maintaining our health. Occasionally, however, they can cause illness by multiplying rapidly inside our bodies. Viruses, including the common cold, influenza, Ebola and rabies, are around 100 times smaller than bacteria and cause illness by penetrating our own cell walls and multiplying within them (Institute for Molecular Bioscience, 2020).

Germ theory emerged from scientific breakthroughs in the late nineteenth and early twentieth centuries - such as Louis Pasteur's claim that fermentation and putrefaction in food was caused, not by a spontaneous process of decay (which was the prevailing wisdom), but by contaminated microorganisms that came from the environment (Gray, 2014). This discovery helped to promote the idea that the same process could be responsible for certain diseases. For example, in the 1860s having been inspired by Pasteur's findings, the British Surgeon, Joseph Lister, began to use antiseptics to clean the wounds of patients that he believed had been infected by microorganisms that had come from the environment, which earned him the title 'father of modern medicine' (Pitt and Aubin, 2012). Putting Pasteur's ideas into practice led to a significant decline in postsurgical infections. Other interventions inspired by Pasteur and germ theory, such as the pasteurisation of milk and vaccination programs, also helped to increase life expectancy during the second half of the 19th Century.

As germ theory became more widely accepted among the scientific community, so too did the search for a medicinal 'magic bullet' - a drug that could cure disease by selectively targeting pathogens. In the early 20th Century, a compound named *penicillin* that had the potential to become a magic bullet was discovered. Alexander

Fleming is often credited as the individual who fortuitously discovered this new compound in 1928. However, discovering how it could be mass produced and made widely available required a collaboration between scientists, pharmaceutical companies and policymakers (Lax, 2005). Fleming's research in the 1930s enabled a team of scientists working on the therapeutic use of *penicillin* at the University of Oxford, led by Ernest Chain and Howard Florey, to discover how it destroyed the cell walls of bacteria and, also, how refining the purification process would increase its potency.

The medical and commercial potential of *penicillin* was quickly recognised by pharmaceutical companies in the US and the UK and by 1942, the amount being produced had increased 140,000-fold over the amount produced just two years previously by the scientists working in the Oxford University laboratories. This was mainly due to the demand from US and UK governments who realised that it could make a valuable contribution to the Allied war effort. By the end of the Second World War in 1945, the US government lifted all restrictions on selling *penicillin* to the general public who now had very little difficulty acquiring it cheaply due to competition between pharmaceutical companies bringing down its price (Hall *et al*. 2018).

Before the discovery of *penicillin*, compounds such as arsenic and mercury were widely used to treat syphilis, tuberculosis, bacterial pneumonia, and other bacterial infections that were responsible for the deaths of millions of people. These compounds worked effectively against bacteria, but they could also be extremely harmful to the human body. Antibiotics revolutionised healthcare because they can be consumed orally to attack intrusive bacteria, but in the majority of cases (notwithstanding those who are allergic to *penicillin*), they do not cause the human body any serious harm (Allen, 2000). Most antibiotics are produced naturally by bacteria and fungi, and they are also synthesised (synthetic antibiotics) and chemically modified (semisynthetic antibiotics) by scientists in the laboratory to

increase their potency. Although most antibiotics are used in human health to treat infection, they are also used prophylactically to prevent infection, particularly in cancer patients with depleted white blood cells (the body's main protection against foreign invaders and infectious disease) due to aggressive chemotherapy treatment, and in those who have undergone surgery. With the rise of AMR, we could be forced to return to a pre-antibiotic past in which hip replacements and other treatments that many people now take for granted would no longer be possible due to the high risk of contracting an untreatable infection. Addressing this problem requires an understanding of why and how AMR occurs.

1.3. Why does AMR occur?

Looking at the issue through the lens of Darwin's theory of evolution, many biologists assert that this process of bacteria, viruses and fungi developing resistance to the compounds that were previously able to destroy or limit their potency occurs naturally because of what Darwin called "natural selection" (Sykes, 2010). In short, microbes that possess resistant genes are able to pass those genes on to their offspring (Browne, 2006: 41). Bacteria are also able to mutate by rapidly acquiring genes from other bacteria that are resistant to antibiotics. Many experts argue that the overuse and misuse of antimicrobial agents in human health and animal agriculture accelerates the problem of AMR (WHO, 2015).

1.3.1. The overuse and misuse of antimicrobials in human health

It has been estimated that in 2015, humans consumed over 35 billion doses of antibiotics (Klein *et al.* 2018). A study by the Pew Charitable Trust (2016) estimated that between 20 and 50 percent of antibiotics are now being used inappropriately in humans. Another survey carried out by Nesta in 2017 found that over 70 percent of General Practitioners (GPs) in the UK admitted to prescribing antibiotics even though they were not sure whether their patient's infection was viral or bacterial in origin. This uncertainty occurs because there is still no cheap test available that enables GPs to quickly determine the aetiology of an infection. In fact, the testing methods that

were developed by Koch and Pasteur in the 19th Century are still widely used today (King, 2015). This problem has become increasingly important in relation to Covid-19 as studies have shown that in order to prevent death from co/secondary infections, 72 percent of hospital inpatients who had been diagnosed with COVID-19 were given antibiotics as a preventative measure. Only 17.8 percent of those patients, however, were confirmed as suffering from co/secondary infections such as bacterial pneumonia (Chedid *et al.* 2021). 90 percent of GPs also explained that they felt pressure from patients to prescribe antibiotics (Baker, 2017). Salyers and Whitt argue that this pressure occurs because, in neoliberal societies, many people are in precarious and low-paid jobs, so need to return to work quickly to pay their bills. Thus, they have little time to "care much about whether an antibiotic is deemed by experts to be appropriate for their condition. In the mind of the patient, the antibiotic can't hurt, and it might help" (2005: 1).

The Economist and Chair of the Grantham Research Institute on Climate Change, Nicholas Stern, draws on people's attitude towards climate change to explain why antibiotics are not considered to be harmful in the minds of patients. "People (struggle) to find something immediate in effects that are coming through with a long lag" (cited in Hall *et al*. 2018: 151). Appreciating how taking a short course of antibiotics contributes to AMR is as difficult as appreciating how a short car journey to the shops is contributing to climate change. According to Stern, publics need to be persuaded that the threat from AMR is more pressing than concerns about their job and other social pressures (ibid). Concerns about antibiotics being misused by lay people have a long history. For example, during his acceptance speech upon being awarded the Nobel Prize for Medicine in 1945, Fleming asserted that:

> *The time may come when penicillin can be bought by anyone in the shops. Then there is danger that the ignorant man may easily underdose himself and by exposing his microbes to non-lethal quantities of the drug may make them resistant. Here is a hypothetical illustration. Mr X has a sore throat. He buys*

> *some penicillin and gives himself, not enough to kill streptococci but enough to educate them to resist penicillin. He then infects his wife. Mrs X gets pneumonia and is treated with penicillin. As the streptococci are now resistant the treatment fails. Mrs X dies. Who is primarily responsible for Mrs X death? Why Mr X whose negligent use of penicillin changed the nature of the microbe. Moral: If you use penicillin, use enough (1945: 93).*

These concerns have become more prevalent because not since the 1980s has a new class of antibiotics been discovered. Those that have entered the market are variations of those that were previously discovered (Wellcome, 2020). In fact, there are over a hundred different types of antibiotics, but most of them belong to the following six groups: *Penicillins* (including *penicillin* and *amoxicillin*) that are used to treat a range of infections, such as urinary tract infections, skin infections and chest infections; *Cephalosporins* - such as *cephalexin* – that are generally used to treat a wide range of infections, but can also be used to treat more serious infections, such as meningitis and septicaemia; *Aminoglycosides* – such as *gentamicin* and *tobramycin* – that can have serious side effects, including kidney damage and hearing loss, so are usually only used to treat very serious illnesses - such as septicaemia - in a hospital setting; *Tetracyclines* – including *tetracycline* and *doxycycline* – that can also be used to treat a wide range of infections, including acne and other skin infections; *Macrolides* – such as *erythromycin* and *clarithromycin* – that are useful for treating those who are allergic to *penicillin* and also strains of bacteria that have become resistant to *penicillin*. *Fluoroquinolones* – such *ciprofloxacin* and *levofloxacin* – are broad spectrum antibiotics that are used cautiously due to the risk of serious side effects to treat a wide range of infections, including respiratory and urinary tract infections (Salyers and Whitt, 2005). Data on how antibiotics are consumed by humans globally is difficult to find. However, Browne *et al*. (2021) were able to provide the first estimates of longitudinal human antibiotic consumption from 2000 to 2018 for 204 countries by applying novel spatial modelling techniques that incorporated a wide range of sources, including large-scale antibiotic usage surveys that focused exclusively on 28,405 children aged

five with lower respiratory tract infections. They discovered that antibiotic consumption rates increased globally from 9·8 (95% UI 9·2–10·5) defined daily doses per 1000 per day in 2000 to 14:3 (13.2-15.6) in 2018. They also discovered that, due to lack of access, there was a significant discrepancy between low-income countries and high-income countries in terms of the amount of antibiotics consumed. In middle and high-income countries antibiotics are being overconsumed, but in lower income countries they are often not consumed by those who genuinely need them (see Figure 1).

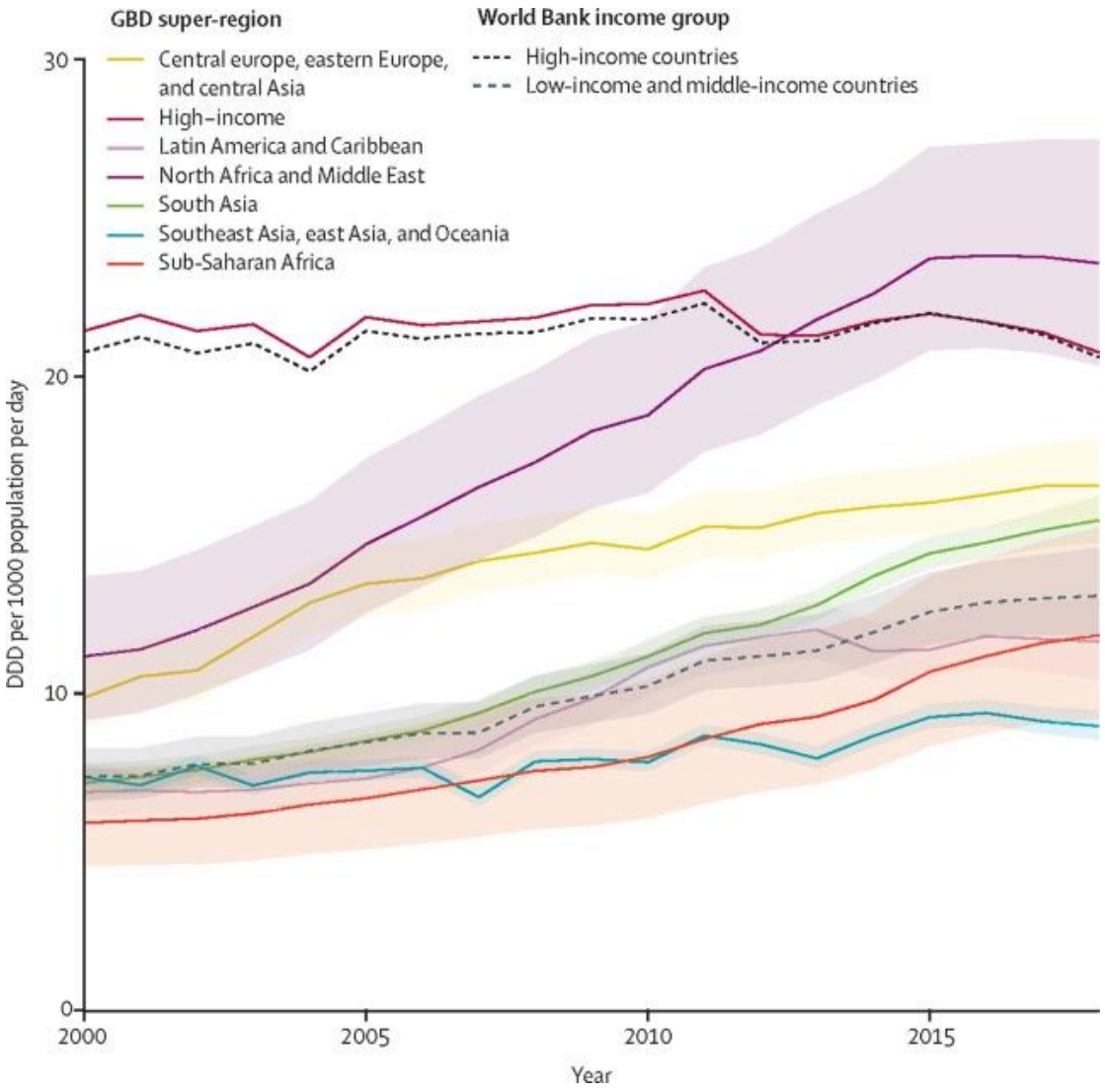

Figure 1"Temporal trends in the total antibiotic consumption rates GDB super-regions and World Bank income groups" *(Note: reproduced from Browne, et al. (2021, Figure 5, p. e900, retaining the original legend).*

Although the research on antibiotic consumption continues to grow, there has been much less research on antiseptics and disinfectants in relation to debates about AMR. Antiseptics and disinfectants (also known as antibacterial biocides) are also important in relation to killing or inhibiting the growth of bacteria, but they are different to antibiotics because:

> *Antiseptics are compounds that are too toxic for internal use but can be safely applied to the skin. Examples are triclosan (a common ingredient in antibacterial chopping boards and soaps), peroxide and mercury derivatives such as mercurochrome. Disinfectants are compounds that are too toxic to be used to cleanse the skin but are valuable agents for cleaning inanimate surfaces. These include household bleach and formaldehyde. Disinfectants and antiseptics prevent infection by reducing the number of bacteria that have access to vulnerable areas like cuts or surgical wounds. They are nonspecific in their killing power. In fact, many kill viruses and fungi as well as bacteria* (Salyers and Whitt: 2005: 3).

Antiseptics and disinfectants have become an increasingly important part of the fight against bacterial infections, not least because it is now much less profitable for pharmaceutical companies to discover, develop and manufacture antibiotics (O'Neill, 2016: 6). Just like antibiotics, they have also been made widely available to the public. In 2012 the market for hand sanitisers in the US alone was valued at over $400 million (Barton, 2012). In 2020, due to Covid-19, sales of hand sanitisers had increased by over 600% in the US, totalling $1.45 billion (Terlep, 2021). This may indicate that antibacterial biocides are being overused. However, although sales remain higher than before the emergence of the Covid-19 pandemic, there is now a surplus of hand sanitiser as people are more aware that coronavirus is primarily spread through the air from person to person, not on surfaces (Bomey, 2021). Some experts are also concerned that the misuse of hand sanitisers (i.e., not applying

enough gel or wiping it off before it dries) is selecting for resistant bacteria for the same reasons explained by Fleming, above (Mahmood *et al*. 2020). Furthermore, a study by Jutkina *et al*. (2018) has shown that the overuse and misuse of antibacterial biocides stimulates antibiotic resistance between bacteria. Co-selection is possible because of the close genetic relationship between some antibiotics and antibacterial biocides. In another study Lu *et al*. (2018) at the University of Queensland's Water Management Centre found evidence that *triclosan* could contribute to AMR by causing the genes of bacteria such as *Escherichia coli* to mutate and resist the threat from antibiotics. Lu *et al* (2018) explain that the regular use of chemicals such as *triclosan* in large quantities is accelerating the spread of antibiotic resistance in the environment.

Advocates of the 'hygiene hypothesis' (Strachan, 2000) argue that the ubiquitous use in hospitals and homes of hand sanitisers, toothpastes and other products that contain *triclosan* is unnecessary because our immune systems have evolved over millions of years to withstand threats from bacteria, and lack of exposure to infectious agents, particularly during childhood, does not enable the immune system to fully develop. Thus, the more we try to protect ourselves, the more at risk we may become according to scientists (ibid). Some scientists have also argued that too much importance has been given to antimicrobial drugs because the most significant gains in the health of people living in the US and Western Europe can be traced back to large-scale interventions that reduced overcrowding and improved living conditions. For example, the construction of London's first modern sewage system in the 1860s reduced the risks from water-borne diseases (Hall *et al*. 2018). These claims remain open to debate, and so do those that have emerged in relation to the use of antimicrobials in animals as will be made clear in the next section.

1.3.2. The overuse and misuse of antimicrobials in animal agriculture

Nearly 70 percent of antibiotics being produced globally are currently being consumed by animals rather than humans (Harvey, 2018) and, in contrast to the way

they are often used in human health, according to the O'Neill paper titled *Antimicrobials in Agriculture and the Environment* (2015: 1), they are mainly given prophylactically to prevent disease spreading rapidly amongst "healthy animals" that are living in cramped conditions on factory farms. However, some scientists state that, although they may appear to be healthy, "animals that are bred for maximal production of meat, eggs or milk can be somewhat immune compromised because protein is being diverted from the immune system – a major consumer of protein in a normal animal. Hence the need to prevent disease is even more urgent" (Salyers and Whitt, 2005: 46-47). According to the WHO (2017), improving the living conditions of livestock so that they are more hygienic and less cramped would help to prevent the spread of infections in animals, and thus, reduce the need to use antibiotics. The Netherlands and Denmark are two countries that have shown that doing this can have a positive economic impact (Hall *et al*. 2018).

Growth promotion is another reason why antibiotics are given to livestock. In high-income countries, using antibiotics for promoting growth may only generate "modest benefits to farmers… typically less than five percent" (O'Neil, 2015: 1). However, Salyers and Whitt (2005: 47) argue that "given the slim profit margins most farmers face, even a 4 to 5% increase (the level of effect of the best growth-promoting antibiotic) can be critical". Much of the controversy about the agricultural use of antibiotics revolves around the fact that some scientists believe that some antibiotics that have been labelled as "growth promoters" can prevent and tackle disease, particularly if they reduce an animal's load of harmful bacteria (ibid). Mulchandani *et al*. (2023) argue that this is the main reason why the overall use of antibiotics did not fall across Europe and the United States when growth promotion as a category was banned by the EU in 2006 and by the Food and Drug Administration in 2017. The ban is able to be subverted by manufacturers of antibiotics who market them as disease prevention drugs rather than growth promoters. In 2020 almost 100,000 tonnes of antibiotics were used in livestock, and this is predicted by Mulchandani *et al*. to increase to 107,500 tonnes per year by 2030. As Figure 2 shows, Asia (primarily China) has the highest antibiotic use which is

expected to continue until at least 2030. The African continent is predicted to have the fastest growth – increasing by 25% between 2020 and 2030 due to increase in demand for meat.

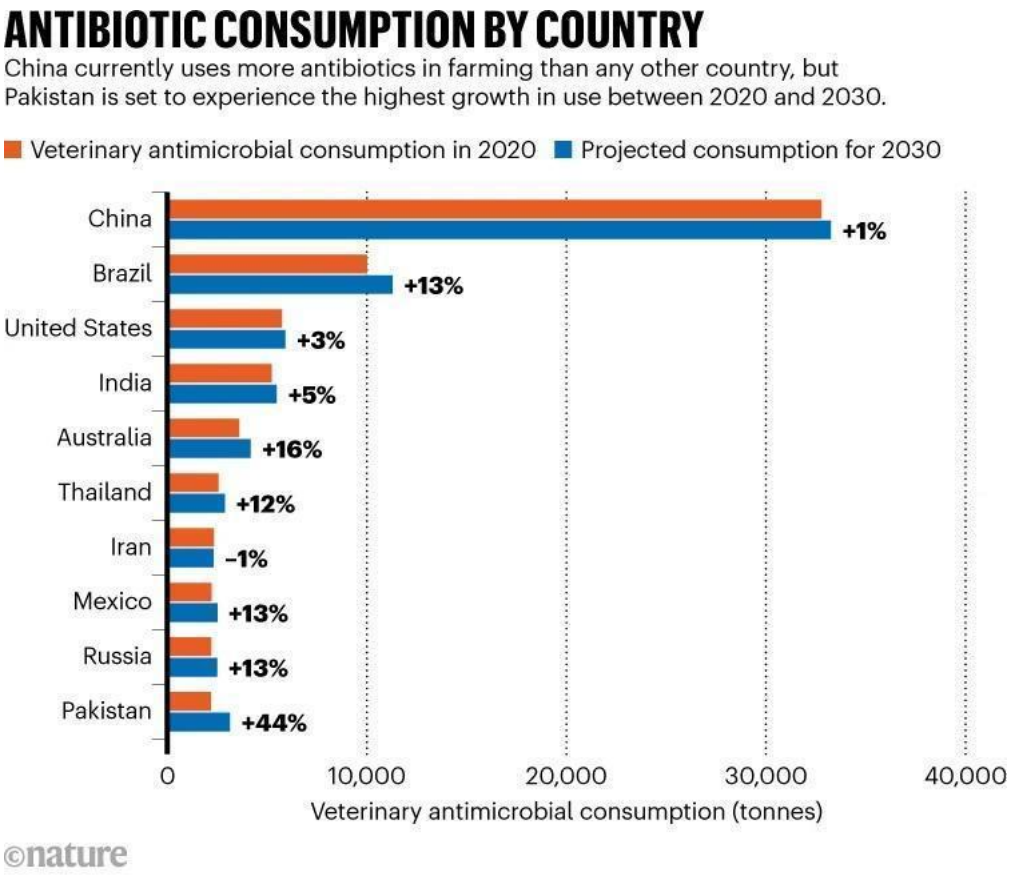

Figure 2 "Antibiotic Consumption by Country" (Reardon, 2023: 1. Adapted from Mulchandani *et al*. 2023: e0001305*).*

In the future Mulchadani and his collaborators state that they will explore whether there would be a reduction in the global use of antibiotics if more countries adopted the same approaches to those in Sweden such as a ban on giving antibiotics to animals without first acquiring a prescription from a veterinarian. Hall and his colleagues (2018) argue that restricting the use of antibiotics that are critical for human health such as *colistin*, so that they cannot be used in animals, might be a

more effective approach. In the US, animals raised for food are given five times as much antibiotic medicine as those raised on UK farms (Harvey, 2018). The policy director at the Soil Association, Peter Melchett, claims that this is because "UK farmers have finally begun to cut their antibiotic use, and the government needs to be careful it does not undermine this process by allowing imports that are not respecting UK and EU standards" (cited in ibid: 1). This is an interesting development because in their social scientific study on how newspapers and the farming press frame debates about the agricultural use of antibiotics and antimicrobials, Morris *et al*. (2016) identify voluntary industry-led action on the use of antibiotics in animal agriculture as a "minority position". More recent social science research has revealed that some UK farmers feel that they are unable to fully adopt the targets that have been set by the UK government to reduce the use of antibiotics in animal agriculture because they lack technical skills and knowledge to measure antibiotic use and resistance. They already stated that they used them responsibly and using them less would have a negative impact not only on their livelihoods, but also on their animals. They claimed that veterinarians and badly run farms are the cause of AMR and are, therefore, more responsible for tackling it (Doidge *et al*. 2020).

The use of antibiotics in the production of livestock remains an important issue not least because a recent study revealed that over 10% of pork being sold in some UK supermarkets, including some that is labelled 'Red tractor' and RSPCA assured, is infected with bacteria that seems to be resistant to "last resort" antibiotics that are used to treat serious infections (Walsley and Savage, 2022). Although the risk to human health is considerably decreased when meat is cooked thoroughly (ibid), there is concern that the food chain could act as a conduit for bacteria that have developed resistance on farms to enter the human body. Only five percent of scientific experts claim that there is no evidence to support the link between animal and human resistance to antibiotics (O'Neil, 2016). Hall *et al*. (2018: 173) add that the "vast majority (88 percent) of the papers that found evidence of a link were written by independent academics, whereas almost half the papers that found no link were written by people in industry or government." A recent study by Liu *et al*.

(2023) argues that every year in the US, over half a million urinary tract infections (UTIs) are caused by the consumption of meat that contains E-coli bacteria that are resistant to the combined antibiotics *trimethorprim* and *sulfamethoxazole*. Although UTIs often produce symptoms that are not serious, each year between 36,000 and 40,000 people are killed by E-coli bacteria that enters the bloodstream via the bladder and this number could rise if E-coli continues to become resistant to other antibiotics. In contrast to other illnesses caused by meat, lay publics do not instinctively make the connection between consuming meat and contracting a UTI because there is a delay between the bacteria entering the body and the emergence of UTI symptoms explained one of the authors of the study, Professor Lance Price, in a discussion with the *Guardian* newspaper (Kevany, 2023). He also discussed how factory farming contributes to spread of AMR:

> *When you are packing animals together very tightly, pigs or poultry, and buying them from [the] same breeder, yes, the dangerous strain of E-coli is going to spread very quickly.* [If the animals pass it on to each other it] *could develop new characteristics to develop that cause worse disease and be more resistant to antibiotics (ibid: 1).*

For Price and his colleagues, inoculating the animals could prevent this from becoming a reality. This research is primarily focused on the overuse and misuse of antibiotics in animal agriculture. However, as will be explored in the next section, the environment is becoming increasingly important for scientist working on AMR.

1.4. The emerging environmental dimensions of AMR

AMR in the environment was not considered a particularly important issue until Gullberg *et al*. (2011) discovered that antibiotics are not stable in the environment because they can select for resistance even when levels are far below the minimum inhibitory concentration (MIC – the concentration at which bacterial growth is

inhibited) (Murray, 2018). Unmetabolized waste from animals, humans and the manufacturing process are the three main ways antimicrobials and their residues and bacteria that have become resistant to them enter the environment. Waste from animals goes into the soil before being washed into rivers, lakes and coastal waters. Unmetabolized antibiotics excreted by humans also pollute these bodies of water via wastewater treatment plants that are unable to eradicate all traces of them (Hall *et al.* 2018). A global study led by scientists at the University of York (Gilbert, 2019: 1), argues that rivers around the world, including the Thames, which is considered one of Europe's cleanest rivers, contain "dangerously high" levels of antibiotics that could promote resistance. Antibiotics were discovered by the researchers in 65 % of 711 sites tested in 72 countries and safe levels of concentrations of antibiotics were exceeded in 111 of the tested sites. The highest concentrations of antibiotics were found in rivers located in Bangladesh and Kenya where sewage waste is dumped directly into them.

Most manufacturing of antibiotics takes place in lower-income countries where production costs are lower – most notably India and China. During the manufacturing process of antibiotics, insufficiently treated waste is released by some manufacturers into water bodies situated close to the manufacturing plants. The lack of universal standards for the discharge of active pharmaceutical ingredients (AIPs) – the ingredients that are essential for enabling antibiotics to work – promotes this practice due to the fact that it is far cheaper to discharge potentially dangerous waste into the local environment than to treat it (Hall *et al*. 2018). The highest cost is thrust upon local communities that use the polluted water to bath and wash clothes and dishes in (ibid). Engaging with these communities about the environmental dimensions of AMR is beyond the scope of this project. However, it has been argued that these water systems can become 'hotspots' for antibiotic resistant bacteria that are able to spread around the world, including through the air which potentially puts everyone at risk.

To elaborate, scientific research has been carried out on how the antibiotic resistant genes of bacteria are spreading through the air. Between 2016 and 2017, scientists at Peking University in Beijing, in collaboration with a team of international researchers (Lu, 2018), found that diverse antibiotic resistant genes were prevalent in all the 19 cities they examined around the world. In six of the cities, low levels of the genes resistant to the antibiotic of last resort for MRSA treatment, *vancomycin*, were discovered. The researchers argue that even the immune systems of people in remote regions could be damaged by inhaled antibiotic resistant genes that have emerged in other parts of the world. The hotspots for airborne antibiotic resistant genes include hospitals, wastewater treatment plants and animal feeding operations, argue the authors of the study (Li, 2018). In their work on environmental imaginaries, Helliwell *et al*. (2021) argue that even though empirical research for AMR hotspots is still limited, it remains a dominant imaginary because it helps to justify and direct research to these perceived sources of resistance. Hedriksen *et al*. (2019) explain that developments in whole-genome sequencing may soon enable scientists to more accurately discover the origins of drug-resistant bacteria in the environment and this could help them to direct their focus.

1.4.1. The risks AMR in the environment poses to human health

Although scientists have been aware of antibiotics being released into the environment for over two decades (Salyers and Whitt, 2004), little research has been done to explore what impact this is having on human health. One study by scientists at Exeter University, known colloquially as the 'Beach Bum Study' (Leonard *et al*. 2018) involved collaborating with a grassroots environmental charity, called 'Surfers Against Sewage. This study discovered that, because they are often immersed in the water, surfers and open-water swimmers are more at risk of swallowing antibiotic-resistant *E. coli* that pollutes UK coastal waters, than other publics who engage with the environment for recreational reasons. Although surfers may be asymptomatic, future health conditions could make them more vulnerable to infection. In addition, surfers and other water users could be contributing to the spread of antibiotic-resistant bacteria to the wider population. Eden's (2017) work on 'environmental

publics' can be used to explain how and why surfers and open-water swimmers could contribute to tackling environmental issues. Environmental publics, Eden argues, "are differentiated by how they relate to the environment through their environmental practices (as consumers, campaigners, workers, voters and recreational users), rather than their own characteristics" (2017: 1).

Eden's main argument is that, although they may not possess academic credentials, lay publics are able to gain knowledge about the environment through engaging with it when they are, for example, surfing in the sea, swimming in a lake or walking through a park. These ideas have been influenced by social science research over the past two decades - especially in relation to consumption, science and technology, where there has been what has come to be known as 'the turn to practice' (Whatmore, 2006) which places emphasis on how publics are produced by their practices. The concept of 'environmental publics' also provides a useful framework because it explicitly tries to understand the power relations between 'expert' and 'lay' publics by exploring the extent to which public participation exercises enable lay publics to participate in the planning and decision-making processes in relation to environmental issues. In relation to addressing AMR in the environment, there has been no discussion in the social science literature or policy documents about engaging in a dialogue with surfers, open-water swimmers or any other environmental publics, as will be made clear in the following sections. Even participants in the 'Beach Bum' study are treated by scientists more as, in Foucauldian terms, objects of information than as subjects of communication (Rabinow, 1991).

1.4.2. Tackling AMR in the environment

Some social science research has been carried out on how AMR in the environment can be tackled. For example, Hall *et al*. (2018) argue that improving wastewater treatment in hospitals should be a priority because antibiotic residues as well as bacteria that have become resistant to drugs are more likely to be found in hospital

patients. However, Ju Li *et al*. (2018: 5) assert that "wastewater from residential areas has similar or even higher levels of antibiotic resistant bacteria and antibiotic resistance genes compared to hospitals, where you would expect greater antibiotic concentrations." Another area that is being addressed to tackle AMR in the environment is waste produced by antibiotic manufacturers. In January 2016, at the World Economic Forum in Davos, 100 pharmaceutical companies and associations signed the Declaration on AMR and committed to the roadmap that was produced by the AMR Industry Alliance. On its website, in relation to the roadmap, the AMR Industry Alliance states that companies have pledged to "Reduce the environmental impact from the production of antibiotics, including a review of companies' manufacturing and supply chains, and work with stakeholders to establish a common framework for assessing and managing antibiotic discharge" (2016: 1).

The roadmap forms part of a wider pledge that companies have promised to make good on by 2020 in order to help tackle the problem of AMR. The Industry Alliance states that it will ensure that signatories deliver on the specific commitments made in the Declaration and Roadmap. However, most companies that manufacture antibiotics have still not committed to the Industry Alliance, including the thousands of companies that are mainly based in India and China. Furthermore, because there is no clear consensus around antibiotic discharge, companies are not compelled to make reforms that could have a significant impact in relation to tackling AMR in the environment. A report entitled *Antimicrobial Resistance Benchmark 2018* by the not-for-profit organisation Access to Medicine Foundation, which acts as a drug industry watchdog, reveals that 18 of the world's well-known pharmaceutical companies, including Johnson and Johnson, Pfizer, Sanofi, Shinogi, Novaritis, Roche, and GSK, do not disclose how much antibiotic discharge is released from their factories into the environment. None of the companies polled would reveal the name of its suppliers and only eight claimed that they set limits on how much could be released in wastewater. Only four companies stated that they demand that their suppliers of Active Pharmaceutical Ingredients and drug products agree to adhere to the same limits.

In 2016 the NGO, Changing Markets, produced a report that argues cleaning up the supply chain would be one of the best ways to reduce antibiotic residues being released into the environment. Changing Markets draws on the textile industry in order to show how significant improvements can be made to the antibiotic supply chain. To elaborate, the textile industry was severely criticised for the working conditions of production lines of many large companies based in parts of Asia. Criticism forced the textile industry to become more transparent about the working conditions of those they employ to make garments. Companies are now competing with each other on having a good ethical code of conduct. According to Hall *et al*. (2018) the use of a labelling system would also enable purchasers of antibiotics, including the NHS, to see that antibiotics have been manufactured according to high environmental standards, which would put added pressure on manufacturers to meet the standard in the same way food labeling systems do. Some social science research, however, has argued that labels on food packaging that were introduced to help tackle rising levels of obesity by displaying information about nutrition to help consumers make more informed decisions, has only had a small impact on people's behaviour in relation to them buying items that contain fewer calories (Kiszko, *et al.* 2015). As will be explored in detail in Chapter 2, another approach to tackling public health issues is to treat lay publics as blank slates who need to be filled with scientific information. However, AMR policy documents that discuss engaging with the public advocate this strategy as will be explored in the next section.

1.5. Policy responses to tackling AMR in the environment.

Developing strategies to tackle AMR is the focus of AMR action plans that have been produced by Influential organisations, including the European Commission (2011), the Department of Health/Defra (2013), the WHO (2015), the Department of Health and Social Care (2019) and the O'Neill Review (2016). These action plans have been criticised for their lack of engagement with the environmental dimensions of AMR.

According to Singer *et al.* (2016), this lack of engagement is a consequence of being reliant on scientific knowledge that is unable to answer fundamental questions such as: what effect do antimicrobials flowing from wastewater treatment plants and farms have on microbes, plants and animals? Unless there is more of a focus on the environment, Singer and his colleagues conclude that AMR action plans risk not achieving their stated goals of maintaining and improving the effectiveness of existing and future antibiotics. However, there is little or no criticism of the lack of focus on other antimicrobial compounds, including antiseptics and disinfectants that are also critical to human health (see, *1.3.1*). Furthermore, there is no discussion about how the action plans construct the public in a way that adheres to the 'deficit model' of the public understanding of science (PUS) (Wynne, 1992). To elaborate, the 2015 WHO action plan and the 2016 O'Neill Review are the only AMR policy documents that discuss the importance of engaging with lay publics. They assert that one of the main ways to tackle the overuse and misuse of antibiotics is to educate unknowing publics so that they can change their behaviour.

The seeds of the O'Neill Review were planted in 2014 when the then Prime Minister, David Cameron, appointed a macroeconomist, Jim O'Neill, to focus on the threat AMR posed from several perspectives. The review produced 7 papers which looked at AMR from different angles, including, health, agriculture and the environment. The final paper, completed in 2016, included an action plan which is based on the recommendations presented in the previous 7 papers. Rather than engaging in a two-way dialogue that enables lay publics to shape debates about AMR, the WHO and the O'Neill Reviews recommend didactic education. In particular, the global action plan of the WHO which was endorsed at the sixty-eighth session of the World Health Assembly in May 2015, sets out 5 objectives. The first objective is most pertinent to my research because its aim is to "Improve public awareness and understanding of antimicrobial resistance through effective communication, education and training" (2015: 8) to change the behaviour of lay and professional publics working in human health, animal health and agriculture. There is particular emphasis on targeting children so that an understanding of AMR is gained at an early

age from the education system. Similarly, the O'Neill Review (2016: 19) has ten objectives and the first is also the most salient in relation to my research in the sense that it states that one of the most effective ways to tackle AMR is to generate "A global public awareness campaign that change behaviours" by using sports stars, celebrities and other popular figures in the public eye to communicate information about AMR via old and new media platforms such as TV, radio, social media and text messaging.

However, as research on previous health campaigns has shown, using celebrities and sports stars to generate trust in science is a strategy that has not been very successful. For example, in 1956 Elvis Presley was praised for setting a good example for American teenagers when he received a polio vaccine live on the Ed Sullivan Show (McKie, 2016). However, 'confirmation bias' (Pinker, 2003) meant that teenagers ignored or downplayed new information because it did not support their existing (whether positive or negative) values and beliefs. One of the main reasons people held negative beliefs about the vaccine was because of an event now known as the 'Cutter Incident'. In 1955 doses of the vaccine were presented to the public as efficacious even though they contained live poliovirus due to inadequate preparation at the Cutter Laboratories in Berkley, California. Consequently, it was bottom-up approaches that proved to be the most successful strategies as teenagers themselves – particularly members of 'Teenagers Against Polio' – organised campaigns and popular dances that only admitted those who had been immunised (Arnold-Foster, 2020).

In industrial societies, opposition to mass vaccination programmes seems to revolve around a lack of trust in what Anthony Giddens (1990) calls 'expert systems' – "the public health experts who tell us to get vaccinated, the pharmaceutical companies who made and tested these vaccines, the medical practitioners who recommend them to us personally and the people who ultimately do the jabbing" (Arnold-Foster, 2020: 1). In both the AMR action plan and the O'Neil Review, lay publics are

perceived as unknowing about AMR but able to be persuaded by rational information. There is also an acknowledgement that there are multiple publics that need to be addressed (physicians, veterinarians, farmers and consumers, school children etc.) and that information about AMR will be understood and mobilised by diverse publics in different locations. Information produced by expert systems about AMR is more likely to be trusted when it acknowledges local infrastructure and the social norms that shape the way people interpret and engage with science. However, there is no recognition that lay publics may also possess expertise gained from experience and therefore it might be fruitful to engage with them in a genuine dialogue about what AMR is and how it should be tackled, particularly in relation to the environment. Adopting a 'One Health' approach, as will be explored in the next section, could help to address this limitation in AMR policy documents.

1.6. Social science and the 'One Health' approach to tackling AMR

The idea of the 'One Health' approach being used as a framework to tackle AMR has become popular since it was first discussed by the WHO (2015; 2017). The One Health approach involves researchers from a wide range of disciplines working together to improve public health. In relation to AMR, this would include those working on human health, animal health, food safety, the environment and the social sciences who can contribute to AMR stewardship and one health by drawing on knowledge from sociology, psychology, and human geography. On its website The WHO states:

> *While health, food, water, energy and environment are all wider topics with sector-specific concerns, the collaboration across sectors and disciplines contributes to protect health, address health challenges such as the emergence of infectious diseases, antimicrobial resistance, and food safety and promote the health and integrity of our ecosystems. By linking humans, animals and the environment, One Health can help to address the full spectrum of disease control – from prevention to detection, preparedness,*

response and management – and contribute to global health security (WHO, 2017: 1).

From the perspective of 'One Health', human health is largely dependent on the health of animals and the environment as figure 3 shows:

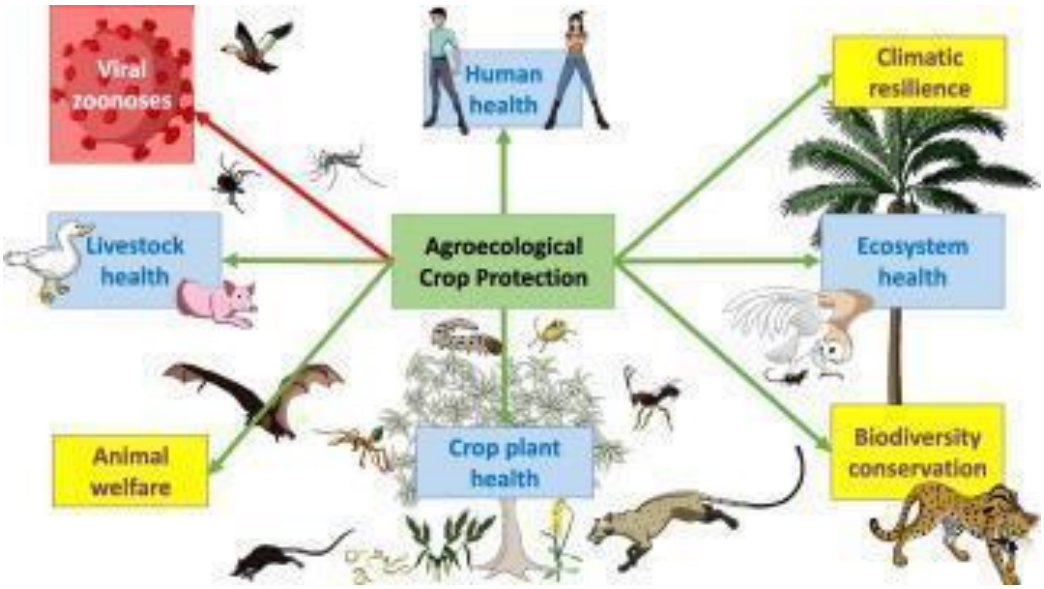

Figure 3 One Health: the relationship between the health of humans, animals, and the environment (*Ratnadass and Deguine, 2021: 1).*

Although social science has made a significant contribution to a variety of public health and environmental issues, such as HIV/AIDS, obesity and climate change (see chapter 2), social science research on AMR remains scarce. The studies that have been carried out by social scientists on AMR have mainly focused on the reasons for overuse and misuse of antibiotics in clinical and community settings and on the use of antibiotics in agriculture (see Chapter 2). The fact that the environment has been mostly ignored by social science is proof that One Health remains at the margins of AMR research (Lu, *et al*. 2020).

1.7. Research aim and objectives

The main aim of this research is to contribute to a 'One Health' approach to AMR by exploring the emerging environmental dimensions of AMR from a human geography perspective. The following objectives were devised to operationalise this aim:

1. Explore how scientific experts imagine 'lay publics' in relation to the environmental dimensions of AMR.

2. Explore how surfers and open-water swimmers make sense of scientific debates about the environmental dimensions of AMR.

3. Explore how public participation exercises can help scientists, policymakers and lay publics better understand each other's perspectives and knowledge bases in relation to the environmental dimensions of AMR.

Addressing my aim and objectives could also contribute to the ongoing debates about the tension between the 'problem of legitimacy' on the one hand, and the 'problem of extension' on the other (Collins and Evans, 2007). In other words, this project will generate knowledge that could redefine the criteria that used to distinction between 'lay' and 'expert' knowledge (see Chapter 2). It could also be used by by organisers of public participation mechanisms to develop practices that build trust between 'lay 'and 'expert' communities.

1.8. The structure of this thesis

Having contextualised the environmental dimensions of AMR and how the present research will address some of the gaps in the current social science literature on AMR, the thesis will proceed as follows. Chapter 2 will review the existing literature on how lay publics have been imagined by scientific experts and policy actors. I will also explore what previous research has discovered about how lay publics make sense of other environmental issues and the broader dimensions of AMR. Chapter 3

will outline the methodological approach (including, semi-structured interviews and grounded theory) to data collection and analysis. In Chapter 4, I will present my findings from the interviews that I carried out with scientists on how they imagine lay publics in relation to the environmental dimensions of AMR. In Chapter 5, I will present how surfers and open-water swimmers make sense of the environmental dimensions of AMR. In Chapter6, I will present a synthesis of the study's key findings. In the concluding chapter I will draw attention to the strengths and limitations of the investigation, and I will identify key avenues for further research.

Chapter 2. Contextualising 'lay' and 'expert' knowledge in relation to the emerging environmental dimensions of AMR.

2.1. Introduction

Much of the research undertaken by social scientists studying the public communication of science focuses on the 'lay/expert dichotomy' and ideas related to the 'deficit model' of the public understanding of science (PUS) that was first introduced and developed in the 1980s and 1990s to understand how scientists and policy actors imagine 'the public' (Irwin and Wynne, 1996; Wynne, 1992). The term 'expert' is inherently geographical because how it is defined depends on the context in which it is employed (e.g., in a university lecture theatre, a courtroom or a scientific laboratory) (Eden, 2017). Within the framework of the 'lay/expert dichotomy' and the 'deficit model', the possession of scientific knowledge, gained from formal education and training, particularly a doctorate, is used to separate 'experts' from 'lay publics' who are imagined by scientists and policy actors as being a misinformed or ill-informed mass. Thus, to generate public support for science and technology, emphasis has been placed on the transfer of scientific knowledge (that, in contrast to 'lay' knowledge, is perceived as being objective and value free) from 'experts' to 'lay publics.' Over the past twenty years, however, these ideas have been challenged by social science research that has explored what it means to be an 'expert' and why it is erroneous to imagine the public as a monolithic entity that is homogenous in its lack of knowledge because there are multiple publics and their relationship with science is more nuanced than adherents to the 'deficit model' appreciate (Sismondo, 2010). In particular, social scientists have challenged the epistemological authority of scientific knowledge by drawing attention to the various ways in which it is socially constructed and how it can be appropriated or come into conflict with lay publics' pre-existing knowledge, values and beliefs, including those (see below) related to environmental risk and the wider dimensions of AMR) when it is removed from its place of production (e.g., laboratories) and applied to the

messiness of the 'real' world (Collins and Evans, 2007; Latour and Woolger, 1979; Livingstone, 2013; Yearley, 1999).

To elaborate, a lack of trust in the solutions being put forward by scientists and policymakers to tackle problems in the public sphere can emerge when they fail to take account of 'lay' publics' pre-existing knowledge, values and beliefs. Thus, it has been argued that to establish trust, scientists and policy actors need to genuinely engage in a dialogue with 'lay publics' rather than imaging them as blank slates to be filled with scientific knowledge, as this will provide legitimate opportunities for them to understand each other's perspectives (Chilvers, 2008). Public participation mechanisms have emerged to enable dialogues to take place that include 'citizens' juries', 'citizens' assemblies', 'task forces', 'town meetings', 'consensus conferences' and 'citizen science' projects. (Rowe and Fewer, 2005). However, to what extent these mechanisms enable publics outside of the scientific and policy communities to genuinely participate in environmental decision-making remains unclear, not least because ideas related to the 'deficit model' continue to shape how policy actors and scientists imagine and engage with other publics (Simis *et al*. 2016).

In this chapter, I will review the literature that explores these ideas in more detail. In sections 2.2, and 2.3, I will explore the empirical research that focuses on how and why scientists adhere to the 'deficit model'. In 2.4, I proceed to explore how social science research has challenged the deficit model by focusing on how scientific knowledge is socially constructed. How scientific knowledge is a key part of the criteria that have been used to distinguish between 'lay' and 'expert' publics is explored in section 2.5. In 2.6, I explore the importance of embodied practice and sensory experience. How this knowledge is used by lay publics to make sense of environmental risk will be explored in 2.7. Lay perspectives on AMR are the focus of 2.8. In 2.9, and 2.10, I will explore to what extent public participation mechanisms that emerged in response to demands for 'lay publics' to be part of the decision-making process remain within the framework of the 'deficit model.' Or to put it

another way, to what extent do these mechanisms genuinely empower 'lay publics' to become co-producers of knowledge rather than simply consumers of it?

2.2. Imagining 'the public' as an ill-informed or misinformed mass

Some scientists believe 'the public' knows about science closely adheres to the 'deficit model' of the public understanding of science (Irwin and Wynn 1996). Within the discourse of the 'deficit model', 'the public' is characterised by scientists and policy experts as being deficient in technical and scientific knowledge. Opinion polls have been cited to support this position. For example, 35 percent of respondents surveyed across Europe in a 1999 opinion poll agreed with the following statement: "Ordinary tomatoes do not contain genes, while genetically modified tomatoes do". 35 percent disagreed and a further 30 percent explained that they were unsure. In the UK, 40 percent of respondents said they did not know. (INFRA [EUROPE] – ECOSA 2000. Cited in Eden, 2017: 13).

Some of the most recent empirical research on interactions between 'expert' and 'lay' publics also shows that scientists imagine the public as lacking in knowledge about science. For example, in their analysis of two focus group discussions and eight interviews with pesticides experts and eight members of 'the public', Blok *et al*. (2008) argue that it was common for scientists to imagine people's perception of risk as being based on irrational fear rather than accurate information. Furthermore, Besley and Nisbet's (2013) literature review, which combines their analysis of previous qualitative studies with their analysis of two large-sample surveys also shows that scientists often imagine 'the public' in ways that adhere to the 'deficit model'. The first survey was funded by three organisations (Royal Society, Research Councils UK and the Wellcome Trust) and carried out by People, Science and Policy Ltd. on behalf of a study group aiming to promote and understand engagement with science. Data was collected in 2005 from 1337 scientists based at 50 higher education institutions in the UK. The second survey was completed in 2009 by the Pew Research Center for the People and Press' in collaboration with the American

Association for the Advancement of Science (AAAS) (Pew, 2009). 2,535 AAAS members were randomly selected to take part in online interviews, and a response rate of 25 percent was achieved. Contextualising the results of the surveys enabled Besley and Nisbet (2011: 25) to examine "(1) scientists' views of 'the public'; (2) scientists' views of the news media, and (3) scientists' views of the role of the public in the policy process". What their review concludes is that scientists adhere to the assumptions of the 'deficit model' in the sense that they imagine 'the public' as an indistinguishable group of non-experts with little room "for any relevant expertise outside of the scientific community, or for any intermediate degrees of scientific knowledge or understanding" (ibid: 5). Although Besley and Nisbet found that there was a consensus among scientists that 'the public' is deficient in knowledge about science, there was disagreement about to what extent this constitutes a problem that needs to be solved. To elaborate, 'older' (the term 'older' was not clearly defined) scientists were more likely to see the problem as "major". In relation to tackling scientific illiteracy, scientists also talked about 'the public' as being emotional and reliant on anecdotal evidence, focused on sensationalism, self-interested and reluctant to change their views when new evidence emerges. 53 percent of scientists considered the education system to be the main cause of the poor understanding of science.

Proponents of the 'deficit model' assert that providing the public with information from experts will generate more support and trust for science and technology and the Royal Society Survey (2006), that contained open-ended questions, reveals that for 80 percent of scientists the main motivation for public engagement is to create more awareness about science and technology and to correct misinformation. However, according to the 2001 Mori/Wellcome Trust survey, scientists are reluctant to engage with members of the public because they believe they are unable to comprehend their work. Physicists, engineers, and mathematicians were most likely to believe that their work is too specialised for a lay audience to comprehend. By contrast, those working in environmental science had more confidence in people's ability to understand their research. Some scientists also

believe that the public can be hostile because they distrust scientists. The survey also found that 44% of scientists assumed that 'ordinary' people considered scientists to be taciturn in relation to discussing their research. A further 44% thought that scientists were viewed as surreptitious, and 58% thought that scientists were perceived to be withdrawn. Similarly, in the Royal Society (2006: 10) survey, scientists expressed concern about becoming a 'target' if they engaged with the public about their work.

In addition, scientists also expressed concern about their work being misrepresented and being made to look bad because of the public's lack of understanding and 19% of scientists stated that the 'wrong message' could be sent out by engaging with them. Scientists' reluctance to engage with 'the public' helps to create what Collins and Evans (2007: 6) refer to as the 'distance effect', which revolves around the claim that 'the public' can be ignorant and intolerant of disputes and uncertainties about issues such as climate change because they are far removed from laboratories and conferences where scientific experiments and debates take place. "Distance lends enchantment" is the phrase that has been employed to describe this phenomenon (ibid: 6). Simis *et al*. (2016) assert that the main reason for the 'distance affect' is that scientists are not skilled in relation to presenting their work to those outside of the scientific community. In particular, they lack formal training in public communication that has a distinctive focus on how diverse publics make sense of scientific knowledge and this is also one of the main reasons why the deficit model continues to persist in science communication (see below). However, in their review, Besley and Nisbet (2013) found that only 20 percent of scientists acknowledged their own and other scientists' poor communication skills. 11 percent focused on scientists' apathy in relation to communicating their work to a 'lay public'. In their qualitative study of how 'experts' working on environmental projects perceive 'lay publics' and 'lay knowledge', Koizumi and Yamashita (2021) argue that apathy occurs because scientists imagine 'lay publics' to be concomitant when it comes to achieving power, status and promotions. However, according to Simis *et al.* (2016: 403) "there is growing evidence that scientific communication via forms of social

media can positively impact the careers of scientists." For example, the number of Twitter mentions is correlated with higher h-index scores, a measure of research productivity (Laing *et al*. 2014). As we shall see in the next section, much of the research on how scientists prefer to communicate with 'the public' was undertaken before social media platforms became ubiquitous, thus it shows that many scientists prefer communicating with 'lay publics' via traditional mass media outlets which they found to be problematic. However, scientists who did take part in public engagement activities have come to view the public as non-confrontational, eager to learn, and more knowledgeable than they expected (Koizumi and Yamashita, 2021).

2.3. Scientists' view of the media in relation to 'the public'

Scientists' views about the media revolve around issues of trust. For example, data generated from the 2001 'Mori/Wellcome Trust' survey reveals that a higher percentage of scientists believe that 'the public' has more trust in television documentaries (67 percent), broadcast media (68 percent) and journalists working for national newspapers (49 percent) than in scientists working at universities (39 percent). 48 percent of scientists stated that engaging with television and radio was the best way to communicate their work to 'the public'. A further 26 percent asserted that National newspapers were the best platform for communicating with 'the public'. Only 5 percent talked about engaging with local newspaper reporters. 19 percent mentioned writing for press that focused on popular science. Although there was a consensus that coverage of science was oversimplified, scientists were divided on whether this constituted a 'major' or 'minor' problem. Despite the fear of being misquoted, promoting a more positive view of science, and creating a better educated public was the main reason given by nine out of ten scientists for choosing to interact with the media as journalists are imagined as being the most skilled at communicating science to non-specialist audiences because they can present scientific information in simple and entertaining ways. However, as will be explored below, the notion that there needs to be a didactic transfer of scientific knowledge

from experts - including via the media - to non-experts has been challenged by social science research that explores how scientific knowledge is socially constructed and the values and beliefs that lay publics bring to bear on that knowledge, will influence how they make sense of it.

2.4. The social construction of scientific knowledge

The 'deficit model' is underpinned by the assumption that science generates universal truths and is therefore superior to 'lay' knowledge. The latter is perceived by scientists and policymakers as idiographic in the sense that it is "locally bound and not readily transferable to other scales or places" (Eden, 2017: 27). However, this assumption has been challenged by historians, sociologists and geographers who have asserted that science also produces knowledge that is historically and socially situated in the sense that the time and place will shape not only how it is produced, but also how it is made sense of. Although science may appear to produce knowledge that is value-free, it is almost impossible to stop one's values and prejudices from entering one's scientific work. As the geographer of science David Livingstone (2007: 180) explains:

> *Botanists do not shed their ethnicity when they engage in fieldwork. Chemists do not discard their gender when they walk into a biotechnology lab. Anthropologists do not set aside their politics when they map ethnic differences. Science is not some eternal essence slowly taking form in history; rather, it is a social practice grounded in social and historical circumstances.*

The common-sense view of science is that its exploration of nature is disinterested and impartial (Barnes, 1982). However, multiple publics, including the scientific in different geographical and historical settings, employ different understandings of evidence to support their values and beliefs. For example, the evolutionary biologist and historian of science Stephen Jay Gould explores how Darwin's arguments about

natural selection were initially rejected by many in Victorian society because they came into conflict with the dominant ideology about women being naturally passive. In his discussion about the geography of rationality, Livingstone (2007) also draws on Darwin's theory of evolution to highlight the importance of location in relation to how scientific knowledge is generated and appropriated by different communities. He explains that in the late 1800s, Darwinism was welcomed by many white settlers in New Zealand because it supported their beliefs about them being superior to the indigenous populations. At the same time in the American south, however, it was rejected by some whites who believed that a divine creator had endowed them with the abilities to achieve intellectual and cultural greatness. Elaborating on how knowledge is historically and socially situated, the sociologist Derek Phillips explained that:

> *When we speak about the "facts" we are speaking about what people in a given social milieu at a given time accept as facts. If the milieu happens to be considered a scientific community, then, we can speak of "scientific facts". In science, then, truth cannot be regarded as conformity with the "real", but rather as conformity with standards held in a scientific community* (117: 1973).

From this perspective, the scientific community has no more direct access to nature than any other community does. However, some commentators challenge this position. For example, in their criticisms of what they describe as 'cultural relativism', professor of Life Sciences, Paul R. Gross and professor of Mathematics Norman Levitt (1998) assert that it undermines any criteria that is used to separate truth from superstition. Livingstone (2007), by contrast, argues that the main focus of social scientists should not be on trying to uncover the 'truth', but what is a rational belief for a particular person or group in a particular time and place. For example, a 12th Century sailor, a 15th Century religious leader and an astronomer in the 20th Century are all justified in believing different things about how the earth

moves because rationality is always embodied, not disembodied. Eden also explains how place and space can shape the way lay publics think about and engage with the environment: "the way someone eats, uses a computer or learns about environmental change may differ depending on whether they are in their work office, their home, or halfway up a mountain on a walking holiday" (Eden, 2017: 5). Eden adds that these 'geographies of practice' have been neglected in the social science literature (ibid). In relation to the movement of the planets, the sociologist Steven Yearley (1991) draws attention to the fact that even within the scientific community, disputes about whether the sun revolves around the earth or the earth around the sun cannot not be completely settled because evidence can be used to support both claims even though one of them must be false. Such disputes lend support to the claim that scientific knowledge should not automatically be viewed as superior to 'lay knowledge' because it can provide valuable insight into problem-solving, particularly in relation to environmental issues, as it is "more relevant to action than traditional, universal, abstract and context-independent scientific statements" (Lidskog, 2008: 77). It is also more able to respond quickly to environmental change (Chambers, 1997) while remaining authentic and exploratory (Fagerholm et *al*. 2013). In contrast to formal or codified knowledge, 'lay knowledge' has also been described as 'tacit knowledge' that is difficult to communicate to others verbally or in writing (Collins and Evans, 2007). These ideas, particularly in the social sciences, continue to shape debates about what criteria should be used to distinguish between 'lay' and 'expert' publics – as will be explored in the next section.

2.5. Distinguishing between 'lay' and 'expert' publics

Traditionally formal qualifications have been used to distinguish between 'expert' and 'lay' knowledge. However, Collins and Evans (2009) argue that formal qualifications are illegitimate in relation to defining expertise as they (a) only provide one with superficial knowledge and (b) exclude those who have gained expert

knowledge from experience, such as AIDS activists and sheep farmers as will be explored below.

2.5.1. AIDS patient groups

In his sociological study of the interactions between scientists and AIDS activists in America during the 1980s and 1990s, the American sociologist Stephen Epstein (1995) focuses on how members of the 'gay community' were able to draw on their experience of activism in defence of their rights when they thought about how they could contribute to tackling the emerging deadly disease known as "Acquired Immune Deficiency Syndrome", or "AIDS". The tactics activists employed included lobbying AIDS researchers and government agencies and learning the discourse of medicine. Scientists were regularly surprised by the "lay expertise" of the activists' detailed knowledge of the disease, the immune system, potential treatments, and the processes of clinical testing. Epstein provides a vivid example of a biostatistician working on AIDS trials engaging with literature produced by activists: "I walked down to the courtyard and there was this group of guys, and they were wearing muscle shirts, with earrings and funny hair. I was almost afraid." However, in response to reading research produced by activists he added: "There were many places where I found it was sensible – where I found myself saying: 'You mean, we are not doing this? Or we are not doing it this way?'" (Cited in Epstein, 1996, 247). In contrast to assumptions of those who adhere to the 'deficit model', another scientist told Epstein that some of activists' knowledge of science was "unbelievably high" (ibid, 338). Activists also took control of parts of the research and treatment processes. For example, 'Project Inform' – the community-based HIV research movement that was founded in San Francisco in 1984 – generated epidemiological studies and groups throughout the United States created buying clubs for new drugs. Among the most obvious targets of activism were such things as funding for research and treatment. There was also a demand for quicker and fairer access to potential treatments and for the right to decide the level of risk they were willing to take. In relation to the methodology of clinical trials, activists were also successful at limiting the use of placebos and the right to take alternative medicine, not just those given

to them by researchers, because they believed the trials should mimic the messiness of the 'real' world.

Much of the research on how experts imagine members of 'the public' has little focus on perceptions gained from actually engaging with them in a dialogue (Koizumi and Yamashita, 2021). However, Epstein's research (1996) lends support to the claim by Blok *et al*. (2008) that scientists and policy experts have a more positive view of lay publics the more they interact with them. By contrast, lay publics can develop a distrust of scientific experts and policy actors when they ignore or downplay local knowledge that has been gained from practical experience. As will become clear in the next section, Wynne's (1992; 1996) study of Cumbrian sheep farmers' rejection of the recommendations given to them by government scientists in response to the 1986 Chernobyl disaster is a prime example.

2.5.2. The Cumbrian sheep farmers

Wynne's (1992; 1996) study of the fallout from the nuclear accident at Chernobyl in 1986 that impacted the ecology of the Cumbrian landscape in northern England is a prime example of how scientific knowledge can come into conflict with lay knowledge when it is applied to the messiness of the 'real' world. Sheep farmers in Cumbria had gained expert knowledge about the behaviour of sheep and the ecology of the landscape from practical experience. Wynne explains that the farmers' expertise had been 'black-boxed' and excluded from official analysis because it came into conflict with assumptions made by government scientists. When the government could no longer dismiss the risk of contamination from caesium isotopes that had been dropped by localised rainstorms on higher ground in various parts of the UK, advice from the Ministry of Agriculture, Fisheries and Food for lambs to be kept in cleaner valleys for longer was contested by the farmers because they believed this strategy would deplete the valleys. Similarly, farmers rejected government advice to keep sheep fenced in when bentonite was being

spread at different concentrations in an attempt to achieve decontamination on the grounds that the health of the sheep deteriorates if they are fenced in.

Much of the farmers' distrust of the information disseminated by government officials and scientists can be traced back to a fire that occurred in 1957 at the Sellafield plant which caused radiation to be omitted into the local environment. For many years before the Chernobyl disaster, Sellafield had generated controversy and criticism due to the high rates of leukaemia, accusations of illegal discharges, poor safety management and allegations of misleading information being presented at enquiries. Farmers rejected the official claim that caesium 'fingerprints' in the Cumbrian hills more closely matched Chernobyl, not Sellafield. Later studies revealed that 50 percent of the radioactivity did not emerge from Chernobyl, indicating that the farmers were correct (Sismondo, 2010). Furthermore, the experiments to decontaminate were eventually abandoned because the fenced-in sheep did deteriorate, as the farmers had warned.

Rather than arguing that one side produced the truth, and the other did not, Wynne (1996: 38), echoes the sociological claim that the knowledge produced by scientists and farmers was equally "socially grounded, conditional and value-laden", but the scientists were less reflexive about this. The importance of Wynne's research is that it focuses on the contextual nature of knowledge and that scientists and policymakers can learn from publics who may not possess relevant formal qualifications but have gained expertise from practical experience. Collins and Evans (2007) refer to the AIDS activists and the Cumbrian sheep farmers as "lay experts". In his discussion about how people make sense of health and illness, Prior (2003: 44), however, asserts that the term 'lay expert' is an oxymoron because, by definition, 'lay' refers to a 'non-expert' while 'expert' refers to a person who has specialised knowledge in a particular domain. The ongoing debates about how knowledge can be gained and what constitutes expertise have also been shaped by discussions on embodied practice and sensory experience, particularly in relation to the

environment where there is a focus on knowledge gained *in situ*, i.e., in the environment that is being researched or recreationally enjoyed (rivers, lakes, coastal waters) rather than *ex situ* (the home or a classroom) (Eden, 2017), as will be explored in more detail below.

2.6. Gaining knowledge of the environment through sensory experience.

According to Ulrich Beck (1992) and Anthony Giddens (1991) - two of the most prominent thinkers on modernity – we are now living in a 'risk society' that is preoccupied with climate change and other environmental issues that pose a serious threat to our survival. In pre-industrial societies God, bad luck or natural disasters were perceived to be the cause of devastating events (Bernstein, 1996). However, in societies that are dominated by industrialisation, Beck, and Giddens claim that risks are produced by working conditions, transport systems and other ways of living that are closely linked to modernity which tries to deal with them by means of calculation and political regulation. In addition, illnesses and accidents that are, in their consequences perceived to be deeply personal, are also 'predictable' types of events in the sense that they are "systematically caused and statistically describable". Thus, we are all restricted by "political rules of recognition, compensation and avoidance" (Beck, 1992: 99). Calculating risks, however, is becoming increasingly difficult not least because they are often global in scope and invisible to our senses. AMR is a prime example because it is a global issue that cannot be seen, smelt, heard, or touched. To address the limitations of the senses, Beck argues that we need to rely on more scientific perceptions of the world (Beck 1992). However, as explored above, this position is problematic because it fails to acknowledge that, although scientific knowledge may appear to be objective and universal, it is socially situated and, thus, can come into conflict with local knowledges including those that have been gained through embodied practice and sensory experience; sight, touch, smell, and to a limited extent, taste and sound (Macnaghten and Urry, 1998; Wait and Cook, 2007).

The senses are interconnected and cooperate with each other to produce a sensed environment. The claim that we gain knowledge of the environment through sensory experience is related to structuralist approaches to meaning, particularly signs (Layton, 2006). A sign is defined by the linguist Ferdinand de Saussure (2013) as an object, sound or smell together with its meaning. Put more technically, it is the unit of meaning produced by the relation of the signifier to the signified. The signifier is the material object, sound or smell or taste etc. A red rose, for example. The signified is the concept or mental image to which the signifier gives rise. For example, 'romance' or 'passion' signified by the red rose. The relationship between the signifier and the signified is arbitrary in the sense that there is no 'natural' reason why a red rose should signify passion, it is simply a matter of convention. Culture has coded red roses in this way, and we have come to take this coding for granted. The arbitrary relationship between a sign and its meaning does not mean we can make signs mean anything we want. Individuals can neither invent signs of their own out of nothing, nor 'read' signs in any way they please. One is never at liberty to create purely personal interpretations of things, including the environment. In some ways, understanding is always constrained by rules and conventions. According to Douglas, 'dirt' and 'pollution' are all those things that are "matter out of place" in the sense that they break socially accepted rules and conventions. Shoes on the kitchen table or cutlery in the bathroom, for example. 'Dirt' and 'pollution' then, is anything that cannot be classified or is not on the correct side of the socially accepted boundary which carries considerable symbolic meaning.

> *The whole universe is harnessed to men's* (sic) *attempts to force one another into good citizenship. Thus, we find that certain moral values are upheld, and certain social rules defined by beliefs in contagion…As we examine pollution beliefs, we find that the kinds of contacts which are thought*

> *dangerous also carry symbolic load…Some pollutions are used as analogies for expressing a general view of the social order* (Douglas, 1966: 3).

How we make sense of dirt and pollution is mediated by the senses, primarily sight, but also smell, touch and sound. I will explore these senses in turn.

2.6.1. Sight

Before the scientific revolutions of the 16th and 17th Centuries, oral accounts of nature based primarily on the sense of hearing were considered the most reliable. However, by the 18th Century sight was perceived as more reliable, and scientific authority was underpinned by the doctrines of "seeing is believing" and "believing is seeing" (Slater, 1995: 226). By the 19th Century, the other senses were perceived as subservient to sight (Crawshaw and Urry, 1997). Or as Irigaray (1978: 50) puts it: "In our (Western) culture the predominance of the look over smell, taste, touch, and hearing has brought about an impoverishment of bodily relations. The moment the look dominates, the body loses its materiality."

It is often argued that we are now living in a surveillance society that is dominated by the 'panoptic gaze'. To understand what this means it is important to explore the work of Foucault (1977). Foucault draws on the work of the philosopher Jeremy Bentham to make sense of how power operates in modern societies. Bentham's idea of the panopticon revolved around a tower located in a central position within a prison. From this tower guards would be able to observe every cell and the prisoners inside them without being seen themselves so the prisoners would never know whether they were being watched or not. However, they would assume they were being observed at every moment of the day and night and adjust their behaviour accordingly. In most prisons the architecture of the panopticon was not implemented. For Foucault, however, its logic reveals how disciplinary power works in modern societies that rely on surveillance techniques to control their populations.

In contrast to Orwell's 'Big Brother' (Orwell, 1949/2013), the authoritative gaze is not confined to a particular individual – on the contrary, it is part of the system that pervades all areas of society, including schools, shopping centres, sports arenas and even the countryside where visitors are subject to a detailed 'country code' that is partly enforced by countryside wardens or rangers. In addition, many stretches of lakes and rivers are controlled by angling clubs that employ bailiffs to patrol their club's waters to ensure that anglers have the correct equipment and permission to fish at certain sites. Anglers who do not obey club rules often face the scorn of other anglers. In modern Western societies there is a gender dimension to the authority of the gaze because females have often been positioned as objects of what has been called the 'male gaze' that has dominated Western culture for at least the last three hundred years. In such societies, how females are valued – and how they value themselves – is closely linked to how they look (Rodaway, 1994).

2.6.2. Smell

Even though geographers and other social scientists have mainly drawn attention to the importance of sight, we are also reliant on our sense of smell, or what Rodaway (1994: 61) calls "the geography of the nose" for our relationship with space and place. Without a sense of smell, not only would it be more difficult to distinguish food from poison, but also friend from foe and our attachment to specific places, including home - what Porteous (1990) terms 'smellscape' - would be much weaker. As Rodaway explains:

> *(T)he perception of an odour in or across a given space, perhaps with varying intensities, which will linger for a while and then fade, and a differentiation of one smell from another and the association of odours with particular things, organisms, situations and emotions which all contribute to a sense of place and the character to places (1994: 68).*

2.6.3. Touch

One of the erroneous assumptions about the geographies of touch is that it is only concerned with how the fingers sense the environment (Rodaway, 1994). To avoid limiting discussions about touch to the fingers, I will employ the term 'haptic geographies' because it defines touch as a "property of skin that covers the whole body" (ibid: 41). As Gibson explains:

> *The haptic system … is an apparatus by which the individual gets information about both the environment and his* (*sic*) *body. He* (*sic*) *feels an object relative to the body and the body relative to an object. It is a perpetual system by which animals and men* (*humans*) *are literally in touch with the environment* (1968: 97).

Of all the senses, touch is, perhaps, the most intimate. It is the sense that we first experience in the embryo, when, explains Montagu, we are:

> *Less than one inch long, less than 8 weeks old, light stroking of the upper lip or wings of the nose will cause bending of the neck and trunk away from the source of stimulation. At this stage in the development the embryo has neither eyes nor ears, yet its skin is already highly developed. Although in a manner not at all comparable to the development it is still to undergo* (1971: 1-2).

It is difficult to overstate the importance of touch in relation to our experience of the environment – not least because it is the largest organ system of the body that is packed with sensory receptors and fibres that enable us to experience pleasure and pain and unlike other organs, it is, unless it has been severely damaged, able to

regenerate itself quickly. Physiologically it serves the following main functions: to protect the underlying parts of the body from being invaded by foreign organisms; to secrete salty water from the sweat glands to ensure that one's body temperature and metabolism are regulated; and to provide detailed information about one's environmental surroundings (Rodaway, 1994). We may fear losing our sight, hearing, taste or smell, but without touch we would not be able to sense what it means to exist in the world. Touch, according to Tuan (1993), is the most honest sense and the one we trust the most. The English language alone has an abundance of metaphors to express the importance of touch in social life. For example, we tell our friends to 'keep in touch'; during conversations we try to stay clear of 'touchy subjects'; we might try to use a 'light touch' when dealing with controversial subjects and we might describe a film or book that has moved us emotionally as 'touching'; on a cold morning we might wake up to a 'touch of frost' and a first draft is often described as a 'rough' copy and we hope that any transitions we make go 'smoothly' (Rodaway, 1994: 41). However (this will be different for those who have impaired vision or hearing, of course), unless we come into contact with something especially jagged, smooth, hard, hot or cold, we tend to pay more attention to the information we receive via our eyes and ears (ibid).

2.6.4. Sound

In Western culture, as people moved from the countryside to large towns and cities, sight replaced sound as the dominant sense. However, over the past two decades sound has once again become increasingly important as people try to find peace and tranquillity away from the 'unnatural' 'sound pollution' that contaminates towns and cities. However, in 1995 The Council for The Protection of Rural England produced a report that claimed that North Devonshire, the North Pennines, and parts of Herefordshire were the only three areas left in England that were not affected by street lightening, road noise and urban development (cited in Macnaghten and Urry, 1998). Part of the appeal of the 'natural' environment is that it offers different soundscapes to those in urban areas. Of course, what is considered 'natural' in

relation to sound changes over time. There is nothing 'natural' about hearing the sound of a tractor in the countryside.

2.7. Lay perceptions of environmental risk

The foregoing discussion reveals that people are able to make sense of and participate in debates about environmental risk by drawing on the knowledge that they have gained from their senses as they are immersed in the environment. Other empirical studies have explored how lay publics make sense of environmental risks by drawing on their pre-existing knowledge, values and beliefs that have been gained both *ex situ* and *in situ*. Rather than engage with them all in a necessarily superficial manner, I will explore in detail research carried out by Wibeck *et al*. (2017) on how 'lay publics' in four geographically and culturally diverse countries (Japan, New Zealand, the USA, and Sweden) made sense of the emerging ideas about climate engineering as a tool to combat anthropogenic global warming. This study is extremely relevant to my own research in the sense that like the environmental dimensions of AMR, climate engineering is an emerging environmental issue that participants were unfamiliar with. However, they were able to make sense of and make valuable contributions to debates about climate engineering by drawing on their local knowledge and shared cultural narratives, including those about social and environmental issues that they were already more familiar with. Despite the heterogeneous makeup of the focus groups, the researchers found most participants expressed negative views about climate engineering due to the following five reasons:

1. 'Unintended side effects and the limits of human control of nature'

One of the main fears of participants was that trying to manipulate the climate on a global scale could have unpredictable negative consequences that humans are unable to control, such as changes in the ecosystem that could put those groups who are already vulnerable at more risk. Despite being shaped by national and cultural

narratives, participants used similar analogies about the introduction of new species, including toads in Australia, Canada Geese in Sweden, and possums in New Zealand, to make this point explicit. Introducing these new species was done with good intentions, but the negative effects they had on the local ecosystem were difficult to control.

2. 'Treating the symptoms rather than the cause'

Participants also used analogies and metaphorical descriptions from medicine to express their concerns about climate engineering only addressing symptoms rather than the causes of anthropogenic climate change e.g., trying to plaster over the problems or taking blood pressure pills rather than adopting a lifestyle change. As will be explored next, a focus on lifestyle was the third theme to emerge from the study.

3: 'The need for change in lifestyles and consumption patterns'

It was common for participants to assert the need for people in rich countries to change their lifestyles, especially overconsumption, to stop the depletion of natural resources and the destruction of conditions that support life. For many participants, climate engineering is a superficial solution that would enable business to continue as usual. Although participants felt that many people would not voluntarily decrease their consumption, analogies to how people came together during the Second World War to tackle the imminent threat from Hitler were made by some participants to emphasise that emergencies can force people, both individually and collectively, to act.

4. 'The need for political solutions'

It was common for participants to express pessimism about the ability and willingness of governments and international organisations, such as the UN, to work together to produce international political solutions to the climate change crisis. However, most participants preferred political solutions to technological ones and if climate engineering is to be used as a last resort, it should be governed by international organisations rather than by corporations or superpowers, particularly China and the US.

5. 'Keeping the door ajar for all options'

Tipping point and safety net metaphors were used by some participants to express the imminent threat that climate change poses and the notion that, rather than dismissing climate engineering completely, it should be one option among many others that are available for scientists to tackle climate change. One participant compared it to the development of nuclear weapons that are an option that you do not want to have to use.

Other qualitative research has also shown that people tend to filter information in a way that supports their pre-existing values and beliefs, particularly in relation to emerging issues that they are unfamiliar with. For example, focus group research that involved a total of 108 EU nationals was carried out by 'The European Commission' (2015) to understand why lay publics' perception of environmental risk differs from the scientific assessment of the same risk. One of the main findings of the study was that people's consumption habits were an important issue for experts. However, in contrast to the findings of Wibeck *et al*. (2017), lay publics did not consider it to be an issue that they were particularly concerned about. Among the reasons the European Commission (2015) identifies for this discrepancy is 'confirmation bias'. In essence, people gather information from multiple sources, including television documentaries and social media platforms, but whether positive or negative, people tend to focus more on the information that supports their pre-existing values and beliefs. Thus, people do not usually change their minds or

behaviours when provided with more information which advocates of the 'deficit model' do not fully acknowledge (Horlick-Jones *et al*., 2007; Owens, 2000) 'The European Commission' (2015) focus group research also found that public concern about environmental risk, including air and water pollution, is also shaped by the following factors:

1. The level of trust they have in the individuals and/or organisations presenting information

How 'lay publics' make sense of environmental risk is bound up with their views of those individuals and institutions who are presenting the information. Lay publics are more concerned about particular risks when they do not trust the assessments of those who are presented as experts. In Wynne's (1992) study of the fallout from the Chernobyl disaster (section 2.5.2), for example, farmers' tacit distrust of scientists emerged because they were perceived as hiding evidence that contradicted their positions and making mistakes about issues, they claimed to be experts on.

2. The extent to which environmental risks are perceived to have an impact on their daily lives

People are likely to be less concerned about environmental risks that seem abstract and remote. Although class and other socioeconomic interests are important, immediate threats to their everyday concerns (such as the prospect of having a nuclear waste site built close to them) are more likely to encourage the local community to take action. Proximity to the environmental risk was also mentioned in relation to issues such as air pollution. However, the same focus group research also found that people tend to stop thinking about environmental risks the more they become accustomed to living with them.

3. The scale and severity of the environmental risk

The likelihood that a risk will affect a large area, or that the impacts will be serious and be felt by a large number of people. For example, air and water pollution, chemicals in products and the depletion of natural resources in some countries.

4. The importance of place and space

The way in which people make sense of environmental issues is often dependent on the practical context in which they are being engaged with. For example, whether someone is at home, at work, or in the countryside influences the way they think about recycling due to the different discourses that are circulating within those environments (see, also, Eden, 2017).

5. A sense of personal control and efficacy

Fears about environmental risk are usually reduced when people feel that they have more control. For example, when consumers are presented with a choice that enables them to avoid chemicals in products or noisy places that could damage their health, concerns about environmental risks tend to be reduced. By contrast, fears often increase when people are exposed to risks that they have little or no control over. These ideas about personal control is also a theme that emerges in research on how lay publics make sense of debates about AMR, as we shall see in the next section.

2.8. Lay perspectives on AMR

A small number of studies have focused on how the public understand and engage with antibiotic resistance. McCullough *et al*. (2016) carried out a systematic review of 54 studies (41 quantitative, 10 qualitative and 3 mixed method studies that

involved a total of 55,225 participants) - mainly conducted in Europe, Asia, and North America from 2010 to 2014 - of the public's knowledge and beliefs about antibiotic resistance. They found that the public believed that: (a) others were largely responsible for the development of antibiotic resistance; (b) they had a low personal risk from resistance; (c) their risk increased if they were hospitalised or used prolonged courses of antibiotics; and (d) causes of resistance included antibiotic use and overuse and not completing an antibiotic course. They also discovered that people felt that approaches to tackling antibiotic resistance ought to be aimed at clinicians because they themselves felt powerless in relation to tackling the issue. The most in-depth study of lay perspectives on AMR was carried out by Browne *et al*. (2017). Thus, it deserves to be explored in detail. Their focus is on comments made by contributors to the social media platform 'Mumsnet'. They explain that 'Mumsnet' has been critiqued for being a platform that is mainly dominated by middle class women who are well-educated and economically privileged. They also explain that 42 posts on the 'Mumsnet' website that directly focused on antibiotic resistance between 2007 and mid 2015 were analysed. Posts in which antibiotic resistance was a concomitant issue were excluded from their analysis. The following themes were identified.

1. 'Temporal constraints and technological fixes: 'When the axe is swinging at work''

Discussions about the demands of work and parenting were employed by participants to situate debates about antibiotics in a wider context. Antibiotics enable the immune system to cope with the demands that are placed on it in contemporary capitalist societies that are dominated by the fast-paced pressures and precarious, temporary and 'flexible' working which force workers to get back to work as soon as possible rather than take time out to fully recover. In contrast to advice from public health officials about the need for social distancing, lay publics often view common infections as inevitable and contact as unavoidable and such views support the needs of capitalism.

2. 'Restorative bodies: 'Sitting it out'

In contrast to the theme explored above, some participants also discussed how illness provides a welcome, albeit temporary, opportunity to escape the pressures of life. The metaphor of 'sitting it out' (Browne et al. 2017: 16) was used to express the belief that people have a moral obligation to rest so that they can recover from illness without relying on antibiotics. This would allow the body to restore its own health equilibrium.

3. 'Spatial othering: 'I had a particularly annoying au pair from France''

In relation to the causes of antibiotic resistance, participants' discussions about moral accountability often revolved around regional and cultural 'othering.' 'Foreigners' rather than 'natives' were blamed for failing to adhere to the recommended guidelines such as completing a course of prescribed antibiotics rather than keeping some for future use or getting hold of unprescribed, 'off label' antibiotics. In an interconnected world where international travel is more prevalent, resistance is imagined as an alien threat from without, rather than one that is already within the nation and one's own body. The idea that the huge number of 'natives' travelling abroad could be responsible for the perceived increase in novel diseases in the UK was absent from participants' discussions.

4. 'Moral accountabilities: 'Not many nowadays will do that''

In participants' discussions, older people were also designated as 'other' because of their perceived overuse and misuse of antibiotics when they first became widely available in the 1930s. However, the politics of blame did not dominate discussions because past generations were imagined by participants as being somewhat naïve about the risk of antibiotic resistance and its causes. Participants claimed that doctors and other medical professionals are now more responsible in relation to

prescribing antibiotics. Those who demanded them from their doctors were presented as selfish 'others.'

5. 'Domestic immunity environments: 'How many of us use antibiotics in our homes just to keep them clean?''

Debates about antibiotic resistance were often situated within wider political discussions about cleanliness and sterility. Echoing those who adhere to the 'hygiene hypothesis', participants claimed that people's immune systems become stronger when they encounter environments that have not been sterilised. In contrast to scientific experts, participants did not make a distinction between antibacterial cleaning products and antibiotics, and they talked about humans rather than bacteria that become resistant.

Somewhat paradoxically, in her discussion about qualitative and theoretically driven research on AMR, Wood (2016: 2) found that "most people do not feel they have a personal role in either the problem of AMR or its solution". This discovery supports Brooks *et al.'s* (2008) qualitative investigation which employed focus groups and semi-structured interviews (that were conducted and analysed between April 2006 and March 2007) to explore primary care patients' perspectives on antibiotic resistance. The latter were sampled from general practices in social-economically contrasting areas of the UK with contrasting antibiotic consumption habits. The authors found that antibiotic resistance was generally considered by patients to be an abstract problem that would not affect them personally. Blame for bacteria becoming resistant to antibiotics was aimed mostly at hospital managers and to a lesser extent cleaners, nurses and doctors. No distinction was made between patients from different socio-economic backgrounds. Similarly, in their cross-sectional survey (that was carried out between July 2014 and February 2015) in order to explore how people understand antibiotic usage and antibiotic resistance, Mason *et al*. (2018) found no difference between publics in affluent and deprived areas in terms of the levels of knowledge about the issues. This they argue reveals a failure of numerous public awareness campaigns about the threat AMR poses to

human health. In their analysis of over 100 national surveys and peer-reviewed studies of how the public in the United States understands science and medicine, Nisbet and Markowitz (2016: 57) claim that a "disconnect between science, knowledge, and patient expectations has led some scientists to argue that public health campaigns need to focus on bolstering public understanding of antibiotics". They also add, however, confidence in scientists when it comes to discovering new antibiotics was found to be high among the public. By contrast, when it comes to tackling environmental issues, Giddens (1990: 130-1) explains that the opposite seems to be true in his discussion about environmental risk.

> *Widespread lay knowledge of modern risk environments leads to an awareness of the limits of expertise and forms one of the 'public relations' problems that has to be faced by those who seek to sustain lay trust in expert systems… (R)ealization of the areas of ignorance which confront the experts themselves, as individual practitioners and in terms of overall field of knowledge, may weaken or undermine that faith on the part of lay individuals.*

One of the ways of addressing the 'public relations problems' has been to include, ostensibly at least, lay publics in the decision-making process – as will be explored below.

2.9. Public participation in environmental decision-making

At least since the 1960s, social science research has promoted the claim that creating more opportunities for publics to participate in decisions that they are interested in and affected by will not only improve democracy, but also the quality and public value of science and technology (e.g., Burningham, 1998; Irwin, 1996; Owens, 2000). Some researchers have also argued (e.g., Petts, 2005; Walker 2011) that public participation can contribute to barriers related to environmental justice if

those who are disproportionately impacted by environmental degradation are able to educate themselves through the process of participation. Bijker (2001: 44) explains why the participation of publics in the decision-making process is important:

> *The average citizen (may not be) able to design a nuclear reactor or river dike, but… more is involved in designing large projects such as nuclear power stations and water management systems than is described in the engineers' handbook.*

Although Collins and Evans (2007) redefine the concept of expertise to include knowledge gained from experience, they also argue that, in relation to decision-making, the 'lay/expert' dichotomy should remain. Besley and Nisbet (2013) found that it was common for scientists to agree with this position and, thus, scientists' views on 'lay publics'' right to be part of the decision-making process in democratic societies, is at odds with their views on the public's ability to do so. They found that scientists believe that experts have a duty to educate 'the public' so that it is able to make good decisions. A 'good' decision, however, is one that agrees with the point of view of scientists. Eden (2017: 24) adds: '"Good' environmental publics are those imagined to be motivated by altruism and civic interest, whereas 'bad' publics are those imagined to be motivated by NIMBYism (Not in My Backyard) and self-interest, often regarded as 'specialised publics' because they are more knowledgeable and often more active in campaigning about 'their' issues." During the 'GM Nation?' debate in 2003 on how genetically modified crops should be managed in the UK, the comprehensive debates were criticised by scientific experts for being dominated by 'green groups' and other organisations that were perceived to 'bad' publics because they had pre-existing views about GM crops that prevented them from being persuaded to make 'good' decisions about the issue and, thus, they were not genuinely representative of the general public (Horlick-Jones *et al*., 2007; Irwin, 2006).

The need for scientists to receive "legitimacy and validation" was also identified as a reason why scientists feel they need to engage with the public about their research. This claim was explored in Hobson-West's (2010) research on the role of public opinion in animal research which involved in-depth interviews with senior laboratory scientists at two universities based in the UK, and other stakeholders with conflicting reasons for existing, including those who fund and support animal research on the one hand, and leaders of organisations that campaign against it on the other. Hobson-West identifies three main reasons why public opinion polls are often cited by all sides in the debate, including "a desire to communicate rationality, moral legitimacy and democratic authority" (p. 20). Scientists do talk about giving opportunities to contribute to debates, but only once the boundaries and potential solutions have been framed by science (Irwin, 1997). Rather than expecting information to genuinely flow in both directions, scientists discussed how they felt it was their responsibility to work directly with regulators to protect the public from its own ignorance and apathy (De Boer *et al*. 2005). However, even if 'lay publics' do lack scientific knowledge, they should have opportunities to contribute to decision-making because environmental problems often encompass political, economic and ethical questions that cannot be answered by science alone. This point has become more widespread over the past decade. In the UK, for example, the following demands were made in the Report of the House of Lords Science and Technology Committee: "That Direct Dialogue with the public should move from being an optional add-on to science-based policy making and to the activities of research organisations and learned institutions and should become a normal and integral part of the process" (2000: 48).

Although these recommendations have not always been put into practice, in principle, at least, they have been reinforced by the Aarhus Convention in Europe (Petts, 2005). Many of the debates about creating dialogues and increased public participation draw on ideas of 'deliberative democracy'. Deliberative democracy is a term that can represent many positions that call for the public to be part of the decision-making process. These include such things as 'citizens' juries, people's

assemblies, task forces, town meetings and 'citizen science' (Rowe and Frewer, 2005). The Danish consensus conference is the most cited model for citizen participation. The Danish Board of Technology created the consensus conference in the 1980s, which consisted of a panel of citizens charged with reporting and making non-binding recommendations to the Danish parliament on a specific technical topic of concern (Sclove, 2000). Experts and stakeholders have opportunities to present information to the panel, but the lay group has full control over its report. The consensus conference process was deemed a success for its ability to democratise technical decision-making and has been exported to other parts of Europe, Japan and the U.S. However, Nishizawa (2005) has shown in her research on a Japanese consensus conference on genetically modified crops, cultural norms, and values, such as polite agreement, may also influence how willing publics are to challenge knowledge generated by experts. Publics that are imagined as unknowing by experts are also more likely to imagine themselves as unknowing (Eden, 2017). As will be explored below, most public participation exercises, including consensus conferences, have also been criticised for not genuinely enabling information to flow in both directions.

2.10. The limitations of public participation mechanisms

Drawing on the knowledge that she had gained from working in the U.S. Department of Health, Education and Welfare during the 1960s, Sherry Arnstein developed her influential 'ladder of citizen participation' (1969) in order to understand the power relations between 'expert' and 'lay' publics'. Arnstein's ladder is made up of the following eight rungs with the most empowering and democratic at the top, and the most oppressive and least empowering at the bottom.

Table 1. The eight rungs of Arnstein's (1969) 'Ladder of citizen participation'.

8. Citizen control

7. Delegated power
6. Partnership
5. Placation
4. Consultation
3. Informing
2. Therapy
1. Manipulation

Rungs 1 and 2 are made up of practices that ostensibly enable 'lay publics' or, as Arnstein describes them, "the have-not citizens" to participate in decision making. Arnstein argues that, in reality, these practices have been constructed to produce "non-participation" and to "educate" or "cure" participants of their ignorance so that they are able to make the "right" decisions – i.e., those that are aligned with the interests of the powerful. Thus, the bottom rungs of the ladder closely resemble the 'deficit model' in the sense that the public are imagined only as consumers of news. Within the framework of Arnstein's (1969) 'ladder', public participation practices are higher up on the rungs the further away they are from the 'deficit model' and ideas about 'good' and 'bad' publics. Arnstein asserts that rungs 3, 4 and 5 offer lay publics little more than the appearance of power and control when it comes to decision-making in the sense that their views are likely to be taken on board only if they support those of relevant elites who often make key decisions away from public scrutiny. Rungs 6, 7 and 8 refer to practices that enable a genuine dialogue between 'expert' and 'lay' publics who have opportunities to define problems and their solutions from the outset. Since it was first published, Arnstein's ladder has influenced how public participation mechanisms are evaluated. For example, Eden (2017) asserts that, although 'consulting' the public has become a key part of environmental planning, most of the public participation mechanisms remain near the bottom of Arnstein's ladder because they have more of an emphasis on placating rather than genuinely engaging in a dialogue with lay publics.

Although consensus conferences are on much higher rungs of Arnstein's (1969) ladder, they can still have their limitations. Not least, they often take place far removed from where environmental problems occur, such as office buildings and affluent hotel meeting rooms. Eden (2017: 59) asserts that "This 'de-placing of public participation is another spatial strategy for control, a geographical fix that seeks to neutralise emotional engagement, but one that is neglected in the literature". Another spatial strategy for control in relation to public participation that has not received much attention in the literature is the fact that the arrangement of furniture often does little to break down the barriers between expert and lay publics. Eden makes the point well: "(A) participation meeting in which the invited or accredited 'experts' sit on chairs on a raised platform at the front… will influence how they are asked and answer questions from the 'floor'" (2017: 42). For example, Goven (2003) research on how lay and expert perspectives at the first consensus conference in New Zealand on biotechnology provides a good example. A consensus conference in Australia encountered similar difficulties due to the way the furniture was arranged, according to Mohr (2002).

A practice known as 'citizen science', which emerged in the 1990s, can also claim to be on the top rungs of Arnstein's (1969) ladder because, according to Irwin (1996), it enables lay publics to apply science in order to tackle the issues that they themselves consider to be the most important. By contrast, another definition of 'citizen science' limits the role of lay publics to one that enables them to contribute scientific data to debates that have already had their parameters defined by scientific experts (Cavalier *et al*. 2016). Thus, it does not erode the power dynamics between 'amateur' and 'expert' publics because 'amateur' publics are not provided with the resources to take science in their own hands so that they can tackle the problems that they themselves have identified. On the contrary they are typically unpaid 'amateurs' out in the field collecting data to support the work of paid professionals who have already defined the issues that need to be tackled (Gieryn, 1995). The second definition of 'citizen science' seems to underpin a citizen science 'Swab and send' project currently being run by Dr Adam Roberts (2019) at the Liverpool School

of Tropical Medicine (LSTM). The LSTM states on its website that it wants members of the public to join "in the hunt" for the next antibiotic by 'swabbing' any area they consider to be significant, whether that be a bin or a mobile phone, and returning it so that it can be tested by experts to see if it contains any useful bacteria. Lay publics are only given opportunities to contribute to knowledge once the issues have been defined by scientists. Simis et al. (2016) argue that this is because the 'deficit model' continues to be influential in relation to public communication due to the following four reasons:

1. 'Scientists are trained to process information in a rational manner'

The scientific endeavour is perceived by experts to be guided by objectivity and rational thought. To put it differently, in contrast to lay publics, scientists are able to modify or abandon their theories when they encounter evidence that is more reliable. Although science is perceived as removed from the local, the questions that scientists ask and how they ask them are often shaped by economic and political interests. This is not something some scientists acknowledge.

2. 'Scientists lack formal training in public communication'

One of main reasons why scientists continue to adhere to the 'deficit model' is due to a lack of training in relation to communicating their research to lay audiences as it is not a requirement of their scientific training. This lack of training produces a lack of awareness about the nuanced relationship lay publics have with scientific knowledge and the strategies that they use to make sense of it. Within the 'hard' sciences, social science research is perceived as being 'soft' and less reliable. However, those scientists who have a more positive view of social science are more willing to embrace public participation mechanisms that do not revolve around the 'deficit model.'

3. 'Most scientists view the public as a variety of "others"

Echoing the research carried out by Besley and Nesbit (2013) above, the authors find that another reason why the 'deficit model' continues to endure is that there is a lack of awareness about society being made up of multiple publics who make sense of science in different ways. On the contrary, 'the public' continues to be perceived by many scientists as an ignorant mass that needs to be filled with scientific knowledge. Some scientists do believe that the term 'the public' is outdated and even harmful because it promotes a one size fits all approach to public communication.

4. 'The deficit model works well for policy design'

The final reason Simis *et al*. (2016) identify for the 'deficit model' remaining popular is that designing and implementing solutions that address the needs and expectations of multiple publics can be difficult and slow moving. Trying to implement solutions can be difficult and precarious when there are multiple publics with competing interests. The 'deficit model' is more straightforward because it identifies an ignorant public as the main reason for a lack of support for the recommendations of scientific experts and policymakers. Correcting that ignorance is perceived to be the obvious solution.

2.11. Conclusion

In this chapter I have contextualised my research aim objectives by exploring what other researchers have discovered in relation to similar issues. Much of the literature I reviewed has revealed that many scientists and policy actors imagine that there is a monolithic public that is homogenous in relation to its lack of understanding about science and technology and didactically transferring knowledge from experts to lay publics is perceived as being the best way to remedy that lack of understanding. However, what we have also seen is that 'lay publics' are not black slates. On the contrary, they make sense of scientific knowledge by drawing on their

pre-existing knowledge, values and beliefs that are not always compatible with science. This involves employing sense-making strategies such as metaphors and analogies. To build trust, over the past couple of decades public participation exercises have been created to enable 'lay publics' to be part of the decision-making process, but often they are only able to contribute once the debates have already been shaped by scientists and policymakers. Furthermore, despite the 'deficit model' being interrogated by much social science research, it continues to endure because it is the simplest participation exercise for those who have had little or no training in public communication or design. In Chapters 4 and 5, I will explore how scientific experts imagine 'lay publics' in relation to the emerging environmental dimensions of AMR. I will also explore how lay publics make sense of those dimensions of AMR.

Chapter 3. Methodology

3.1. Introduction

This research project is primarily focused on exploring how surfers and open-water swimmers make sense of the emerging environmental dimensions of AMR, and how scientists imagine lay publics in relation to the environmental dimensions of AMR. It is guided by the ontological assumptions about the nature of social reality that were explored in Chapter 2. Namely, that although the world around us may exist 'out there' independent of the human mind, it is perceived by each of us in different ways (Crotty, 1998). Thus, rather than adopting a positivist position and claiming to produce knowledge that is value-free, I approached my research from an interpretivist perspective that helped me to see the world through the eyes of my participants as they engaged with ideas about AMR in the environment, lay publics and public participation mechanisms. My research has also been influenced by the 'reflexive turn' that emerged in 1970s (and became dominant in the social sciences in the early 2000s) in response to the claim that there is no such thing as disinterested knowledge because positionality - gender, class, ethnicity, likes and dislikes etc. - influences how we perceive different publics and how they perceive us (Venkatesh, 2013). Thus, rather than seek to deny or eliminate my preconceptions, throughout this research I have tried to be reflexive about the ways in which they shaped how I gathered and interpreted my data. As the sociologist Gary Armstrong explains: "The way that you, as a researcher, interpret meaning depends on your outlook and this should never be forgotten" (1998: xiii). Reminding myself of this point as I collected and analysed my data has, I hope, enabled me to produce research that is both balanced and original.

With the foregoing in mind, the present chapter will proceed as follows: section 3.2, explains how and why I selected participants. Section 3.3, focuses on the tools that were used to collect data; this will include details of how I dealt with the challenges that I faced, including those caused by the Covid-19 'lockdown' restrictions. Section

3.4, explains what methods were used to analyse the data that I collected. Section 3.5, explores the strengths and limitations of my methodology and Section 3.6, addresses the ethical issues that I encountered.

3.2. Identifying and recruiting participants

My systematic literature review in Chapter 2 revealed that, according to the scientific discourse, rivers, lakes, and coastal waters, including those in the UK, could be a key source of antibiotic resistant bacteria that is released into the environment via wastewater treatment plants and/or water run-off from land where livestock graze and manure is spread to treat crops (Amos *et al*. 2015). Thus, I made the decision to recruit open-water swimmers and surfers because they are the 'environmental publics' (Eden, 2017) who are most at risk from AMR in the environment as they are more likely to ingest bacteria that have evolved resistance to antibiotics than other publics – such as anglers, due to being immersed in the water (Leonard *et al*. 2018). The decision to recruit members of the surfing and open-water swimming communities was also strongly influenced by social science research that has shown that people are more likely to be interested in taking action and participating in research about the environment when they perceive the risks to be more immediate in relation to their own lives (Yearly, 1991). As we shall see, no strict criteria were used to define a surfer or an open-water swimmer; some were beginners, while others had been swimming and surfing for several years.

3.2.1. Recruiting surfers

Recruiting participants has long been one of the key challenges faced by scientists and social scientists carrying out research that may have significant social value. For example, due to a lack of enrolment, an estimated 60% of clinical trials are cancelled or delayed (Gelinas *et al*. 2017). Thus, utilising social media platforms such as Facebook as a tool to recruit participants is becoming increasingly popular because (1) in contrast to traditional recruitment methods such as advertising on the radio, television or in print media (Fenner *et al*. 2012), it is relatively cheap or free to access

and (2) because of its potential to reach large numbers of people social science research has shown that it can yield higher rates of participation (Benedict *et al*. 2019). Some examples include depression prevention studies (Morgan *et al*. 2013), clinical trials for HIV vaccines (Sitar *et al*. 2009) and paediatric cancer research (Akard *et al*. 2015). I made the decision to utilise Facebook as a tool to help me recruit surfers because I believed it would enable me to gain access to people who are most relevant to my research aim and objectives. In August 2019, once I had gained ethical approval from the University of Nottingham and two months before I was engaging with participants in Newquay (see below), I joined the 'Newquay Surf Community' Facebook group and posted the following message about myself, my project and what potential participants were being asked to do.

> "Dear Newquay Surfing Community,
>
> Scientists have recently discovered that due to swallowing water, those who swim in rivers and lakes and coastal waters may be more likely to have bacteria in their guts that have become resistant to antibiotics.
>
> I am a PhD student at the University of Nottingham, and I will be in Newquay from the 17th of October to the 26th of October 2019 to engage with surfers about antibiotic resistant bacteria in coastal waters, so that I can hear their views about these issues and to understand how they could help contribute to our knowledge of what the risks actually are and how they can be tackled. Those who would like to help with my research do not need to have much knowledge about antibiotic resistance because their views could still be extremely relevant.

Participation in this research would be completely voluntary and if at any stage someone chooses not to take part, no questions will be asked. Participants will also be able to remain anonymous.

If you would like to take part, or know anyone who would, please email me at: Anthony.shenton@nottingham.ac.uk. Your help is greatly appreciated.

Many thanks for your time.

Tony Shenton."

Utilising Facebook as a tool to generate interest in my research and recruit participants proved to be fruitful because over 30 members of the surfing community replied to my message and said they would discuss the issue with their friends. Five members of the community also explained that they would be available to participate during the time that I was in Newquay. Another strategy that I employed to recruit surfers is known as "on-site recruiting" or "recruiting on location" (Krueger, 1988: 94). Being in Newquay was the first opportunity to be 'out in the field' once I had received ethical approval from the University of Nottingham. Newquay was chosen because of its significance for the British surfing community that was reinforced on the 22nd of August 2012 when new and old members of the British surfing community gathered on Fistral Beach to celebrate the 50th birthday of British surfing where, it is claimed, four teenage Australians from Sydney introduced modern surfboard-riding in 1962 (Booth, 2012). Although the locals were grateful for exotic teenagers' work as lifeguards (helping to significantly reduce the number of deaths that had risen to nineteen the year before they arrived) they were more impressed by their surfing abilities that they displayed during their leisure time and also by their fiberglass surfboards that looked extremely futuristic in comparison to the more familiar British-made wooden planks. Since it was first introduced, surfing has continued to grow in popularity, and it is estimated that the number of regular

surfers had doubled from 50,000 in 1993 to 100,000 in 1999. Just over a decade later it was claimed that there were over half a million people who surfed regularly in the UK in addition to the same number of tourists who tried the activity each year for the first time. In Newquay alone, hundreds of businesses, including hotels and surfing shops, are dependent on £70m that is generated by surfing each year (Booth, 2012) and this is something some participants discussed when I engaged with them about AMR in the environment.

Although I was concerned that it would be difficult to recruit participants because the surfing season is traditionally between May and September, fortuitously when I arrived in Newquay it was still busy with surfers. Some were taking part in various surfing competitions on the 20th of October. However, once the competitions ended, many surfers left Newquay and the place became much less busy and, thus, it did become more difficult for me to recruit participants. In total, 20 surfers were recruited and, although I sought to recruit females and those from ethnic minority backgrounds, Table 1 reflects the fact that most of those taking part in surfing activities were white males during the time that I was in Newquay. There was a small number of female surfers. However, as a sole male researcher, I felt apprehensive about trying to recruit them on location because I remained conscious of the claim made by feminist anthropologists that which publics can be accessed and what data can be collected is strongly influenced by the gender of the researcher (Ahearn, 2001).

The difficulties that I faced in relation to recruiting both surfers and open-water swimmers (see below) from black and Asian communities could be due to the fact that, according to research carried out by Sports England in 2020, 95 percent of black adults and 80 percent of black children in England do not swim. Similarly, 93 percent of Asian adults and 78 percent of Asian children also avoid swimming activities because they face complex barriers, including cultural, religious, and racial, that preclude them from taking part in water sports (Kaur, 2022). However, steps are

being taken to change this. For example, in March 2022 the Black Swimming Association launched a campaign to fully identify and overcome all of the barriers faced by those from Asian and black communities (ibid).

Table 2. Surfers (Pseudonyms were given to all participants to help protect their identity - see section 3.6.2. on P. 98 for more details).

Name	**Gender**	**Ethnicity**	**Age**	**Date**	**Duration**	**Location**
Ben	Male	White	30	October 18 2019	24 minutes	Fistral Beach, Newquay
Brad	Male	White	42	October 20 2019	41 minutes	Fistral Beach, Newquay
Bobby	Male	White	42	October 19 2019	35 minutes	Fistral Beach, Newquay
Brian	Male	White	55	October 19 2019	25 minutes	Fistral Beach, Newquay
Carl	Male	White	54	October 20 2019	15 minutes	Surf shop, Newquay
Claire	Female	White	26	October 20 2019	19 minutes	Fistral Beach, Newquay
Dale	Male	White	34	October 20 2019	23 minutes	Fistral Beach, Newquay
Dave	Male	White	44	October 21 2019	21 minutes	Towan Beach, Newquay
Freddy	Male	White	28	October 20 2019	36 minutes	Fistral Beach, Newquay

James	Male	White	21	October 21 2019	35 minutes	Fistral Beach, Newquay
John	Male	White	29	October 21 2019	24 minutes	Newquay town centre
Marc	Male	White	23	October 22 2019	20 minutes	Fistral Beach, Newquay
Paul	Male	White	39	October 20 2019	17 minutes	Fistral Beach, Newquay
Phil	Male	White	23	October 24 2019	18 minutes	Newquay town centre
Ralph	Male	White	40	October 20 2019	16 minutes	Fistral Beach, Newquay
Sanjay	Male	Asian	50	October 22 2019	22 minutes	Fistral Beach, Newquay
Steve	Male	White	23	October 21 2019	19 minutes	Fistral Beach, Newquay
Wayne	Male	White	30	October 23 2019	37 minutes	Towan Beach, Newquay
Will	Male	White	18	October 22 2019	31 minutes	Fistral Beach, Newquay
Winona	Female	White	21	October 22 2019	35 minutes	Fistral Beach, Newquay

3.2.2. Recruiting outdoor swimmers

Lakes and rivers have been perceived as sources of tranquillity for centuries, according to authors such as Roger Deakin (1999) who helped to bring fresh

attention to the pursuit of open-water swimming that was first popularised in the modern age by Lord Byron on May 3rd 1810 when he swam the Dardenelles that represents the continental boundary between Europe and Asia (ibid).The work of romantic artists also attracted those seeking health cures and recreational sports to rivers, lakes and waterfalls and by 1923 over 600 informal swimming clubs had been established in the UK. However, by the second half of the 20th Century the popularity of outdoor swimming declined as river and lake pollution became more prevalent (ibid). Environmental legislation in the 1970s and 1980s helped to tackle this problem and today, according to research carried out by the Sport England Active Live Survey (2018), 4.1 million people swam in British rivers, lakes and coastal waters between 2017 and 2018. However, the *Guardian* journalist George Monbiot (2021) laments that this number is likely to decline because the legislation that was introduced to protect rivers from pollution no longer exists as farmers and water companies are now able to discharge untreated waste into them without fear of being punished by the law. This is despite the fact that in 2016 the UK government admitted that only 14 percent of rivers in England are in good ecological condition. To recruit open-water swimmers, my aim was to travel to open-water swimming events and recruit on location. However, my recruitment of open-water swimmers began when Covid-19 'lockdown' restrictions were put in place by the UK government in March 2020. Thus, I recruited 15 participants via Facebook open-water swimming groups by posting a similar information sheet that was used to recruit surfers. It explained that I would like to engage with them about AMR in the environment via video or phone calls. As table 2 shows, although I was able to recruit more females, there was still a lack of participants from ethnic minority backgrounds.

Table 3. Open-water swimmers

Name	Gender	Ethnicity	Age	Date	Duration	Platform
Ally	Female	White	41	17 March 2020	38 minutes	Phone call
Beth	Female	White	26	15 March 2020	47 minutes	In person
Chris	Female	White	34	24 March 2020	32 minutes	Phone call
Derek	Male	White	38	23 March 2020	29 minutes	Video call via Skype
Ed	Male	White	42	17 March 2020	36 minutes	Video call via Zoom
Elaine	Female	White	35	19 March 2020	23 Minutes	Video call via Zoom
Fran	Male	White	37	19 March 2020	32 minutes	Video call via Skype
Julie	Female	White	30	27 March 2020	30 minutes	Video call via Zoom
Nichola	Female	White	53	22 March 2020	24 minutes	Video call via Zoom
Mason	Male	White	34	24 March 2020	34 minutes	Video call via Zoom
Richard	Male	White	32	29 March 2020	25 minutes	Video call via Skype

Sian	Female	White	23	April 2 2020	37 minutes	Phone call
Tessa	Female	White	45	April 3 2020	32 minutes	Video call via Skype
Thelma	Female	White	40	April 3 2020	30 minutes	Video call via Zoom
Wendy	Female	White	40	April 6	36 minutes	Video call via Zoom

3.2.3. Recruiting scientists

The final phase of my recruitment also occurred during Covid-19 'lockdown' restrictions. I focused on contacting scientists working on the scientific dimensions of AMR who were identified from the peer reviewed research papers (Chapter 1). As Table 3 shows, 14 of them were recruited via an email that contained an information sheet about myself and my research.

Table 4. Scientists

Name	**Gender**	**Date**	**Duration**	**Platform**
Professor Adam Bruce	Male	April 25 2020	75 minutes	Video call via Skype
Professor Mike Cam	Male	April 7 2020	63 minutes	Video call via Teams
Professor Beth Dean	Female	April 15 2020	87 minutes	Video call via Teams

Professor David Edwards	Male	March 30 2020	42 minutes	Video call via Teams
Professor Alan Jacobs	Male	April 9 2020	69 minutes	Video call via Zoom
Professor Jon Lane	Male	April 21 2020	71 minutes	Video call via Teams
Professor Sarah Rodgers	Female	May 2 2020	58 minutes	Video call via Teams
Professor Laura Roberts	Female	April 10 2020	60 minutes	Video call via Teams
Dr Jan McKenzie	Female	May 3 2020	95 minutes	Video call via Zoom
Professor Scot Smith	Male	April 11 2020	71 minutes	Video Call via Zoom
Professor Jane Stevens	Female	May 4 2020	65 minutes	Video call via Teams
Professor Paul Walker	Male	April 10 2020	62 minutes	Video call via Teams
Professor Garry Williams	Male	May 17 2020	61 minutes	Video call via Teams
Professor Jim White	Male	April 9 2020	69 minutes	Video call via Teams

3.3. Methods used to collect data from participants

Qualitative researchers can employ several methods to collect data from participants such as open-ended questionnaires, individual or group interviews and observation (Sutton and Austin, 2015). Questionnaires are often described as the most economical method for collecting data because they can provide a large amount of data for relatively low costs which can be converted into quantitative data without too much difficulty. Future researchers are also able to check the consistency of the results because the standardised questions mean that the questionnaire can easily be replicated. However, the fixed nature of the questions limits participants' ability to talk about the issues that they consider to be important. Thus, the data is less rich in detail. I chose to use semi-structured interviews and to a limited extent participant observation because they are the methods that best enabled me to see the world through the eyes of my participants as I gathered data from them. To contextualise my choice, I begin this section with a general discussion on interviews before going into more detail about its three main subtypes: ‘structured’, ‘unstructured’ and ‘semi-structured’ (Gill, Stewart and Chadwick, 2008).

3.3.1. Interviews

Interviews are used to collect information from participants, including facts, opinions and attitudes (Gill, Stewart and Chadwick, 2008). Interviewing involves the interviewer in face-to-face contact or contact via phone or video call with participants on their own or as part of a group. Participants respond to interviews in an entirely different way to questionnaires that are posted through their letterbox or sent to their email address primarily because the researcher is able to relate to them while talking to them, listening to what they are saying and using prompts such as gestures or words to encourage them to say more. In addition, whether the researcher chooses to use structured, unstructured or semi-structured interviews will also determine how and what data is gathered (Thomas, 2013).

Structured interviews have a number of strengths, including the fact that they can be administered with relative ease, and participants' responses can be less difficult to decode (Bryman, 2008). However, I decided not to use structured interviews because they provide limited scope for further follow-up or for pursuing an interesting comment once the predetermined set of closed questions that mainly make up structured interviews have been asked. By contrast, although unstructured interviews may begin with a general question such as: "What are your views on antimicrobial resistance in the environment?", they are usually more conversational in style. In short, rather than primarily relying on closed questions that demand a 'yes' or a 'no' answer participants are encouraged to set the agenda, not least because they are able to explain to the researcher what they consider to be the important issues. However, the lack of predetermined questions can often leave both the interviewer and interviewee confused when it comes to defining what should be discussed. This can cause interviews to be both time-consuming and difficult to manage. Therefore, they are often only used by researchers who are still trying to define their research question(s) (Gill, Stewart and Chadwick, (2008). My research aim and objectives had already been narrowed down. Thus, I felt that semi-structured interviews were the most appropriate method for addressing my research aim and objectives in the sense that they combine the best of both worlds as far as interviewing is concerned, providing the structure of a list of issues to be explored together with the flexibility to follow up points when I thought it was necessary, as will be explored in more detail below.

3.3.2. Interviewing surfers

An electronic voice recorder was used to record semi-structured interviews with 20 participants who were recruited on or near the local beaches before or after they had been in the sea to undertake their surfing activities. The discussions were open-ended, and some were longer than others. The weather also had an impact on the length of the interviews, but by and large, most lasted between 15 and 30 minutes (Table 1). The first interview was not strictly a pilot interview because it was used to collect data for analysis. However, it helped me to understand that my interview

guide (see below) was adequate. An accompanying set of written notes was used to record the behavioural cues that may have been missed by the audio recording. Initially I considered engaging with participants in a quiet setting so that the quality of the audio recording would not be compromised by outside noise. However, I was strongly influenced by a claim made by Eden (2017: 59) that conducting interviews *ex situ* "is another spatial strategy for control, a geographical fix that seeks to neutralise emotional engagement". My focus was not on control in the sense that I remained committed to working with, rather than on, participants. Thus, rather than carrying out interviews in anonymous office buildings or hotel meeting rooms, I interviewed most participants on or near the main beach (see Figure 4) that surfers frequent because it acknowledges "the geographical context being debated (and) the ways in which local publics feel and know about local environments under discussion" (ibid). However, this strategy was challenging because most participants were either eager to get into the water or eager to get warm and dry once they had finished surfing. I tried to remain reflexive as I carried out my research particularly in relation to thinking about how I could communicate my aim and objectives more effectively. To help me do this, an interview schedule that was devised prior to interviews taking place enabled flexibility because the following questions did not have to be followed in a rigid way.

- Can you tell me what got you into surfing and how often you do it?
- How does Newquay compare to other places for surfing?
- I've heard about the big waves created by the 'Cribbar'. Have you ever surfed it or know anyone who has?
- What injuries and illnesses do surfers usually suffer from?
- Does being a surfer give you an intimate knowledge of the beach and coastal waters and more awareness of environmental issues?
- What are your thoughts about scientists' claim that coastal waters are being polluted with bacteria that have become resistant to antibiotics?
- How do you think surfers and other members of the public can help when it comes to making decisions about how to tackle this problem?

- Are there any questions that you would like to ask me?

This guide was flexible because when an interviewee provided a response to one of my questions while addressing another, I did not have to ask that question again, but I did have the flexibility to do so when I wanted to prolong the discussion on a particular point to obtain more 'rich' data. To elaborate, my interview schedules were a framework of issues and questions that led to possible follow-up questions and 'probes' that were used to encourage participants to expand on their answers. These probes were both verbal, for example "Go on…", and non-verbal – a tilt of the head, a nod and a raising of the eyebrows. This schedule of issues, questions and probes provided a structure to help me carry out interviews rather than a straitjacket. In other words, it gave me the freedom to ask different or supplementary questions when the need arose. This flexibility was also useful because when participants were producing particularly interesting comments, I was able to spend a significant part of the interview exploring them in detail. This is the essence of the semi-structured interview – namely that it reminded me of my aim and objectives but did not limit me (Sutton and Austin, 2015). I wanted to learn about participants' perspectives rather than simply try to extract or fill them with information in a way that resembled the highly contested 'deficit model' that was explored in Chapter 2. Thus, I continued to refine my interview guide in response to the information I received from participants. For example, I realised that potential participants were more likely to understand what my research was about when I began by mentioning bacteria in the sea that may become resistant to antibiotics rather than using the more scientific term 'antimicrobial resistance' because this term seemed confusing to some of the surfers that I conversed with.

Figure 4 Welcoming surfers (Photo taken by Anthony Shenton).

Bryman (2008) argues that one of the limitations of one-to-one interviewing (in contrast to focus group discussions, where participants often passionately challenge each other's perspectives) is that researchers rarely challenge the views of interviewees when they say things are untrue or inconsistent with what they said previously. This claim resonated with me because I did feel uneasy about challenging participants' statements as I did not want to come across as didactic or patronising. However, I did do so when I felt it was necessary because, as Kvale (1996) argues, one cannot be a successful interviewer if one is not prepared to be critical. My goal was not to appear detached or uninterested, but rather fully engaged with the culture of surfing as I carried out what is often described as 'participant observation' (Burgess, 1982). However, as will be explored in the next section, my inability to take part in surfing activities made this more challenging.

3.3.3. Participant observation

The terms 'participant observation' and 'ethnography' are often used interchangeably and methods that are used to both gather and analyse data as they emphasise the fact that the participant observer/ethnographer immerses him or herself for a considerable period of time in a group, observing behaviour, listening to conversations and asking questions and writing notes in order to uncover the unwritten rules that make up the culture of the group (Watson and Till, 2003). Lave and Wenger (1991) coined the term 'legitimate peripheral participation' to refer to the type of research I carried out. Although I only observed surfers undertake their recreational activities (primarily due to fact that I am not a confident swimmer), I could still be described as a participant in the sense that my presence as a researcher may have changed the behaviour of participants in some ways. This phenomenon is often referred to as the 'Hawthorne effect' which was first discovered by researchers observing workers at the Hawthorne, Western Electric plant in Illinois between 1924 and 1927. Although highly contested, the researchers concluded that due to the novelty of being observed the productivity of workers significantly increased (McCarney *et al.* 2007). A more recent study revealed that people even tend to change their walking gate when they know they are being observed by researchers (Friesen *et al*. 2020).

It is likely surfers changed their behaviour in some ways when they knew that I was observing them. This would have been easier to uncover if I had observed them for longer. However, being 'in the field' for weeks or months at a time was beyond the scope of my project. Thus, my research could be described as a form of 'micro-ethnography' (Wolcott, 1990) in the sense that I was observing surfers *in situ* (see Figure 5) for less than a week. Carrying out micro-ethnography was legitimate because it did not make sense to immerse myself in the lives of surfers for a lengthy period of time in order to understand their practices as they are only likely to be observable when they undertake their recreational activities. Thus, it did not make sense to be embedded in the lives of participants during the whole day. Beardsworth and Keil (1992) made a similar argument in their research on vegetarianism because, for many people, vegetarianism is an issue that is only thought about during

shopping and mealtimes. Thus, the researchers only chose to spend time with their vegetarian participants when they ate and went shopping.

Figure 5 Surfers on Fistral Beach (Photo taken by Anthony Shenton).

Carrying out micro-ethnography may have limited my ability to follow the familiar trajectory of the researcher moving from 'outsider' to 'insider' in the sense that I

may not have been seen by participants as 'one of them' because, although I had some basic knowledge of surfing, I had no knowledge of the nuances that make up the surfing culture. However, the fact that I was not immersed in the culture of surfing for a significant period of time may also have helped me to maintain 'analytical distance' in the sense that I did not, I hope, acquire participants' taken-for-granted assumptions that may have influenced their perceptions about AMR in the environment. Maintaining analytical distance also enabled me to avoid the limitations of 'going native'. However, I also remained conscious of the plight of some researchers who had the exact opposite reaction to going native when they carried out ethnographic research. For example, when Lee-Treweek (2000) carried out research in homes for the elderly, she found the staff to be lacking in empathy and, thus, dislikeable. To avoid being disliked a qualitative researcher must be able to build a rapport with participants as this will motivate them to respond as accurately as they can to the questions they are being asked (Thomas, 2013). However, there have been few attempts to clearly define what rapport means both empirically and conceptually in relation to qualitative research. Potter and Hepburn (2012: 566) argue that despite the fact that rapport has been recognised for decades as an essential element of qualitative research, it has mostly been defined by research methods texts glibly as "attentive listening and engagement". Some researchers have tried to be more nuanced. For example, Seldman (2013: 98) asserts that rapport involves "getting along with each, a harmony with, a conformity to, and an affinity for one another". Patton (2015: 458) adds that the researcher must convey an "understanding without judgement". I focused on trying to do this when I engaged with all participants. However, as will be explored in more detail below, due to Covid-19 restrictions I had to engage with swimmers and scientists via video and phone calls, which made it more challenging to build a rapport with them.

3.3.4. Interviewing open-water swimmers

Covid-19 restrictions had a significant impact on my research because I had to deal with the limitations of carrying out semi-structured interviews with outdoor swimmers and scientists via video and telephone calls rather than in person. On the

one hand this was a positive because open-water swimmers were often eager to engage with me about issues related to AMR such as how contagious diseases are spread because they felt they were related closely to Covid-19 (see Chapter 5). It also enabled me to overcome geographical barriers, expensive transport issues and the busy schedules of participants (Deakin and Wakefield, 2014). However, on the other hand, I did not have the opportunity to employ some of the behaviours that I relied upon to build a rapport with surfers such as shaking their hands and offering to share my food. According to Seitz (2016), when these behaviours are absent interviews can produce data that is less rich. I did not sense that this caused any problems as I still focused on putting participants at ease by asking icebreaker questions about how their day was going etc. In addition, although this was not as much of a problem when I was interviewing participants via video calls, building a rapport during phone interviews was more challenging as I did not have access to participants' non-verbal cues such as facial expressions and body language and they did not have access to mine. However, in contrast to the claims made by Irvine *et al*. (2013) open-water swimmers did not seek reassurance around the adequacy of their replies any more than surfers being interviewed *in situ* did. Their responses were often longer – lasting between 30 and 60 minutes (Table 2) and sometimes more detailed than those given by surfers perhaps because they felt more relaxed in the comfort of their own surroundings (ibid). The first interview also enabled me to test the adequacy of the following interview questions, designed before interviews were carried out, was used to help guide the discussions:

- Can you tell me what got you into open-water swimming and how often you do it?
- Where is your favourite place to swim outdoors?
- Where would you say is the most dangerous place you have swam?
- What injuries and illnesses do open-water swimmers usually suffer from?
- Does swimming outdoors give you an intimate knowledge and more awareness of environmental issues.

- What are your thoughts about scientists' claims that rivers, lakes and coastal waters are being polluted with bacteria that have become resistant to antibiotics?
- How do you think open-water swimmers and other members of the public can help when it comes to making decisions about how to tackle this problem?
- Are there any questions that you would like to ask me?

Some of the main challenges that I faced when I carried out video calls were technological, including the loss of visual and/or sound connection on several occasions which tended to disrupt the flow of the interview, but in contrast to previous research (Hanna and Mwale, 2016; Williams, *et al.* 2015) this helped to generate more of a rapport rather than unease between myself and participants as we joked about the limitations of modern technology. In addition, although critics of video calls via the internet have mainly focused on the loss of data rather than the experience of participants (Mirick and Wladkowski, 2019), there has been some discussion about the fact that participants are able to view themselves on screen during video interviews and that this can create a sense of unease (Oates, 2015). I did not observe this behaviour and none of my participants mentioned this as a problem when I asked if they felt comfortable carrying out an interview via video call. One of the main benefits of being in Newquay was that I was able to observe surfers walking to and from the beach barefoot and I was able to ask them questions about this. By not being able to observe outdoor swimmers *in situ* (Figure 6), I may have missed gestures, practices and behaviours that could also be relevant to my research. Furthermore, the tacit knowledge (see Chapter 2) that swimmers possess would have been more difficult to express verbally during interviews that were carried out *ex situ*.

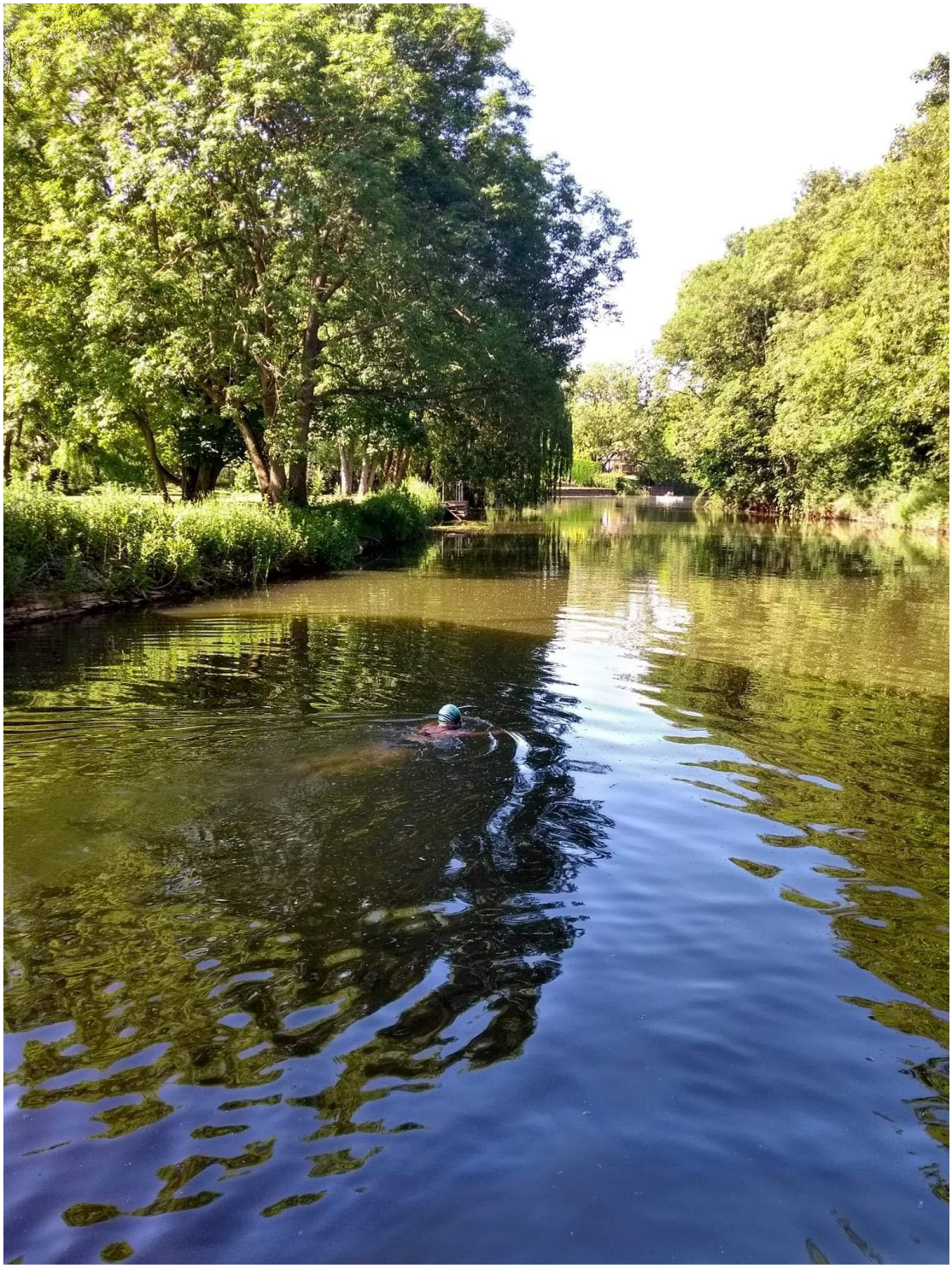

Figure 6 Swimmer enjoying the river Avon (Photo courtesy of owner).

3.3.5. Interviewing scientists

Not being able to observe scientists *in situ* as they carried out their scientific practices due to Covid-19 restrictions, was much less of a problem because my focus

was on understanding how they imagine lay publics in relation to the environmental dimensions of AMR rather than on trying to emulate Latour and Woolgar (1979) by providing an anthropological account of how scientists construct knowledge about AMR in the environment. However, it may have been useful for me to have been able to observe how scientists engaged with lay publics as they carried out public participation exercises. Interviews were carried out via video calls between March and May 2020. The first interview with a member of the 'EVAL-FARMS' project (see Baker *et al*. 2022) also helped me to see that the following interview guide - that I had devised in advance of any data collection - was useful:

- What do you think lay publics know about AMR in the environment?
- How should scientific information about AMR in the environment be communicated to 'lay publics?'
- How can lay publics contribute to debates about the environmental dimensions of AMR?
- In relation to political decision-making about AMR in the environment, how much influence should lay publics' have?
- How have public participation activities influenced the way you perceive lay publics?

Most interviews with scientists lasted between 60 and 95 minutes (Table 3) and, although I was interacting with fellow academics, I was conscious of the fact that I am not an expert on the science of AMR in the environment. Although my lack of scientific expertise was probably evident to the scientists that I engaged with, they still answered my questions with patience and understanding. This supports Gross and Levitt's claim (1998: 43) that "Above all, natural scientists are reluctant to take a haughty attitude towards hypotheses and theories of outsiders merely because they seem at first paradoxical or are expressed in a recondite language. They are aware that some matters of the greatest professional concern may strike an outsider as abstruse, bewildering, perhaps even nonsensical."

3.4. Analysing the data that was gathered

There are several techniques that social scientists employ to analyse interpretative data such as grounded theory, the constant comparison method, discourse analysis and 'thick description'. Below I will explain how and why I drew on each of these techniques to contextualise and analyse the data that I gathered from the interviews with participants which totalled 195,723 words.

3.4.1. Grounded theory and the constant comparative method

Grounded theory provides a concise encapsulation of the essence of interpretative enquiry in that one lets ideas (theory) emerge from one's immersion in a situation rather than going in and imposing a fixed theory on it (Glaser and Strauss (1967). Lincoln and Guba (1985) argue that constant comparison is the key element of grounded theory that enables it to remain relevant. This method involves constantly pouring over the collected data and comparing each sentence and paragraph to make connections so that codes and themes can emerge from the data. However, as Bulmer (1979) explains, although no fixed framework was upon the data, the theory that emerges will never be completely free of the researcher's own pre-existing knowledge, values and beliefs.

I began my coding process by storing all my notes and transcribed interviews in two separate files. One file was titled 'raw data' and the other was titled 'working data'. I constantly read through my working files, made notes, and highlighted parts that I thought might be relevant and interesting. This process enabled me to identify recurring ideas and issues that I used to create temporary constructs. I focused on letting themes emerge from these temporary constructs by closely reading my data again and creating a grid with a list of my temporary constructs on the left and where in my interviews and notes evidence could be found to support them on the right. Those constructs that were not supported by what I considered to be strong

evidence were removed. The most interesting and relevant passages from the interviews that I carried out with participants were used to illustrate my themes. I continued to analyse my data until I reached theoretical saturation i.e., the point where no new themes were emerging from it (Fincher and Mason, 1990; Glasser and Strauss, 1967). Thus, I felt that it was not necessary for me to continue to recruit participants. Although there are several software programmes available that claim to assist with the analysis of data, such as NVivo, I chose not to use them because I did not feel the data that I had gathered was too large for me to analyse on my own. I also did not want to fall into the trap of thinking that all the analysis could be done by a computer programme (Thomas, 2013).

3.4.2. Discourse analysis

Discourse analysis is the study of how language is used in social situations to produce power relations between and among people. As with grounded theory and the constant comparative methods, the focus is on analysing an interview or another language sample to generate codes and themes. However, although discourse enables one to uncover statements and utterances that are made within a narrow framework about a particular issue such as AMR in the environment, it also emphasises uncovering the unwritten structures and rules that enable the production of those statements and utterances. (Hodges and David *et al*. 2008). In contrast to Marxist ideas about ideology, discourse is not only about oppression but also empowerment because ideas can only be expressed once they have been brought into being by discourse. Thirty years ago, in the fields of medicine and farming for example, claims that overusing and/or misusing antibiotics could lead to AMR in the environment did not really 'exist' (Salyers and Whitt, 2005). Even when discourses do become dominant, scientific experts express concern that there is often resistance and opposition from those with competing discourses such as farmers (see Chapter 5). As with grounded theory and the constant comparative method, discourse analysis is limited when it comes to gaining a detailed understanding of how people make sense of the environmental dimensions of AMR because it focuses exclusively on how language is used. I wanted to not only

understand how surfers and open-water swimmers used language to make sense of the environmental dimensions of AMR, but also their practices and behaviours. Thus, in a limited sense, I also employed what the anthropologist Clifford Geertz called (1975) called 'thick description'.

3.4.3 Thick description

Thick description refers to interpreting a type of behaviour - a wink, pause or assertion etc. - within a particular context by drawing on one's pre-existing knowledge about human behaviour. If one does not provide context, then one is simply a "decipher clerk" (1975: 9). To emphasise this point, Geertz borrows an example from Gilbert Ryle (1968/1996) - who originally coined the term 'thick description' – of three boys moving their eye muscles. Geertz asserts that it is a "speck of behaviour, a fleck of culture, and *voila* a gesture*"* (ibid) that turns one of the first boy's eye movements into a twitch, the second boy's into a wink and the third boy's into a parody of the second boy's wink. It is the researcher's job to explain to the reader one's interpretation of a piece of behaviour or practice. Although I did pay attention to participants' pauses and laughs etc during interviews, I was also focused on trying to understand what I observed them doing such as surfers walking to and from the beach barefoot and not washing their hands before eating or drinking after getting out of the water. I initially interpreted this behaviour as simply a lack of concern about the environmental dimensions of AMR. However, they explained that there were practical reasons for this such as concerns about having their footwear stolen and the lack of nearby facilities to wash and shower and they did try to avoid treading on anything that could cause an infection.

3.5. The strengths and limitations of my methodological approach

One of the main benefits of quantitative research is that it enables a researcher to explore many cases because one does not need to get to know each case in detail – statistical information is more important. The main benefit of my qualitative research, by contrast, was that it enabled me to gain a much more in-depth

understanding of participants' views about the issues being explored and, thus, much more likely to spot something that had been missed by quantitative researchers working on AMR in the environment (Bryman, 2008). To elaborate, unlike the two surveys that were completed in 2006 and 2009 (Besley and Nisbet, 2011) in order to elicit the views of scientists on lay publics and public participation exercises (Chapter 2), my research did not focus on a large number of people and because of the nature of qualitative research, I was able to provide a more in-depth understanding of the views held by scientists, surfers and swimmers (Crotty, 1998).

Qualitative research has been criticised for producing knowledge that cannot be generalised to other publics or settings (Bryman, 2008). For example, Armstrong's (1998) study of Sheffield United hooligans cannot be used to make factual claims about hooligans who support football clubs in other towns or cities. Similarly, it would be erroneous to claim that Holdaway's (1982) findings about the police in Sheffield represent all police forces. However, although I engaged with a relatively small number of scientists, none were based at the same academic institution. Likewise, open-water swimmers were from different parts of the UK, and they often swam in different rivers, lakes and coastal waters. Many of the surfers in Newquay were also from different parts of the UK and had experiences of carrying out their surfing activities in different parts of the world. Thus, I believe I have produced findings that Payne and Williams (2005: 11) call "*moderatum* generalisations". As such, researchers exploring other environmental issues and other communities may be able to draw on my findings and make comparisons and connections with their own work.

3.6. Ethical issues

Although I have engaged with policy issues related to AMR, the nature of my qualitative research has mainly involved in-depth interviews with individuals. Thus, I have had to consider ethical issues that focused on informed consent and voluntary

participation (3.6.1.), anonymity and confidentiality (3.6.2.), and how my positionality may have shaped how I collected and interpreted my data (3.6.4.).

3.6.1. Informed consent and voluntary participation

Informed consent is the central tenet of ethical research. However, in some studies a conflict arises between the rights of participants to be fully informed about the research that they are being asked to participate in and the benefits to society if they are not fully informed. Two famous studies are often cited to explore this argument in detail - the Milgram experiment (Milgram, 2010) and the Tuskegee syphilis experiment (Jones, 1992). These studies have been explored in detail elsewhere. Here, I will provide an overview of the experiments to show why they helped inform my own ethical considerations.

The Milgram experiments were named after the social psychologist Stanley Milgram who wanted to understand how and why people obey those in authority even when they feel reluctant about doing so. To test his ideas, Milgram recruited 'ordinary' people to participate in a study ostensibly about learning. Participants were instructed by a person in authority to administer pain to another person using a dial that had markers on it ranging from 'Slight Shock' to 'Severe Shock.' The participant was ordered to turn up the dial every time the person got a question wrong. Even though the victim's screams of mercy became more desperate, two thirds of participants obeyed orders to continue to turn up the dial and inflict more pain. Unbeknown to participants the victim was an actor, and the shocks were not real. This deception meant that Milgram's work was rejected by several major journals on ethical grounds. However, the work still received the annual Socio-Psychological Award of the American Association for the Advancement of Science because the means were perceived as justifying the ends i.e., helping society understand why so many people find it difficult to disobey those in authority (Zimbardo, 2008).

The Tuskegee syphilis experiment was another infamous study that was carried out by the United States Public Health Service in Tuskegee, Alabama, between 1932 and 1972 on 600 black men – some with syphilis and some without – to understand how syphilis progresses when it is left untreated. This research has been criticised for being extremely unethical since the purpose of the study was kept hidden from the men who took part and, thus, they erroneously thought that they were receiving free healthcare. In reality, the men with syphilis were not given penicillin to cure their illness, despite the fact that it had become widely available by the 1940s (see Chapter 1) as the purpose of the study would have been undermined and closed down. Ultimately the study was forced to end when details about it were leaked to the media. In response to public outcry, the United States government created the National Commission for the Protection of Human Subjects of Biomedical and Behavioural Research, which outlined the following three ethical principles in the Belmont Report (1982: 5):

1. "Respect for persons.
2. Beneficence: persons are treated in an ethical manner not only by respecting their decisions and protecting them from harm, but also by making efforts to secure their well-being.
3. Justice: depending on the 'riskiness' of the research, you shouldn't carry out research on people if they are unlikely to benefit."

Although my research is not as controversial as the Milgram or the Tuskegee syphilis experiments, these principles did help to shape my research. For example, to ensure participants were able to give their consent freely to take part in my research, I informed them about what my research was about in language that was easy to understand. Thus, I explained what the scientific term 'antimicrobial resistance' means and how it relates to the environment and also how my research will be published and how it could potentially contribute to science and the improvement of policy in relation to public health. Before any interviews could take place, participants were asked to read an information sheet about my research and to sign

an informed consent form and both surfers and swimmers were also asked basic biographical information such as their age, gender and ethnicity. I also addressed any issues they had and explained that their participation was voluntary so they could withdraw their consent at any stage without facing any repercussions.

3.6.2. Anonymity and confidentiality

I used several strategies to protect participants' personal information such as providing them with pseudonyms when presenting their thoughts in verbatim quotes. However, I explained to surfers and open-water swimmers that their age and ethnicity would be used to help understand the make-up of the surfing and open-water swimming communities. This information could be helpful for future researchers who want to try and replicate this study. Interview transcripts were stored in password protected computer files (Lin, 2009) and shared with my supervisors via email and Microsoft Teams for the purpose of accuracy. Hard copies of consent forms and interview transcripts are being stored in a padlocked cabinet that only I have access to. Both hard and electronic data will be stored for at least five years in accordance with the University of Nottingham's rules on data protection.

3.6.3. Ethical approval and access to participants

In contrast to other social scientists researching violent publics (e.g., Guilianotti's (1995) work on football hooligans) or vulnerable publics (e.g., Taylor's (1993) research on female intravenous drug users), I did not need to negotiate with gatekeepers or advocates in order to gain access to participants and settings.

3.6.4. Positionality

Ethical considerations are not only important when considering interactions between researchers and participants but also during the interpretation of data that has been collected from participant. Although I have tried to produce research that

is both original and balanced, I acknowledge the centrality of my subjectivity. That is to say, my position as a white working-class male with little practical experience of surfing or open-water swimming is likely to have shaped my research in ways that I am not even conscious of. I am also conscious of how my views have changed. Before I started this research project, my background in public sociology (MA) had already provided me with a good understanding of the importance of lay publics in relation to defining and tackling social, political and economic problems. Thus, I was already critical of the view that scientific knowledge is automatically more credible than knowledge that emerges from lay traditions.

3.7. Conclusion

In this chapter I explored how and why I chose to recruit surfers, open-water swimmers and scientists working on the environmental dimensions of AMR. I also explained that my research has been guided by the interpretivist paradigm because I perceive the world as being socially constructed. Thus, rather than trying to quantify and measure participants' experiences, my aim was to understand how they engaged with ideas about AMR in the environment and lay knowledge. I have also explained how I dealt with the ethical and practical issues that I faced in relation to getting close to participants so that I could see the world through their eyes and generate rich data. In the following two chapters I will present my interpretation of the interviews that I carried out with surfers, open-water swimmers and scientists.

Chapter 4. Understanding how lay publics are imagined by scientists working on the environmental dimensions of AMR

4.1. Introduction

In Chapter 2, I explored social science research that argues 'the public' does not exist 'out there' waiting to be discovered, but rather multiple publics are imagined and engaged with by different actors for different reasons (Davies *et al*. 2021). Traditionally, the ways in which scientists and policy actors imagine and engage with lay publics about environmental issues have been strongly shaped by the deficit model which constructs lay publics primarily as blank slates to be filled with scientific information (Eden, 2017). However, since the early 1990s, social scientists have challenged this position by focusing on the fact that lay publics make sense of environmental issues by drawing upon their pre-existing knowledge, practices and beliefs which can sometimes come into conflict with scientific knowledge that does not take local conditions into account because of its focus on universal laws (Livingston, 2003). To address any conflict and build trust between scientists, policy actors and lay publics, public participation mechanisms have been designed to enable lay publics to be part of environmental planning and decision-making. However, as explored in Chapter 2, it has been argued that many of these mechanisms continue to reflect the deficit model in the sense that they are designed to didactically inform rather than engage in genuine dialogues with lay publics (Eden, 2017).

In this chapter, I will explore how lay publics are imagined by scientists working on the environmental dimensions of AMR as: 'difficult to define' (4.2); 'unknowing and uninterested' (4.3); 'open to persuasion' (4.4); as 'consumers' (4.5), and as 'subordinate to scientists; (4.6). To contextualise my findings, I will draw upon the debates that were explored in Chapter 2 about how lay publics have previously been constructed and mobilised in relation to other social and environmental issues. This

will help me explore to what extent each of these imaginaries remains within the bounds of the deficit model.

4.2. Lay publics imagined as difficult to define

In Chapter 2, I explored the criteria that have been used by scientists, social scientists and policymakers to differentiate experts from lay publics. Traditionally, formal education and professional training underpin the dichotomy between expert and lay publics (Eden, 2017). However, this definition has been criticised for being too restrictive in the sense that it excludes those publics who may not have any formal scientific training, but possess knowledge gained from practical experience (Collins and Evans, 2007). The lay/expert distinction is still open to debate and identifying legitimate criteria that can be used to produce boundaries around expertise is something that participants found problematic. Professor Scott Smith's discussion is a prime example. Thus, it is worth quoting him at length:

> *If I define what I mean by public, then I'll define what I think about their interests. So, what do I think about the public? Who do I think the public are? You've got your 'lay public' who I'd say doesn't really work in science. Some of those lay people will be better informed than others. Some will not have a scientific background at all, and they won't really consider it* (AMR) *and they'd just go to the doctors. Others will have some scientific background, so they've done some science at some point even up to degree level you can argue, but they won't work in the field.*

By contrast, he added: *"*A non-lay person would be someone who works with antibiotics. So, your doctors, your medics, nurses. You'd expect them to have some understanding of some of the issues to do with infection control risk of resistance. Do you count those as lay persons? Probably not." He explained that the lay/expert distinction is complicated by the fact that it is possible to gain good

knowledge about AMR, not only from formal education and practical experience, but also *ex situ* via the media:

> *So, what you count as 'lay' public I think is quite hard because I could have a conversation with someone in a pub and they might work in an arts department from the university say, or they might be an engineer from a from a factory. Whether I get a better conversation to do with drugs and vaccines and health out of one or the other really depends on what their views are because I could give examples probably for both where some have actually surprised me by how much they know because of what they've read, because they sit there in their warehouse and they read whatever newspapers they're reading, including the higher quality newspapers, which are probably better informing them, so actually they've picked up on the debate.*

According to Collins and Evans (2007), knowledge that has been gained *ex situ,* including via the media, about a particular domain will not be nuanced enough to be placed in the category of expertise. However, as Professor Smith reflexively explained: "They (lay publics) might not know all the nuances, but then I probably don't know all the nuances of all the topics either." He concluded by pointing out that lay publics' level of engagement and awareness depends on the source of their information.

> *Then you can have other people which would be the anti-vaxxer type people. While they use medicine, and they also perceive it as something which they're not really engaged with. I suppose they must be engaged at a level, though, because they're obviously against something. But, actually, how much do they really understand? And where that knowledge is coming from is a bit dubious. So, I see both. I've seen it from people you think… I'm surprised*

that person's got that view which I don't agree with. On the converse, you get surprised because they know a lot.

The claim that 'anti-vaxxers' are getting their knowledge from a 'dubious' place supports Sismondo's (2010) claim that knowledge that emerges from non-scientific sources is viewed as less credible. However, universal acceptance of vaccination programmes has never existed for a variety of reasons, including the belief that the risks of contracting an infection are not as substantial as the risks that are believed to be related to having a vaccine (Martin, 2000). The lay/expert distinction, explored in Chapter 2, is also complicated by the fact that there are multiple publics with diverse views rather than a monolithic mass with homogenous views (Irwin, 2006; and Staeheli, *et al*. 2009). How these publics are differentiated will depend on who is doing the construction. For example, for the purposes of policy, the government agency 'Defra' (2008) and the non-departmental public body Natural England (2012) have relied upon 'socio demographics' - such as age, gender and race - to differentiate publics. By contrast, the social scientist, Sally Eden (2017), argued that there are multiple 'environmental publics' who are differentiated by how they engage with the environment as consumers, recreational users, campaigners, voters and workers. In my interviews, it was common for participants to imagine lay publics as a monolithic entity, employing terms such as "the masses" and "Joe public" and the "general public". Some scientists did acknowledge that there are multiple publics, but this was mainly once I had introduced the idea during the interviews. For example, Professor Adam Bruce discussed how messages about AMR in the environment could be tailored for different publics: "I completely recognise that you could make a lifetime study of how you could break up the public into different target groups and how you would maybe need to modify the message and to appeal to different target groups." Professor Jane Stevens also discussed the idea of multiple publics when she emphasised that scientists need to go into local communities and use different technologies and platforms to engage with them.

We (scientists) need to make a concerted effort to try and get out to those different groups, and it could be on different platforms. I would have thought teenagers would be much more at home with like online videos, interactive games, maybe gaming technology but in an old people's home if you go in and just talk about, you know you're using historical references, I think that often helps as well, and why this has been a problem and how it's been built up in their lifetime. They can really see that. The onus is on us as scientists to get out and do this and make it accessible to all those different groups, but you're right, I think there isn't a monolithic public.

She also explained that the idea of multiple lay publics inevitably comes into play when she takes part in public participation exercises in different locations: "I find that giving a talk at an old people's home is completely different to giving a talk in a school". It was also argued that knowing is more complex than the lay/expert dichotomy suggests because most of us only have a limited understanding of most issues. As Professor John Lane explained as he discussed why scientific knowledge is more credible than knowledge that has emerged from other traditions.

We [scientists] *have to all be aware that while we are experts in some areas, we are lay people in many other areas. It is not so much about the level of expertise you have, although there are of course differences, but it's more about the attitude and the important attitude is that you are evidence based or not. You don't have to be expert to be evidence based. But there's a huge difference between someone who recognises facts and evidence to someone who mentions Trump, who is the exact opposite, evidence is completely irrelevant because some people live in their own world and they're mentally creating their own evidence and that evidence that they are making up themselves seems to be stronger for them than any other evidence, so this is hard to understand for me - that this is actually at all possible that some people are so much absorbed in their own ideas that they mistake it for*

evidence. It's just, it's just crazy, you know, when you hear about people burning Wi-Fi masts because of their concerns that G5 is the cause of the Covid virus outbreak. I mean it is so insane.

What this position ignores is the claims about the limitations of scientific knowledge that were explored in Chapter 2. Namely, what constitutes factual evidence is dictated by theory and 'interpretive flexibility' (Nanda, 1997) which means the same piece of evidence can be used to support multiple (and often contradictory) theories, including those that argue the sun revolves around the earth, on the one hand and, those that argue the opposite, on the other (see Chapter2). As will be explored in the next section, participants mostly perceived lay publics to be lacking in knowledge about AMR in the environment that could be supported by scientific evidence. However, most participants explained that the way they imagined lay publics was not gained from any experience of engaging with them about the environmental dimensions of AMR or any other issues.

4.3. Lay publics imagined as unknowing and uninterested

Many of the interviews with participants were dominated by ideas related to the deficit model (Chapter 2) in the sense that lay publics were imagined as under informed or misinformed about the environmental dimensions of AMR. Professor Gary Williams explained: "I think that people don't really understand what the environmental dimension is, but then most people don't know what antimicrobial resistance is either. Most people still think that you as an individual become resistant to antibiotics." In a separate interview Professor Laura Roberts agreed and added:

I think there's a lot that the public doesn't really understand about microbes, and I don't think it's necessarily to do with resistance. I think the problem is that microbes are generally thought of as, you know, bad and dangerous. And when people think about microbes they think like, urgh, it causes disease or

it's dirty or whatever and they don't understand that actually we're mostly made up of microbes and that they're everywhere and they've always been everywhere, and that we're, if anything, a host for microbes. So, I think there's this issue that the first thing we try to teach our kids is wash your hands because there's these microbes that could make you ill and then maybe that's what sticks in people's minds forever.

It was also argued by participants that one of the main reasons for lay publics' imagined lack of knowledge about AMR was caused by policymakers and scientists' failure to communicate the issues to them clearly. As Professor Jane Stevens explained: "I think that the biggest problem there is, is that we haven't brought them along with us. I think the O'Neill Report did a fantastic job at responding to scientists and getting scientists aware of it, but what we need to do now is really work with the general public". Professor Stevens was the only participant to talk about working with the public. Other participants explained why this would not be straightforward. For example, Professor Mike Cam asserted:

Well, my feeling is that the concept [AMR] is quite difficult to grasp and maybe it's something which requires special skills in communication. You know, I think it's come to the extent where people like GPs often seem to struggle to get it right and they're pretty highly trained individuals and those in veterinary settings and medicinal people as well tend to over prescribe antibiotics and this is a well-known phenomenon, and this has been really initiated maybe by pressures from the public wanting an antibiotic anyway and the farm industry which also wants to make sure that their animals are not diseased in any way.

Many of the claims made by participants about why AMR is difficult to grasp and communicate to lay publics relate to debates about the 'risk society' that were

explored in Chapter 2. In short, environmental risks have not only become increasingly difficult to measure, but also invisible to our senses which makes them more difficult to comprehend. As Professor Gary Williams asserted in relation to AMR: "I think all of our messaging around antimicrobial resistance is complicated by the fact that bacteria and the chemicals are sort of like more or less invisible so people can't visualise what they are." Prof David Edwards also made this point in relation to Covid-19 and other environmental risks.

> *I think that's not easy because AMR is like Covid, the Covid-19 virus, you don't see it and it's always been very difficult to explain risks and dangers of something that people don't see. That's also similar to nuclear energy, I mean radioactivity is something you don't feel, you don't see but it's there and it's the same with resistance in the environment - you don't see it, but it's there, so I'm not sure if it's generally easy to explain these things.*

Even if the risks related to AMR and the environment could be easily explained and grasped, it was also common for participants not only to lament the public's lack of knowledge, but also their lack of interest. As Professor Laura Roberts asserted:

> *On antibiotic resistance and then especially antibiotic resistance in the environment, I think of the different AMR topics, the environment is probably the least understood and has had possibly had the least interest from the public because I guess, you know, as humans we worry about what impact it might have on us and I think maybe thinking about some genes in the environment, it's not seen as being immediately relevant to your health or your loved one's health or whatever.*

Prof Sarah Rodgers also imagined lay publics as uninterested when she discussed her reservations about engaging in a dialogue with them about AMR.

> *I mean, ultimately, that's the approach* [the deficit model] *that has been taken for a long time, but I think it hasn't particularly worked, so I think really it should be more of a dialogue than, you know, us disseminating information to the public. But, I mean, it's not quite as simple as that either, because I can go up to somebody and say: "well, so what do you want to know about antibiotic resistance?", and they'd be like, "nothing." So, I think there's also an issue because they're not necessarily being critical. A critically thinking population out there who wants to ask these questions. And who's interested in asking these questions and getting the answers to them. Erm, and I mean I don't know what the answers are to that. Yeah, I have no idea what the answer to that is, but I'm sure that we could have a public, and I guess we are also members of that public, who might be more interested in these questions as opposed to who's going to win on 'Love Island' or… you know?*

As explored in Chapter 2, public participation exercises that genuinely engage in a dialogue with, and empower, lay publics are much more sophisticated than approaching them and bluntly asking what they would like to know about AMR. Indeed, they also enable lay publics to be part of the planning and decision-making processes at an early stage. Those approaches that do not provide genuine opportunities for lay publics to be part of the decision and planning making process remain on the lowest rungs of Arnstein's 1969 'ladder of citizen participation' (Eden, 2017). When asked about whether lay publics and lay knowledge should be part of the process of planning and decision-making, Professor Paul Walker enthusiastically asserted: "Yes, yes absolutely, but I don't know which of those publics really engages with this question on antibiotic resistance and then especially antibiotic resistance in the environment." Although it was common for participants to imagine most lay publics as possessing little knowledge about AMR in the environment, it was also common for them to claim that lay publics are not only willing to engage with questions about AMR, but also change their views and behaviour if they are presented with the correct messages. As will be explored in the next section,

participants discussed what those messages should be and how it should be presented to lay audiences.

4.4. Lay publics imagined as open to persuasion

In Chapter 2, I explored the claim that lay publics are divided into 'good' and 'bad' publics by policy actors and scientists depending on how open they are to persuasion by scientific information. Although lay publics were mostly perceived as lacking in knowledge about AMR, they were also imagined as being open to persuasion. For Professor Jane Stevens, people's behaviour during the Covid-19 pandemic reinforces this point.

> *You can see it with this lockdown - people have followed the rules. If you explain things to them, they do respond, they will work with you, and I think we need to do the same with antimicrobial resistance because there's still so much of getting antibiotics and keeping it in your drawers or for another two years, later and taking an old tablet here and there, and we have to show why this is the wrong approach.*

As explored in Chapter 2, it has been argued that one of the main reasons why scientific experts have had difficulties persuading lay publics is due to the fact that scientific knowledge practices have become invisible to lay publics because they are carried out in laboratories and are discussed at conferences that are remote from the daily experience of most people. This produces uncertainties and disputes about issues such as climate change (Eden, 2017). However, it was argued by Professor Beth Dean that, during the Covid-19 pandemic, scientists became more visible as they appeared in the media more often to discuss the issue which has helped to erode the 'distance effect' (Collins and Evans, 2017) and build trust between lay publics and scientific experts:

> *Science has suddenly gone back to being a respectable activity. Instead of being sort of weird and, and mischievous boffins who conduct, you know, Frankenstein experiments behind the scenes. I think people suddenly realise, yeah, we do need epidemiologists, we do need environmental microbiologists, we do need these people.*

Professor Dean's claim is supported by the biggest world-wide survey of how people think and feel about scientists that was carried out by the Gallup World Poll in collaboration with the Wellcome Global Monitor (2021). The survey, which was conducted between August 2020 and February 2021, found that during the Covid-19 pandemic 80% of those surveyed said that they trusted science, and 77% said they trusted scientists either "a lot" or "some". Since 2018, in all the countries surveyed, trust in science and scientists was on par with trust in doctors and nurses. However, only a minority of participants agreed with the claim that scientists' expertise is valued by political leaders. The Associate Director of Public Engagement and Campaigns at Wellcome, Lara Clements, explained:

> *The Covid-19 pandemic has thrust scientists into the spotlight, where they have provided information and guidance affecting the day-to-day lives of billions of people. In both 2018 and 2020, we saw a link between people's perceived knowledge of science and their trust in science. As the pandemic has brought science into more people's lives, it is perhaps no surprise that people's trust in science and scientists has risen so much* (Cited in Grove, 2021: 1).

In my research, it was also common for participants to focus on building trust by creating messages that would persuade lay publics to change their behaviour and practices. For Professor Paul Walker, highlighting stories that focus on the impact of

AMR on individuals would help people to understand the severity of the threat that is posed to human health.

> *What people do understand are stories about someone getting an infection that is resistant and how they survived, maybe rescued with phage therapy. You know, these stories are something people actually relate to. So, unfortunately, that means you have to wait until it's really bad before people take action. We have known about the problem of AMR and the environment for a long time. I mean, there is this report from the government in the late 1960s that already identified all the problems, proposed solutions, nothing really happened which is why we have the problem now. So, it's just human nature. I suppose to some extent it has to come to a really bad crisis before people change. Our climate change is an example where it's like this. We have known this is happening for quite a long time, but only now that it's getting so critical that we have to do something very quickly to prevent it getting too bad. It's when people start really changing behaviour. If I knew the solution to this, I would be a very happy man.*

Professor Walker's claim is a non-sequitur because, as I explained in Chapter 2, focusing on the plight of individuals does tend to influence people's perception of risk because it makes those risks seem less abstract and more relevant to their own lives. However, this strategy can be employed successfully before the risks get "really bad". Furthermore, in Chapter 2, I also explored the social science research that has strongly challenged behavioural change theories by drawing attention to the limited power and agency of individuals when it comes tackling issues that are structural and global in scale such as energy consumption, water demand, recycling, climate change (Strengers and Maller, 2016), carbon footprint (Huber, 2017) and food waste in the UK (Evans *et al*. 2017). In relation to food waste in the UK, Evans *et al*. (2017) explain that there has been a shift away from blaming individual consumers and more emphasis placed on supermarkets and other actors in the food

chain. Surfers and open-water swimmers (Chapter 5) also tended to spend more time discussing the structural causes of AMR in the environment rather than individual responsibility. For scientists, however, the focus was mainly on the role of individuals. For example, for Professor Gary Williams, providing lay publics with more information about the causes of AMR in the environment will enable them to be reflexive about how they contribute to the problem.

> *I think that there needs to be messages like, no, it's not just enough to wash your hands all the time. It's actually the way you live your life, it's how your food is produced, it's what you pour down the sink.*

Dr Scott Smith agreed with this position when he enthusiastically discussed creating a 'One Health' narrative that would enable the public to learn more about these issues and make informed decisions so that they can become "part of the mechanism of change":

> *If they were empowered with the information that they need to make those decisions. And so, yeah, a bit like the Fairtrade bananas and coffees and what not, you can make that decision because there's a little symbol on the package that you buy, and it says it's been produced under the you know Fairtrade philosophies and regulations. It's about being able to be informed in such a clear-cut way to make that decision about the world that they're living in what they would prefer to support versus other things and without that how do we expect them to do better?*

The claim that food labelling approaches make it easy for people to change their behaviour and practices was challenged in Chapter 2. Furthermore, stating that lay publics can be part of the mechanisms of change through their consuming practices is incongruous in relation to the official definitions of 'One Health' that were

presented in Chapter 1. Other participants discussed using a 'One Health' framework that was more in line with those official definitions. For Professor David Edwards, a 'One Health' approach would persuade lay publics because it allows them to draw upon their pre-existing knowledge about other environmental issues in order to make sense of the environmental dimensions of AMR.

> *Personally, I think that many members of the public would probably have an appreciation of the sort of, you know, what I call the 'One Health' framing of AMR and human disease more generally; the idea that what goes on in the environment and what goes on in agriculture and animals, and what goes on in humans are deeply connected. I think that because of various other environmental factors that the public are now very receptive to. So, whether that's plastics or climate change or whatever it is - I think the kind of 'One Health' side of things… I would imagine they would probably resonate. Not for everybody but for quite a large number of people it would, probably.*

Although not explicitly mentioning 'One Health', some participants agreed with its focus on communicating with the younger generation in relation to tackling AMR. For example, Professor Laura Roberts explained: "I think we need to basically from a very early age try to educate children that microbes are here and most of them are fine, and they don't bother us but sometimes there's these bad ones, but getting this message across is quite tricky, I think. You know that there's bad and good, that is basically not even a thing." Professor Jane Stevens also focused on younger people being more open to persuasion when she discussed her experiences of public participation.

> *I do a little local, science club things and then I've done 'Pint of Science' and I do lots of school outreach. I go out to lots of schools and give this type of talk. It's always well received; people are really interested because they just don't*

know about it. And then we start to talk to them about it because everybody's had antibiotics, it's like a way of getting in and you know with kids especially you can talk about, try and keep it on the positive level and try and keep an interesting thing rather than a scary thing, but I think people respond to it really well.

She also discussed what a positive impact this experience had been not only for the children, but also for herself.

I think you know it starts to broaden people's minds about microbiology and just you know like gene transfer because when you explain what actually happens - that they're (bacteria) not passing it down, down a family line. You know, if I've got blue and want brown eyes I can't go and get them and if you start to explain it like that and they just suddenly start to understand how amazing microbes are too. It's like a stealth way (laughs) of getting a bit of bacteriology into someone. It's definitely made it more positive for me.

Other participants discussed the difficulties of trying to engage with publics outside of the scientific community. Professor Laura Roberts lamented: "There are lots of different publics and I feel like most of the time the public that you reach as a scientist, as somebody who's trying to communicate science, are the converted or the flock". As explored in Chapter 2, it has been argued that one of the main reasons the deficit model continues to persist is due to scientists' lack of training in relation to communicating science to lay publics. Some participants were reflexive about this when they claimed that scientists lack the ability to communicate their research beyond the confines of laboratories and lecture halls. Some participants also stated that the media does a better job in relation to communicating scientific research to non-specialist audiences. As Professor Alan Jacobs explained:

*You know, I often feel that erm, we as scientists and researchers are often not the best people to communicate what we're doing because we're often into the detail. You're researching at the cutting edge, erm, and sometimes there are better people to communicate this. If you read good science journalism you know journals like 'New Scientist' and some of the science journalists who write for them, some of the main media outlets, they know how to do it very well. If you look at the coronavirus. You look at what people say on the BBC, or the Guardian. People like that can sum up in two-hundred words, and they probably do it in half an hour. It takes me two weeks to do something similar, so it's a different skillset I think, the communication from doing the research. Some people can do both, erm, and that's rare in my experience. It's great if the scientists themselves can communicate, but in my experience, certainly in my area, many scientists find it really hard to communicate at that sort of level. They're fine at communicating with their own peers within their group, but it's more difficult when it's to the public, lay people***.**

Professor Beth Dean agreed and added:

I think you need the public's ear; they need to be aware and alert otherwise they just get bored and mostly you're talking to the initiated, you know you're talking to a group of people that are already interested and concerned. We need to get the message to the masses. I think television is probably the best way to do that. I mean you know in terms of food and mistreatment of animals I think television has done a pretty good job on trying to reduce the amount of factory farming and the impact on chickens, and I do think that has been very beneficial.

Professor Dean's claim about television doing a great job is undermined by the fact that in terms of factory farming, over the last decade, there has been a global

increase in factory farming. To elaborate, a new mega-farm is being built in China with the goal of rearing 2.1 million hogs each year and between 2012 and 2017 in the U.S, the number of animals in factory farms increased by 14 percent. Similarly, since 2011 the number of large, intensive pig and poultry farms in the UK has increased by 26 percent (Hamlett, 2021). As explained in Chapter 1, this expansion can contribute to AMR in the environment due to livestock excreting unmetabolized antibiotics which farmers have given them to try and maintain their health in cramped conditions where disease can spread rapidly (Manyl-Loh *et al*. 2018). Other participants discussed lay publics' perceived lack of knowledge about the increase in factory farming and how the issues should be communicated to them. As Professor Jon Lane explained:

> *Most people have some concern and interest about environmental issues. The sort of the large impacts that it has. You know, global warming and so on. A lot of people have a reasonable level of knowledge that has been built up by the media. That is essentially a good quality way of communicating that. Antimicrobial resistance is starting to come through now I think as an issue because there are diseases, microbial diseases, which are very difficult to treat and people are aware of resistant bacteria and so on, so it's coming into the domain maybe the area of farm practice and how that might affect these issues is probably not very well appreciated by the general public.*

He added that if lay publics become too knowledgeable about the use of antimicrobials in animal agriculture, then this could also lead to problems if they not communicated with caution and sensitivity.

> *it's something which could be quite alarming possibly if you start to spell things out about the high-level use of antibiotics in farms, the fact that those waste materials containing the antibiotics can generate these organisms*

which have got antimicrobial resistance and as a direct route to production of food on the farms because this waste is spread onto the fields. So, you could see that this could cause some concerns that would have to be handled with some sensitivity I think, and I would have thought lay people who, you know, once they understand the situation, would be concerned, and quite rightly about that.

In reality, many lay communities around the world do have a good level of knowledge about the relevant issues and have come together to organise and express their concerns. For example, a 2021 poll commissioned by the vegan charity 'Viva!' found that 85 percent of 2000 people surveyed in the UK want an immediate end to intensive farming methods. Furthermore, in January 2019 a successful legal challenge, that was enabled by a crowdfunding campaign, was brought by residents in Shropshire, England, against the County Council when it gave planning permission for an intensive poultry farm "without properly considering the impacts that the farm would have on our health and our environment" (Crowd Justice: 1). Another crowdfunding campaign known as 'Scrap Factory Farming' was created in 2021 by a non-profit organisation called Humane Being so that it could mount a legal challenge against the UK to force it to stop factory farming – which is unprecedented around the world. In the United States, grassroots communities, including those in poor areas, have been working with NGOs to try and prevent the expansion of factory farms. Evidence suggests that people are relying on personal experience rather than on the media. As the Factory Farm Organizing Manger of 'Food and Water Watch', Krissy Kasserman, explains: "People across the country [US] are seeing the impacts of our hyper-consolidated food system. Rural communities are declining, independent farmers are struggling, and supply chain disruptions are fresh in people's minds" (Cited in Hamlett, 2021: 1). Not all participants agreed with the claim that the media are better at communicating the environmental dimensions of AMR to lay audiences. For example, Professor Laura Roberts stated:

> *A paper came out last year and it was really about a method to look for resistance genes in water samples, but we validated the method on some water courses in London and found resistance and then the media latched onto that, so I guess it was really interesting to see the process of, not the process, but how the paper, the scientific paper, the press release, and then the stories that came out of the press release compared to each other. And it was very, very different. I mean, to some extent I have some knowledge of the reasons why it came out like that, because in speaking to our press office they were like, 'well, you should definitely latch on to this idea that the resistance genes are in London's waters because that's exciting and the public would be interested. It will hook everyone'. But really it meant that people were hooked possibly in the wrong way. So, there's a really difficult balance between getting people interested but also getting the right message across without them losing interest.*

To keep lay publics from losing interest, Professor Jane Stevens explained how she made the environmental dimensions of AMR more visual and entertaining during public participation exercises: "So, we always take just shop bought shrimp or prawns and plate them out on plates, look at resistance. I take them to lots of talks, they're talking about supermarkets and just the fact that it's in them and they're in all of them really shocks people, so that's a very simple way of showing it and they need visual things, I think to hook that onto".

In this section it has been argued that participants imagine lay publics as individuals who need to change their behaviour and practices to help address the environmental dimensions of AMR. They were also imagined as being open to persuasion and much of the focus of participants was on what and how information should be presented to a lay public in order for them to be motivated to change their behaviour. In the next section we will see that individuals particularly need to change their behaviour in relation to their consumption practices.

4.5. Imagining lay publics as consumers

As described above, lay publics are constructed by scientists and policy experts primarily as 'good' or 'bad,' depending on how willing or open they are to accept the scientific consensus (Eden 2017). In this section it will become clear that this 'good/bad' dichotomy is also prevalent when lay publics are imagined as consumers. On the one hand they are imagined as active agents of progressive change with the power to influence producers and retailers through their consuming practices and, on the other, as passive dupes of consumption manipulated by the advertising industry to buy products they do not need. Professor Beth Dean expressed optimism about consumers being a force for change in the world when discussing the need to improve water quality in the UK.

> *I'm hopeful that people will be prepared to spend a bit more money to avoid these kinds of maltreatment and mistreatment of animals. So, the same applies to their water, clean water is a luxury in many countries, and we should pay a proper price for it without despoiling our environment. So, you know we're not paying enough I think in terms of water rates, and we need to pay more. Of course, everything comes down to money and it's always going to be difficult to get 'Joe Public' to pay more for things when they've paid less, but I think people start to change their opinions now about what's important in life and I think that's why this particular time is going to be a great opportunity for scientists to put their message across.*

Clean water might be a "luxury" in many countries. However, the claim that "we should pay a proper price for it without despoiling the environment" once again puts the blame on individuals as consumers and ignores the structural practices of water companies. To elaborate, in 2021 in the UK, Southern Water received a £90 million fine for deliberately dumping billions of litres of raw sewage into the sea (BBC

website, 9 July 2021). In court the Judge, Mr Justice Johnson, explained how the water company disregarded the law to increase profits. He asserted that "the sheer scale of criminal activity meant that it was highly unlikely this was due to a small number of rogue employees. It is far more likely to be due to deliberate disregard for the law from the top down" (ibid). The crimes were discovered by the Environmental Agency who launched its biggest ever criminal investigation after shellfish were found to be contaminated with *E. coli*. Mr Justice Johnson also asserted that Southern Water displayed:

> A shocking *and wholesale disregard for the environment, for the precious and delicate ecosystems along the north Kent and Solent coastlines, to human health and to the fisheries and other legitimate businesses that depend on the vitality of the coastal waters* (*ibid*).

Similarly, in 2020 Severn Trent Water was fined £800,000 for allowing millions of litres of raw sewage into a brook in Shropshire, England (Environment Agency, 30 June 2020). These are just two recent examples. Would these and other water companies change their environmentally damaging practices if they charged consumers more? This is something participants did not consider. The claim that people are beginning to change their views about what is important to them is also interesting because, according to the polling company YouGov, public concern about the environment has now reached its highest level in the UK. Indeed, in 2019, it was ranked more important than immigration, crime and the economy below only 'Brexit' and health (Carrington, 2019). From a sociological perspective, the increase in public concern over environmental issues reflects a shift in value systems. Some commentators claim that we have entered 'a new environmental paradigm' because, in advanced capitalist economies, increasing numbers of people have more time and energy to focus on issues that are less tangible as many of their material needs have now been met (Milbrath, 1984). Consequently, as people have become more concerned about the environment, we have seen the

emergence of the 'green consumer' and in 2020 over £100 billion was spent on ethical consumption in the UK for the first time, according to the 2021 Ethical Consumer Market Report due to more people thinking about ethical and environmental concerns when they consume. The Report states:

> *Our ethical Consumerism Report is a barometer on consumer behaviour – and shoppers are turning up the heat by boycotting businesses which fail to act on ethical or social concerns. The report is a warning to brands that they must do business in a better way for workers, communities and the planet, but it also offers clear evidence to policymakers that they can positively influence change* (Ethical Consumer Market Report. 2021:1).

According to Professor Garry Williams this ethical behaviour is also having a positive impact in relation to tackling AMR in the environment.

> *We can see that in some examples there's been much more effective action driven from the bottom by people's buying preferences around antibiotic produced meat, for example. So, we've seen that some food labelling now talks about antibiotic-free meat and somehow though I think the organic farming industry has missed a trick really because it was always about our respect for how it tastes better but in actual fact, less intensive ways of producing animals and crops has benefits for the environment and for other things such as this issue around antimicrobial resistance. So, I think they're multi-factorial and, people have also said that if a lot of these steps you might take to reduce risk around antimicrobial resistance also has lots of other benefits.*

Professor Laura Roberts also talked about consumers as a force for change in the world by putting pressure on supermarkets to change their practices in relation to AMR. She explained that this is something that supermarkets are fearful of.

> *I do remember once going to a particular event - it was an environmental AMR workshop and there were some diverse people there. There were some vets there and, also, I think there was a representative from Tesco, and they were talking about the fact that they were terrified that people are going to want to know that their organic meat doesn't have antibiotics in, and they were terrified that eventually they'll have to start testing and that's going to be the game changer and I've never thought about it. I never (laughs)… I never thought about environmental AMR as a consumer.*

Some scientists contradicted the claim that consumers could be a force for change. Indeed, although no scientist explicitly referred to lay publics as passive dupes, it was implicitly argued that people are manipulated into buying products that help to promote AMR. In this sense, there is an understanding of some of the structural issues of AMR. For example, Professor Gary Williams explained that:

> *the advertising industry and the chemical industry trades on people's anxiety around cleanliness and around infection which they're going to be even more able to do that now [referring to the COVID-19 pandemic], unfortunately.*

In relation to the advertising industry, the manufacturing of fear of germs began in the mid-19th Century when the microscope enabled scientists to produce new knowledge about bacteria that resonated with people's fears about overpopulation during a period of huge urban population growth. Whether or not this is due to advertising remains unclear, but the psychological impact of the Covid-19 pandemic has also forced many of us to think more explicitly about our relationship with germs

and disease. In the United States, for example, the amount consumers spent on household cleaning products each month rose from $17.30 in January 2019 to $19.41 in January of 2021 – a 12% increase (Drenik, 2021). Many of these products contain the antibacterial agent *triclosan* which may help to select for antimicrobial resistance in the environment and be detrimental to human health along with over cleanliness in general.

As discussed in chapter 2, this argument is also made by advocates of the 'hygiene hypothesis' which states that the development of the immune system is compromised – resulting in more cases of allergies and asthma – when it does not get enough microbial stimulus, especially during early childhood due to excessive cleanliness. Updates to this hypothesis have been given several names, such as 'the microflora hypothesis' 'the old friends hypothesis' and 'the microbiome depletion' theory which focus on specific set of microbial species that have co-evolved with humans over millions of years rather than microbes in general. Some critics of these hypotheses argue that there is strong evidence that reducing hygiene precautions, such as handwashing, is likely to increase the threat of emerging infectious diseases such as Ebola and Covid-19, but there is no clear evidence that this would lead to less people with allergies or immune disorders (Bloomfield *et al*. 2016). This argument was also made by Professor Gary Williams when talking about providing lay audiences with accurate information about the environmental dimensions of AMR and countering 'misinformation' in order to reduce their consumption of products that contribute to the problem.

> *You can now hardly buy a pair of socks that hasn't got some sort of biocide in it, whether it be a protonium ammonium compound or silver. But I remember what my mother had, we had soap and bleach, or we had Dettol. We didn't have whole cupboards full of all these antibacterial products. And, of course, there is evidence that the use of those products and over cleanliness is also causing harm to human health, and there's potentially asthma and some of*

> *the allergies they could be associated with such as perturbed gut microbiomes that don't develop properly in young people, but it could be to do with the huge load of chemicals that everyone is exposed to, you know?*

For some scientists one of the best ways to encourage lay publics to think about the bigger picture in relation to AMR in the environment is to draw attention to what they buy and eat. As Dr Adam Bruce explained: "One message could be: don't buy cheap meat because they cut all the corners and you're supporting an industry that doesn't value animal welfare and uses antibiotics as a substitute for that*."*

Dr Bruce was the only participant to explicitly draw attention to some of the structural issues of AMR when he discussed the economic pressures some consumers must face*.*

> *And then they would say, "well, I can't afford it, meat, unless I buy the cheap meat," and so that's an audience that I need to be able to come up with a message for that allows them to have their cake and eat it too.*

Participants also discussed how lay publics could not only be consumers of products, but also of knowledge. There was also some discussion about how lay publics could be co-producers of knowledge in relation to AMR in the environment. However, as we shall see in the next section, the aim is to generate more data rather than enable lay publics to contribute to debates about the environmental dimensions of AMR and how they should be tackled.

4.6. Imagining lay publics as subordinate to scientists

On the one hand scientists understood that in democratic societies lay publics have the right to be part of the decision-making process, but on the other, they expressed doubts about their capacity to do so. Many of the discussions revolved around the tensions that emerged from these contradictory positions. Once again, the dichotomy of 'good' and 'bad' publics was invoked by scientists when they talked about the difficulties of being part of public participation exercises that were created to promote awareness about AMR in the environment. Professor Gary Williams, for example, lamented the power and influence that 'specialised publics' (Eden and Bear, 2012), including farmers, have to shape and dominate debates.

> *Yeah, I think it can be very valuable* (having lay publics as part of public participation) *and I think in an ideal world that would always be the case. We do have a public engagement group at the* [name of institution redacted] *where there's a panel of people. We basically talk to them about our projects and get lay feedback, but I think there's a caveat to that because I've been to big meetings and I've been involved in organising big meetings where there have been different publics invited, but some of those publics have vested interests and their interests maybe actually confounding the process you're trying to address. So, I think sometimes unfortunately there are certain groups of people that have such huge economic vested interests. I mean, I could start thinking about who they are, but you can probably know just as well as I do who those would be. So sometimes I think they have to be excluded, but I think that within government there are regulatory groups that have very good knowledge of those groups. Sometimes rather than say, for example, having lots of people from the farming industry or from groups who represent the farming, we have to rely on DEFRA and the Veterinary Medicines Directorate and the Animal and Plant Health Agency to help shape those questions, but I still think when you get down to everyday practice you*

need to engage with people that are living those problems, but I think there are difficulties with questions such as AMR.

Professor Laura Roberts explained why Professor Williams position about excluding lay publics is problematic:

Sometimes they're [people's views] *based on things that we've read or not, sometimes they're based on what someone's said, or our personal life experience, so I think maybe it would be dangerous to try to limit who could participate and it could be that those that necessarily don't have.... So, yeah, I don't see why anyone's view should be any less valid than anyone else's, you know?*

She also added that although lay publics may not possess detailed knowledge about the environmental dimensions of AMR, they may possess local knowledge that could be relevant:

I guess you wouldn't necessarily expect them to have some sort of knowledge of AMR, but I guess you could start that conversation because they are an expert on that particular environment and then it goes from there, doesn't it?

Farmers were the only public that were explicitly identified as possessing lay knowledge gained from practical experience that could be useful in relation to tackling the environmental dimensions of AMR.

Yeah, I guess there's sort of the way that farms are operated have obviously changed over the years, and probably the general public including me - I've

not got a great amount of detailed knowledge about what goes on, you know what practices have come about - but obviously as farming has become a more sort of mechanised, a lot more interested in you know productivity and so on, practices have changed. So those who are involved in that area may have knowledge of those changes particularly if they've been there and seen it over many decades and there's maybe something there which could be extracted from those who have got the hands-on sort of day-to-day experience of farming. So yeah, I think there would be some value in that.

Although farmers are recognised as possessing expertise, the claim about extracting information indicates that farmers are imagined as objects of information, rather than subjects of communication. For Professor Jim White, farmers' lay expertise was perceived as useful for generating ideas that could be tested by science, but unreliable on its own.

I learned from the farmers particularly about what sort of mitigation strategies are feasible for them, because obviously they know best about what can and what can't be easily done on a farm. So, I think the main thing I learned from the farmers is what they would find easy to do and what they would find more difficult to do. So yes, I think one can learn from the public. The lay knowledge is a practical kind of knowledge that we often lack, and I just have to be careful because, you know, this is similar to anecdotal evidence or single case studies in medicine. It's not sort of a controlled drugs trial like evidence. So, it's valuable in terms of generating ideas and hypotheses, but it's not really evidence that can be relied upon without having some trial or experimental evidence, but as a way of suggesting experiments or suggesting mitigation strategies it would, by all means, be very valuable, but they have to be validated instrumentally so that these ideas actually have the effect on AMR that they are hoped to have.

Dr Jan McKenzie agreed and discussed how that lay knowledge could become part of 'citizen science' projects.

> *Absolutely, and if you've got someone who is heading out every week maybe we could utilise them. You know, give them sterile universals, collect a sample while you're out every week and we'll analyse it and look at it over the year. That would be a great way of bringing the general public in and actually for us. I can't go out every week and take a sample so it would be a huge help.*

Dr McKenzie's comments, particularly the claim that scientists can "utilise" lay publics support some of the criticisms of 'citizen science' that were explored in Chapter 2. Namely, that it does not really erode the power dynamics between 'amateur' and 'expert' publics because lay publics are not provided with the resources to take science in their own hands so that they can tackle the problems that they themselves have identified. On the contrary, they are typically unpaid 'amateurs' who are out in field collecting data to support the work of paid professionals who have already defined the issues that need to be tackled (Gieryn, 1995; Kinchy and Kleinman, 2003). Professor Jane Stevens explained that the data collected by lay publics needs to be checked by scientists because it could be unreliable.

> *Yes, I completely think that the public, especially like 'Surfers Against Sewage' people like that they you know interact with the water they could have these problems, but it has to be from a realistic, almost scientific background where you have a bit of understanding of what you can actually do.*

Professor Laura Roberts also expressed enthusiasm about 'citizen science', but her comments also reveal that when it comes to generating knowledge, lay publics

remain subordinate to scientists who are seen as people to work on rather than with.

> *I think it's very worthwhile because it allows people to become invested in an issue and also I think what we're going to need is we're going to need to have micro bio information or information on what bacteria people are carrying to be able to work out that risk exposure relationship, so people will need to understand enough to feel comfortable that that's a piece of data that they're happy to give or information or sample they're happy to give without fearing retribution whether it's through health insurance or any other mechanism. So, I think citizen science is a good approach and I think for the AMR issue it would be great to start with something where, you know, we get communities to provide samples. Can we analyse some of those?*

In relation to citizen science and the environmental dimensions of AMR, Professor Adam Bruce discussed the importance of scientists creating reliable data collection methods that would be simple for lay publics to use as those that have emerged from lay traditions are imagined as unreliable.

> *When it comes to collecting evidence in the environment, basically counting up the flies or birds and things like that. That has been done for some years and that works very well. Also, the 'Swab and Send' that Adam Roberts is running which looks very nice, and this is where the public can help. I've had some undergrad projects in my lab where they've looked at ways in which we can search for new antibiotics by isolating new bacteria from the environment in a way that you could do it at school, so kind of thinking about ways in which you can simplify the methods so that you can do it without having an autoclave for example. So, one of my students looks at boiling the medium several times rather than autoclaving as a substitute. It didn't*

actually completely sterilise the medium, so it wasn't a perfect replacement, but these are the kind of things I've been involved with a little bit. The 'Microbiology Society' has had this project that was originally called 'Small World Initiative' originally and then 'Antibiotics Unearthed' it was called later and we have been involved with that in terms of running undergrad research projects and undergrad courses to identify new microorganisms producing antibiotics, not so much crowdsourcing but more sort of undergrad education.

For participants it seems that citizen science projects in relation to AMR are more about imagining lay publics as subordinates than equals. Thus, if the role of lay publics is simply to collect samples for scientists one has to ask to what extent are they genuinely empowered?

4.7. Conclusion

In this chapter I have explored how, in contrast to other environmental issues such as food waste in the UK, scientists working on the environmental dimensions of AMR remain focused on providing lay publics with information so that they change their behaviour in ways that contribute to tackling AMR in the environment. However, in contrast to surfers and open-water swimmers (Chapter 4), apart from the role of the advertising industry and the economic forces that make it difficult to buy better quality meat, there was little or no discussion about the structural causes of AMR, such as the environmental pollution of water companies. This could be due to the fact that I did not encourage participants to engage with these issues. In relation to how lay publics can contribute to tackling the environmental dimensions of AMR, some scientists, mostly those who had experience of taking part in public participation mechanisms, did acknowledge that in democratic societies lay publics should be able to both consume and produce knowledge. However, it was common for scientists to imagine lay publics to be deficient in knowledge about the environmental dimensions of AMR because they are mostly invisible to our senses. However, as we shall see in Chapter 5, my analysis of interviews with surfers and

open-water swimmers reveals that they are able to make sense of the environmental dimensions of AMR by drawing on their pre-existing knowledge, values and beliefs and from their senses as they carry out their recreational activities in various bodies of water.

Chapter 5. Analysis of interviews with surfers and open-water swimmers

5.1. Introduction

In Chapter 2 I explored the claim by social scientists that the possession of academic qualifications cannot be used to produce reliable boundaries that separate experts from lay publics. This is because they exclude those who have gained expertise *in situ* such as sheep farmers and AIDS activists (Collins and Evans, 2007). I also explored Eden's (2017) argument about what 'environmental publics' learn from practically engaging with the environment *in situ* is often shaped by sensory experience (Macnaghten and Urry, 1998; Wait and Cook, 2007), and that this knowledge can be incompatible with scientific knowledge that has been gained *ex situ* (i.e., in the laboratory or other places outside of the environment that is being researched). In this chapter, I will show that, despite the fact that scientists have claimed that surfers and open-water swimmers are likely to be more exposed to the risks of contracting a serious infection that could be resistant to antibiotics (see Chapter 1), most participants differed very little from the wider public (Mason *et al*. 2018; Mccullough, 2020) in their understandings of and what AMR is (5.2.1), why it occurs (5.2.2), and how it should be tackled (5.2.3).

In relation to the environmental dimensions of AMR, participants also lacked expert knowledge. However, the knowledge they gained about the environment - both *ex situ* and *in situ* via the senses (5.3) – enabled them to be reflexive about the risks and the benefits of carrying out their recreational activities in rivers, lakes and coastal waters. In relation to embodied practice and sensory experience, previous research by geographers has tended to focus more on the contribution of sight. As Pocock explains, this is perhaps because "Geography is to such an extent a visual discipline that, unique among the social sciences, sight is almost a prerequisite for its pursuit" (1981: 385). My analysis is novel because it explores not only how sight, but also

smell, touch, sound and taste contribute to participants' knowledge of environmental risk that could be important in relation to tackling the environmental dimensions of AMR. Exploring all of the senses is important because, as Sullivan and Gill assert: "Sight paints a picture of life, but sound, touch, taste and smell are actually life itself" (1975: 181). On the surface, participants' discussions about their sensory experience may not seem completely relevant to debates about the emerging environmental dimensions of AMR. However, it is important for policymakers to not only know where environmental publics need to be in relation to how they engage with the environment as they carry out their leisure activities, but also where they are. According to Beck (1992) and Giddens (1990) (see Chapter 2), scientific expertise is important because modern environmental risks are often unable to be detected by our senses. However, as we shall see, for some participants the problem is not that the risks are invisible to the senses, but that the senses, as Descartes (1641/1998) first explained, cannot always be trusted in relation to providing the brain with accurate information.

5.2. How do surfers and open-water swimmers make sense of what AMR is?

As with previous studies on lay publics' understanding of AMR, it was common for participants to express confusion about whether humans or bacteria become resistant to antibiotics and whether antibiotics can be used to treat viral infections such as influenza. Indeed, although stressed in AMR policy documents (see Chapter 1), most participants were not aware of the claim that antibacterial compounds have no efficacy against viruses. James, a 21-year-old male surfer asked: "So, what does it mean? What if you get one of these antibacterial resistant infections? How serious could it be? So, what is it, you get a virus and then you wouldn't be able to treat it with antibiotics?" Steve, another male surfer in his early 20s asked: "Isn't it just the fact that we're using antibiotics quite regularly now and we haven't got the right antibiotics for strains, so it's becoming resistant to the antibiotics we have?" Marc, a male surfer in his late 30s, asserted that "there are only about 5 different types of

antibiotics, and we take them too easily…So, if we keep using them, we'll eventually be immune to them". Wendy, a 40-year-old female open-water swimmer, also expressed this claim in relation to COVID-19: "If you go back to the clinical side of things, erm, and if a section of the population is becoming resistant to antibiotics, then it's a sort of, well, it's akin to what's going on with Covid at the moment really." Clare, a 26-year-old female doctor and recreational surfer talked about different antibiotics when she alluded to the scientific claim that bacteria become resistant to antibiotics, and this could have harmful consequences for the general population even though the patient being treated may not suffer any immediate harm - before hesitantly discussing how antibiotics become resistant to bacteria.

> *Erm, so bacteria can build up resistance to certain antibiotics and they can transfer resistance between each other. The antibiotic resistance tends to be on a population rather than individual level, is that right? As a population - as a whole - there's more bacteria resistance to certain antibiotics, and they can pass these on through the other bacteria. Some antibiotics work by breaking down the cell wall, I think and it's a resistance to the… Oh, I can't remember what it is called, err - the way penicillin works. They have, like, an enzyme which breaks down the cell wall, don't they? They build up a resistance to that mutation. "Glutolactomase - that's it.*

Clare is a particularly interesting participant because she makes us think about the lay/expert dichotomy that continues to have a powerful impact upon debates about the environment (see Chapter 2) in the sense that she explained that her knowledge about AMR came from her formal education and medical training rather than from her engagement with the environment as a recreational surfer. Furthermore, she claimed that she does not always put that knowledge into practice to avoid contracting a serious infection, such as washing her hands before eating when she gets out of the water. Ralph, a 40-year-old male surfer with no relevant formal training or qualifications related to AMR, echoed the warnings of scientists

and policymakers about returning to a pre-antibiotic era. Most of his knowledge seems to have been gained *ex situ* from watching television and reading articles about AMR rather than from direct experience.

> *Well, I've seen quite a few programmes and I've read up little bits and pieces about it and I understand why. Because you don't want these drugs to be useless. If antibiotics are useless then you'll get all those nasty things that used to kill us and take us back a hundred years ago or sixty years ago, before the NHS. We all take it for granted, don't we? You know all those little illnesses can't remember the names. Even like cholera and all these other little bits and pieces.* Basic stuff like that. *They're deadly, aren't they? But without antibiotics working, you know, we're in trouble, aren't we? Definitely. It does worry you with children though.*

As explored in Chapter 1, many of the illnesses that people contracted before antibiotics became available were not 'little'. On the contrary, they killed millions of people on a global scale. Although Ralph appeared to lack knowledge about these issues, his position lends support to Ropeik's (2002) claim that people tend to be more concerned about risks that affect children. This fear was also expressed by Dale, a 34-year-old male surfer: "I've just become a father. So, it might be something I need to start to think about more, but it's literally a subject that doesn't even cross my mind. I'm so naive to the topic." By contrast, Ben, a 30-year-old male surfing instructor mused:

> *I don't know if it's a good idea to know more about it, because the less I know about it the less I'm worried about it. The more you think about stuff in life, the more you're like dwelling on it, so better not to think.*

Some participants already possessed a good understanding about how antibiotics and their residues enter the environment. Ben also stated: “I think if there’s whatever stuff ending up in the sea - I don’t know if it’s from like farmyards or whether. It’s from town or, whatever. There’s a harbour right there. You know that’s producing a lot of stuff. I don’t really know about the antibiotics.” Elaine, a 35-year-old female open-water swimmer talked about this issue with more confidence and conviction.

> *I know that there's a lot of stuff that’s shown that kind of wastewater in rivers downstream near particularly large, very large intensive farms, and particularly in hospitals and care facilities that they found resistant genes in them.*

Elaine was the only participant to express such detailed knowledge about the environmental dimensions of AMR. Her comments are interesting because, as explored in Chapter 1, according to scientists and policy actors, one of the best ways to tackle AMR in the environment is to improve waste treatment procedures so that they are able to deal with the 75 to 90 percent of unmetabolized antibiotics that have been excreted by animals into the soil and then washed into water systems (Hall *et al*. 2018). Water systems also contain antibiotics that have been excreted into the environment by humans, but partly due to the high cost of development, wastewater systems that are able to eradicate all traces of antibiotics currently do not exist. This problem is even more significant for hospitals since hospital patients are more likely to have residues of antibiotics in their faeces. In addition to reducing the overuse and misuse of antibiotics, improving wastewater treatment in hospitals would be one of the relatively cheapest ways of preventing the spread of AMR in the environment (ibid). When James (cited above) discussed the different levels of awareness about the environment between “kids” in different locations, he expressed a good understanding about the geographical nature of knowing and the importance of local knowledge.

I've made my life down here because I love surfing and everything but, erm, in general the kids round here are a lot more environmentally aware than some kids would be from London.

As with AMR policy documents (see chapter 1) and some of the scientists in this study, He also argued that younger people were the most important public in relation to tackling AMR.

But I'll also say that from my point of view, I think that the youth now coming up are also a lot more aware than my generation, probably. We wouldn't… Yeah, I think you know, that because it [AMR] has become like a mega thing on the news all the time now that when the old people die and the new people grow up then they'll bring that with them, so there is positivity.

Although James mentions that the media has generated awareness about AMR among surfers, it was more common for participants to talk about getting information from organisations that they trusted more, such as 'Surfers Against Sewage' (SAS) in relation to understanding environmental risk, including when it is safe to enter the sea to carry out their recreational activities. They trusted these organisations and other specialised surfing outlets to disseminate information because they felt that they were not run by outsiders with hidden or unwanted agendas. Paul, a 39-year-old male surfer, explained.

Social media would be the easy answer. But definitely 'Surfers Against Sewage'. Everything that they've campaigned for - that I'm exposed to - I see a lot. So, that's something that either of them or I don't know - whoever else that was leading it, that would then get passed on by the

media, surf media. Perhaps if one of the local surfing magazines or websites did an article about it.

As we shall see in the next section, participants also discussed the causes of AMR.

5.2.1. Participants' views on the causes of AMR

People not completing a prescribed course of antibiotics was mentioned as a cause of AMR and although a single 'bad guy' was not identified, participants echoed the findings (see Chapter 2) of Brown et (2017), when they discussed the cavalier attitude of doctors in relation to prescribing antibiotics and pharmaceutical companies having more interest in making a profit than in the promotion of public health. Sanjay, a 50-year-old Asian male surfer, asserted: "Basically, if doctors keep on prescribing antibiotics for colds and antibiotics for this and minor things where the body can itself relieve the pain and heal up itself. Doctors seem to give paracetamol every second after a while you get stronger and stronger drugs, morphine and stuff like that. Individual people then get addicted to it." When asked to elaborate, he added:

I think in doctor's defence, I think most patients go to the doctors thinking they'll be given something, and doctors sometimes think, 'hang on, this guy's not going to go.' I mean, I hate going to doctors, but I only go when I have to check my ligaments and that, but most patients (inaudible word) think, 'I'm going to doctors. He should be giving me something'. But it's not the case and that's whereas years ago he'd just write down paracetamol…And the other thing is, you can get them from your local chemist now. So, you can't blame the doctors. You can go to your local chemist and say you've got a cold and they'll give you these sorts of tablets and those sorts of tablets. So, people are getting medication, not all from a doctor.

Other participants talked about the issue of self-medication and the problems of being able to easily obtain antibiotics without a prescription in some parts of the world where the risk of contracting an infection is believed to be greater due to poor water quality. There was also a perception that the main causes and effects of AMR are distant in time and space. Or to put it another way, it was perceived as being more of a global than a local problem. Ben, (cited above) made this point succinctly: "When I talk to people about going to Bali or Sri Lanka people are like, 'ahh, the water quality over there is horrendous now'." Wayne, a 40-year-old male surfer also made the point that the causes of AMR were happening far away when he discussed his personal experience of self-medicating: "I used to buy my antibiotics in Indonesia or Asia. Just buy them, you know? Amoxicillin is good for chest infections and things like that. You can buy them over the counter there". Closer to home, Wayne had no knowledge about coastal waters in the UK being polluted with antibiotics. For Dave, a 34-year-old male surfer, the possibility of being able to obtain antibiotics without a prescription in some parts of the world was an inevitable part of globalisation and corporate greed that was not only bad for people, but also the planet.

> *It just doesn't surprise me. Everything is profit driven. These people, you know, they don't have to think like we do - they've just got their minds on money and profit and how can, you know, how can you have a market built on profit when the planet is a finite resource? It doesn't make sense. There are only a few people that are going to benefit from this*. And that's what frustrates me and, you know, erm, I'm definitely not, err, one for globalisation that's for sure. I think you work better as communities that are linked together rather than under one big umbrella.

The argument about profit is an interesting one in relation to AMR because, as explored in Chapter 1, according to scientists and policymakers, the relatively unattractive profitability of antibiotics in relation to drugs that are used to treat neurological diseases, heart disease, cancer and depression etc. has played a major

role in the decision of pharmaceutical companies to pull out of the race to discover new antibiotics. The cost of clinical trials that are necessary to demonstrate the efficacy and safety of new antibiotics before they can be brought to market is a significant factor (O'Neill, 2017). In addition, the critical comments about globalisation lend support to Gosschalk and Hatter's (1996) claim that people in the UK tend to identify more strongly with local communities than with those that are perceived as being global in scope. In other words, explain Macnaghten and Urry, "people appear to feel attached to a unit that almost certainly has little power or influence to make much impact with regards to most globally relevant environmental issues" (1998: 272).

5.2.2. Participants' views on tackling AMR

Some participants in this research felt that the issue of AMR was beyond their personal control. In contrast to more visible forms of pollution, Dave (cited above) explained that:

> *Everyone's making a conscious effort at the moment to, you know, pick up litter off the beach and stuff like that. You know, organising beach cleans. I could still do better, but I definitely feel like I'm more aware than the average person. But that's easier because that's something I feel I can stop - the litter getting on the beach - I can go pick up bits when I go surfing or when I go back, but my initial reaction to what you've said about the bacteria levels being higher, that's something I can't really do anything about.*

When discussing what could be done, he added: "My mind was thinking about that even just going back to the plastic on the beach and stuff. We now have, like, the two-minute beach clean, have stands and they've got bags. It's got all the information and it's got a bag where you can go and collect litter with." Participants also make sense of AMR in the environment by linking it to visible forms of pollution such as plastic." However, Ben's (cited above) fatalistic attitude ostensibly at least,

about the risks related to AMR and other environmental issues challenges the claim by the European Commission (2015) (See Chapter 2) that individuals are more afraid of risks that impact a large number of people: “It doesn’t matter (tackling AMR) because I feel like we’re nothing compared to the power of the earth**,** so when the time’s right again the earth would just fill up and freeze over for like a million hundred thousand million years.” Carl, a 54-year-old male surfer, was more optimistic when he talked about the need for collaboration between surfers and scientists in relation to tackling environmental issues.

> We (surfers) definitely have a positive impact. *We use the water as much as anyone. And, therefore, we are as passionate as anyone to see the seas kept as clean as possible but we’re not scientific entrepreneurs in that respect. We can’t lead the way in terms of scientific ways of cleaning up the oceans, so it needs to be a collective responsibility and a collective effort to go forward on this important matter.*

Wendy (cited above) talked about the futility of placing too much responsibility on individuals when the issue of AMR in the environment is more of a structural problem: “would think the way to tackle that is higher up the chain in terms of the environmental restrictions that are put on the use of chemicals. You know, asking swimmers just not to swallow the water or surfers to be careful is not going to do it.” Brian, a 50-year-old male surf shop owner, also talked about how the issue of AMR needs to be addressed by the government, rather than individuals.

> *My thoughts are that the system in the summer months is maxed out in terms of coping with, erm, human waste. And the sheer volume of people, erm, in seaside areas using the beaches and so on and so forth, I’m not sure. I honestly don’t know whether the systems are getting a little bit dated or not but... One would hope that the government and local government could*

continue to, erm, look to update and improve whatever sanitation measures are out there and mushing stations whatever they have, pumping stations in place. Err, but obviously it makes sense that the summer months are the most pressurised months.

Brad, a 42-year-old male surfer, talked about surfers having to take some responsibility as consumers by putting pressure on the surfing industry.

The surf industry is, you know, a billion dollar… Err, corporations are now having clothes made in Indonesia and clothes made in China where, you know, when you look at their record, it's appalling. So, surfers should be more aware of where we get our wetsuits. You know, I bought Patagonia. It's expensive, but it's made from recycled, erm, materials and that but, you are talking 400 quid, you know? Especially down in Cornwall where it's the, I think, it's the second lowest wages in Northern Europe.

Although there was not a consensus about what should be done, participants' claims about wanting to highlight and tackle pollution lend support to Eden's (2017: 101) claim that people who often visit the 'natural' environment tend to be morally worthy guardians and more likely to care about changes to it. In relation to moral designations of accountability, some participants' focus on pollution supposedly caused by tourists echoed the regional and culturing 'othering' that was present in the study (see Chapter 2) by Brown *et al.* (2017) on how lay publics make sense of AMR. Dale (cited above) who had lived in Newquay for over ten years asserted:

You know, obviously people don't understand that if they leave stuff here, you know, when we do coasteering sometimes we go into a cave… Like over that way it's called Adventure Gully and in one of the caves there's a lot of plastics that sometimes get washed up there, so we say to the kids, 'take it away'.

We'll grab it, put it in our wetsuits and then bring it back, but you get some of the kids and they're like, 'no, why do you do that?' Well, because it's the ocean, you know, you've got to take it away but because they see it as it's not their home, they see it as just a tourism place or where they all come on holiday. They don't believe they should take it out because they don't see it as their world, you know? It's almost our problem so...

Elaborating on which publics are more able and willing to tackle AMR in the environment he added:

It depends, different age groups. Because, obviously, I think the older age groups, as in the older generation or like adults let's say, I think they respect it perfectly as well as we do and think that's due to education throughout the country and it's getting better that way. I think it's just the teenagers and kind of like kids - they're still not quite there - they don't quite understand what's happening, but I guess that's just due in time. And kind of not living near the coast they don't really understand what effects it has.

Although scientists and policymakers are concerned about tackling environmental AMR because of the threat that it poses to human health (see chapter 1), contracting a serious infection from the water was something that most surfers and swimmers did not spend too much time thinking about because they felt that they would not personally be affected by the issue due to living a healthy lifestyle. Indeed, it was common for participants to draw on ideas about the health and therapeutic benefits of being close to nature. Brad (cited above) drew on the natural/unnatural dichotomy (Vinning *et al*. 2008) as well as the wider discourse about the claimed health benefits of being at the beach and in the sea.

> *I eat healthy, I live a healthy lifestyle and I rarely get sick. I don't take any pharmaceutical medicines or anything like that. I live a very natural lifestyle. I'd say that probably helped me to stay healthy. That would be my preparation as it were. I just feel because I'm outdoors and I'm doing things. That exposure to the outdoors constantly makes my body good, fighting that sort of thing, I guess.*

The claim about living a "natural, healthy lifestyle" protects one from getting sick is interesting because, as the moral philosopher Peter Singer argues in a recent interview about veganism: "Can you decide what is natural and what is not – which is very difficult - and if you have decided something is natural does that mean it is good and right, and if you have decided something is unnatural does that mean it is bad?" (2021). People do decide what is 'natural' and 'unnatural', but, as explored in chapter 2, this changes across time and space and continues to be contested (Livingstone, 2007). For example, for Brad and 2 other participants, eating healthily meant being vegan. However, Dale (cited above) argued that being a vegan was bad for his immune system: "You know, I wasn't eating enough calories, and I was on a vegan diet which doesn't contain a massive amount of calories unless you eat certain foods so that kind of played into a factor as well and, erm, there's also foods like spinach and stuff like that, that have E-coli and bacteria in them."

Furthermore, the notion that being outdoors is beneficial to one's health is a relatively recent phenomenon in human history. Before the rise of the Romantic movement and its admiration for natural beauty in the 19th Century, 'the great outdoors' were perceived as a place of danger and hard labour that one needed to escape from rather than a playground that provides numerous health benefits. As Corbin (1995: 162) explains: "Romantic creative artists were the first to propound a coherent discourse about the sea. They powerfully enriched the means of enjoying the beach, and stimulated the longing inspired by the fluctuating boundary." Another factor that changed people's perceptions of coastal

environments in the early 19th Century was emerging scientific discourse that promoted the health benefits of being outside. It was claimed that breathing the clean air and bathing in and drinking seawater combined with undertaking recreational activities during the long sunshine hours could help to cure a wide variety of illnesses including, leprosy, gonorrhoea, and cancer (Hassan, 2003). Participants also talked about the benefits of being outside in ways that echoed the views expressed by proponents of these ideas and those related to the 'hygiene hypothesis' (Scudellari, 2017) that was explored in Chapter 2 – namely, the claim that obsessive cleanliness could be responsible for the rise in conditions, including asthma, because it does not provide the immune system with enough stimulus to keep it occupied and under control. Baudrillard (1993: 85) also discusses this idea from a sociological perspective when he draws attention to a paradox – namely, although contemporary societies are becoming cleaner, our immune systems are becoming weaker despite (or, perhaps, because of) our increasing obsession with health and hygiene. The more we try to protect ourselves, the more at risk we become. This generates panic, which leads to further dependence on the "artificial sterilisation of all environments'', which further weakens our "faltering internal immunological defences." Sanjay, (cited above), agreed when he asserted:

> *Washing your hands all the time, I don't think that helps. Me and my wife have this big debate about washing your hands. But the body is... God created the body to be more advanced than a computer; it knows how to defend itself, and it knows how to tackle.*

The scientific community, by contrast, argues that reducing handwashing and other hygiene measures is likely to increase the risk of infection – particularly among vulnerable populations, including the elderly, without having any positive impact on immune disorders or allergies (Sculldellari, 2017). Most participants claimed the risks of contracting an antibiotic-resistant infection would

not stop them from continuing to enjoy surfing and open-water swimming. For example, Dale (cited above) was philosophical about this when he talked about an infection that he had acquired from the sea while surfing.

> At *first, I was considering quitting surfing instructing and quitting being in the ocean and stuff like that, but I love it too much. You can't live your life in fear so…You know, could get hit by a car.* You know you could literally walk down the street and get an infection. Cancer is everywhere right now, you know, so why stop doing something you love just for a rare disease, you know? *And for me, that's my work and I do love it and I think it's great. Like everyone who learns to surf. Everyone's in the ocean and it's amazing so it's a great thing.*

He also explained that he felt there was tension between informing people about the risks related to AMR, and the negative impact the dissemination could have upon the local economy.

> *But putting a sign up saying don't enter the water, it also plays a part in business. It's like [name redacted] said a minute ago, you don't want to upset people's business but at the same time, yeah, you do want to keep everyone healthy which is the main concern.*

Similar comments about the nature of 'risk' in contemporary societies have also been made by social scientists. For example, Bellaby (2003) discusses road traffic accidents to draw attention to the apparent discrepancy between the scale of risk, on the one hand, and the level of concern among the media and the public, on the other. He explains that despite the fact that thousands of people die or are seriously injured every year in road traffic accidents, public concern about this issue remains small. By contrast, virtual risks, such as the alleged link between autism and MMR, receive much more attention.

In this research, although participants expressed more concern about more perceptible risks, such as drowning, most took precautions to avoid contracting a serious infection from the water. These included drinking cola before and after being in the water because it is believed that this could help to destroy bacteria in the digestive system that might be harmful. To date, no scientific study has focused exclusively on the antibacterial properties of multiple brands of cola. However, one study by Medina et *al.* (2007) explored the effects of exposing various beverages to harmful bacteria, including Coca Cola, virgin olive oil, vinegar, fruit juices, coffee, beer, and red and white wine. The study argues that vinegar was the most effective beverage due to it containing high levels of acidity. The alcohol in both red and white wines also destroyed most strains of bacteria after five minutes of contact. However, the other drinks, including cola, had no effect against the bacteria. In fact, the authors conclude that the stomach is more effective at killing harmful bacteria because it has a Ph close to 1-2 which means that it is ten times more acidic than Coca Cola. As explored in chapter 2, proponents of the 'deficit model' assert that when people are provided with scientific evidence, they will change their behaviour and practices so that they are in line with the current scientific consensus. However, this research lends support to the claim that the opposite is true. For example, Lucy – a female open-water swimmer in her 30s – explained that she drank Coca Cola to avoid contracting a serious infection even though she already knew that there was no scientific data to support the claim that this would be an effective strategy to avoid getting ill. However, as we shall see in the next section, it was common for participants to rely on their senses – sight, touch smell, and to a limited extent, taste and sound rather than on scientific data, to create strategies that enable them to avoid not only pollution by pathogens, but also other dangers such as strong currents and stormy weather.

5.3. Making sense of AMR in the environment through sensory experience

In Chapter 2, I explored how we rely on our senses – sight, touch, smell, taste and hearing – to make sense of our environments and whether we, as individuals or as part of a group, perceive something to be pleasant or a threat is conditioned by our biology and culture that changes across time and space. Although a certain sense(s) may seem to be dominant within a particular context, they often work together to provide more detailed, but occasionally contradictory information about the environment which can make them unreliable in relation to risk perception (Laplantine, 2015). In this section, analysis will focus on how the senses shaped participants' perception of risk and emotions such as joy in relation to the environmental dimensions of AMR. For the purposes of clarity, each of the senses will be explored separately in turn.

5.3.1. Sight

Since the industrial revolution, sight has replaced sound as the dominant sense in Western societies (see Chapter 2) and participants' discussions about pollution were also often dominated by the visual. Indeed, whether they perceived their environments to be 'unnatural' and 'polluted' was primarily determined by what they could see, and it was common for both surfers and open-water swimmers to talk about how being in the water had made them aware of more visible forms of pollution and the environment. When asked to elaborate on how being immersed in the water had made her more aware of the environment Thelma, a 40-year-old female open-water swimmer explained that:

> *Well, you notice plastics, you notice stuff that's been chucked about, left about and you think come on you know there's animals that live in this town. I've always been an animal person and people just dump stuff. So, like swimming up the river you can see where people have dumped general waste, there's a lot we've pulled out. Several bikes I've pulled out, we collect*

rubbish as we go up through the river if we can get to it, we can pull out fishing lines and hooks that have been just left and abandoned, so things like that we notice a lot and try and do our best to kind of pull it out and highlight it.

Beth (cited above) subverts the idea of 'the gaze' (Foucault, 1977) being only a male trait (see Chapter 2) when she discusses her experiences of observing and engaging with the environment as an open-water swimmer.

I'll tell you something, it was that that made me more interested in birds. Erm, so many birds, like when you just walk by a lake. You go 'ahh, they look nice'. But when you're swimming on the lake, they're literally coming past you and giving you the hard stare. Going, 'what the hell are you doing?' (laughs), but you start to identify types of birds. My mum's a big bird watcher. So, I just go, 'mum, what's this kind of bird? What's that kind of bird? What's this kind of bird?' And she'll know it. So, I'll start to identify them and then start sort of observing their behaviours because when they think they're away from anyone watching them it's very interesting what they do in the bushes and even around a quite straightforward lake like where I go swimming in Derbyshire. So, I think that's probably like me starting to think much more about it. As I told you, you kind of know like oh, yes, this is the effect we have on the environment, but when you physically see something, the environment playing out before you, you start to think much more broadly about, well what does this do? What does this look like at this level? And then you go, 'ahh, I'm actually thinking about more practical terms.'

Beth's comments about seeing "the environment playing out before you" also emphasise the benefits of learning *in situ* – i.e., in the environment that is being studied as opposed to *ex situ* – i.e., in a classroom. She also discussed how visual

engagement with the environment provides her with opportunities to take part in 'citizen science' projects (see Chapter 2) (Rowe and Fewer, 2005).

> *I'm also observing the staff at Spring Lakes doing maintenance in line with environmental policy and trying to work with the environment in fact. Making things that are, in effect, from the Spring Lakes to help them. So, where we're swimming about, we're meant to report anything we see that goes awry. Another thing that's interesting is that we're meant to say if we get ill from being in the water. So, they* (the staff at Spring Lakes*) will know there's a change in the water. If too many people get ill, they tend to close it and then ask for testing, so they go and get a survey done on the waters. It's just there might be an invasive species, this is apparently particularly common in Autumn when there's obviously the temperature change in the water. There's usually a bloom of algae which can make people quite ill unfortunately.*

Beth's engagement with the environment exemplifies the burgeoning co-production of knowledge between elites and lay publics at a time when scientists are expressing concerns about their funding being cut (Sample, 2021). Enthusiastic environmental publics can collect useful information about environmental phenomena for little or no cost to NGOs and state or private organisations. However, as explored in Chapter 2, according to Eden (2017) it is a mistake to believe that such citizen science projects completely erode the boundaries that exist between lay and expert publics because the usually unpaid 'amateurs' are mostly out in the field collecting data rather than in the laboratories engaging with paid professional scientists. Thus, the spatial separation remains in place and reinforced and the data that has been collected *in situ* and sent in by lay publics, even those with highly specialised knowledge and skills, is checked and analysed by those with formal qualifications and training. Thus, even those with detailed knowledge about certain issues and environments may lack power in relation to the decision-making process that is

often controlled by those working for state and other powerful organisations. These questions about power, gender and the environment remain open to debate. However, Beth's and the other female participants' visual engagement with the environment, as they participate in their recreational pursuits, challenges Irigaray's claim that "investment in the look is not as privileged in women as in men" (1978: 50). In other words, for female participants, sight was also the dominant sense. Even though it was the dominant sense, Rodaway explains that sight provides a "geography of surfaces" (1994: 117) and this was evident in Derek's, a 38-year-old male open-water swimmer, views about pollution.

> *When we had the floods, I swam in the Avon on New Year's Day just before the floods and then I went down again in February after and just the grime scum, the scum on the surface you could see it a mile away and it's horrible, horrible!*

John, a 29-year-old surfer, discussed illness and visible forms of pollution in a way that lends support to the European Commission's (2015) research that we are less afraid of risks that we have lived with for a while.

> *And then, like 2 days later, I had viral meningitis. Yeah, so I personally know that day that particular beach break…They've got a raw sewage pipe there so definitely would have put raw sewage in the sea. On my paddle out, I came across, you know, the usual things like your raw sewage and sanitary towels and other bits and pieces. And when you're a surfer like in Cornwall you sort of get a little bit blasé to it. It used to be really bad - the sewage outlet just off the Top... They said don't put it there because all the sewage will wash back in and sure enough - it would wash back in, but I think they've got a filtration system there now which, erm, supposedly kills most of the bacteria which*

goes in there. But, yeah, it's not as bad as it was in the 90s. It used to be Brown all the way across.

Mason, a 30-year-old amateur triathlete also expressed this view when he compared his experiences of swimming in Lake Windermere with his experiences of swimming in the Thames.

The first time I swam in Windermere it was the best - it seemed like the cleanest open water I've ever swam in. It was like a fifteen hundred metre race, and you could see your hands in front of you, and you could see close to the bottom. It was a great experience. I've swam in the Docklands down in London that tasted quite peaty - the water was black you couldn't see your hands in that.

The above passage reveals how our experience of the environment is multi sensual; sight and taste cooperating to make sense of the environment. Interestingly it is smell and taste that are the senses that are most closely linked together (Rodaway, 1994), but most participants didn't discuss taste, perhaps because they claimed that they often consciously try to avoid getting water in their mouths for fear of swallowing it, although sometimes this was inevitable. Although sight was the dominant sense for participants when they talked about pollution, when the interviewer mentioned how clean the sea and beach looked, Ben asserted: "Yeah, yeah, yeah, but the invisible things are always the most dangerous. Like the most dangerous things are always…." Due to the limitations of sight, participants also relied upon their other senses to create strategies to prevent and tackle infections, including smell, as we shall see in the next section.

5.3.2. Smell

Although smell is a neutral term, it was only ever used in a negative way by participants who often relied upon the "geography of the nose" (Rodaway, 1994: 61) to assess whether it was safe to enter water environments. A lack of smell was an indication that the water was clean. For example, Julie, a 30-year-old female swimming coach, explained that where she swims and how long she spends in the water is dependent on how bad it smells. Rainfall tended to create more of an unpleasant odour.

> *Where I live as well - the estuary…Further up the estuary there's another village and they have these, I did see something about it in our local community magazine fairly recently, they have an overflow kind of thing I don't know what it is, but when the rain falls at a certain height, I don't think the overflow system contains all the…It produces like sewage, so it just leaks into the river. I like to do front crawl in the water, you know goggles, swimming hats and getting under the water to do front crawl. If the river's really stinky, or there's been heavy rainfall, I'll maybe minimise the amount of time I go under the water or not go under the water at all to swim. So, if it's really rough and the waves are too big for us to swim in the sea, we'll tend to go to the river, but if there's been heavy rain the river kind of, the way it, it's got sort of little inlets, so we'll tend to stick to the stiller inlet rather than get into like, you know, the main bit of the river so to speak. Yeah, so we are, we'll consciously avoid certain parts of the river and putting our heads under if we don't think the conditions of the water is too good.*

Aly, a 41-year-old open-water swimmer, also discussed the importance of smell in relation to assessing risk in a similar way.

"I would always like to have a little risk assessment so if something smells bad or looks bad, I wouldn't go in. I know the places fairly well, so I know where there might be outlets, so I never swim downstream of those. Also, the quality has gone down because, like you know, we have had lots of floods recently, so I avoided swimming in the river afterwards."

Beth (cited above) discussed how the smell of the water is related to seasons.

If the smell is really bad, like Colwick Country Park stinks at the moment, I do not go in there in the winter because it's nasty. It improves around the summer because all the ducks come and eat the bloom, and that makes it clean again.

For participants, smell mostly provided negative information about their environments. However, the other senses, including touch as will be made clear below, also generated feelings of joy.

5.3.3 Touch

Touch is the sense that literally connects us to the environment. As explained in Chapter 2, it is appropriate to use the term "haptic geographies" when analysing participants' engagement with the environment because it involves the skin that covers the whole body, not just the fingers. It is difficult to exaggerate the importance in relation to geographical experience because skin is our largest organ system that contains a large number of sensory receptors that enable us to distinguish between pleasure and pain, especially when we come into contact with something that is hot, cold, hard or soft. The geographies of touch are closely connected to the awareness of the body's ability to move through the environment (Rodaway, 1994). Derek, a male open-water swimmer (cited above), expressed this awareness when he discussed how an increasing prevalence of pollution restricted

his ability to swim because he had to focus more on avoiding coming into contact with pollution that he could see.

> *There's definitely been an increase in five years since I've noticed, which kind of hampers your journey a little bit. And yeah, the pollution and the crap sometimes you can see it, sometimes you just avoid it; but like trolleys and people throwing nappies in there and, erm, the worst (laughs) that I've seen is a used condom floating on the top.*

He also discussed how being more aware of environmental pollution had shaped his recreational practices: *"*I'm now more in tune with what's going on in the farmer's field so if it's raining - if it rains tonight, I wouldn't go in the water tomorrow. Because of all the run-off and all the chemicals and crap that goes in it." For most participants, touch was passive rather than active in the sense that it involved pressure on the skin from the environment and other people. As Rodaway (1994: 41) points out: "It is the most reciprocal of the senses, for to touch is always to be touched". Mason (cited above) emphasised this point in relation to battling it out with his competitors during triathlons and the experience being immersed in cold water.

> *So, actually, I have been injured when I've been racing because doing triathlons at Rutland water, I've had someone like scratch my ankle, you know, grab my leg in a race start. I've been punched - like an arm coming over at the start sort of thing. On race day as well, I think you get things like cold water shock. I've had a bit of that myself when I did the 'Vitruvian' or was it the 'Dam Buster'? The water was really cold, and I only had one cap on, and it hit me after with the adrenalin. You do a beach start. You know, I'm a strong swimmer but with the cold water I started to panic, and I*

thought I can't do this but then I sort of calmed down and I got into it, and I was fine.

Beth (cited above) also talked about the initial sense of panic when entering the water and how it can be difficult to assess the risk particularly when one is not used to feeling the cold water.

Now we're still in winter swimming, but we're starting to progress into spring swimming, the waters at its coldest this time of year so when you get in (laughs) so cold it can literally take your breath away. Erm, and it can make people panic. If you do not expect it. The first time you do it they always tell you to just sort of walk in first and then just come straight back out again just so you know what it's like when you go in for the second time. But it's the first two minutes - just panic, panic, panic! Oh my God, God, I'm cold, I can't really feel anything. You kind of have to push your way through that. if you really don't want to just get straight out you know, but the panic is the real problem that's because physiologically your body can handle it. It's your mind that goes (gasps) what's happening? Help! And then when you get through that, I'd say it would be about twenty, thirty minutes of swimming. You have to be able to detect what your tipping point is. For me, my hands suddenly go cold, but for some people it might be a tingling in their toes, it might be a headache. It's like that point when your body can't handle it physiologically anymore and you need to know when that trigger is.

She added that one cannot always rely on our senses to provide the brain with accurate information, and this means one sometimes has to defer to experts to avoid risk.

> *And it's very difficult to know what it is when you first start (open-water swimming), so usually when you start you ask them* (swimming instructors) *to time you for fifteen minutes, twenty minutes - whatever you think you can handle. And for them to wave at you to come in because you might not be able to detect that you need to come in. You don't always know that you need to get out (laughs). So, it can be a little bit dicey, I suppose.*

In contrast to Mason and Beth, who initially panicked from the shock of the cold water, Nichola, a 53-year-old female open-water swimmer found the feeling of cold water to be immediately therapeutic.

> *Anything in water just feels so good. So, there's the joy, you know? It's being able stretch out – while being fully supported, I have bad knees so walking can be painful but, you know, there's none of that in the water. Just being able to stretch out completely just feels very good. You sleep better after being outdoors in fresh air and exercise. You get a buzz from getting in cold water particularly, so that's a winter thing rather than a summer thing. There's that real buzz from the cold and being with people as well you know, it's very,* very rare I would swim alone.

Sanjay, (cited above) agreed: "I reckon nature itself is, for me personally, one of the greatest healers. The body...You go into cold water… The sun...Put it this way - when I go surfing, I feel no pain." For some participants being immersed in cold water provided temporal pain relief which draws attention to the relationship between time and place. Place is also important in relation to acoustic experience, as will be made clear in the next section.

5.3.4. Sound

As explained in Chapter 2, in Western societies sight replaced sound as the dominant sense when large numbers of people migrated from the countryside to work and live in cities in the 19th Century. However, over the past two decades more and more people have been in search of geographical experiences that are dominated by the sound of 'nature'. Elaborating on the distinction between 'natural' sound, such as bird song, and 'unnatural' sound such as traffic, Schaffer argues that "defining space by sound is very different from dominating space with sound" (1985: 95). This distinction was present in the interviews with the two participants who discussed sound. For Sanjay (cited above) part of the enjoyment he got from surfing was defined by the sound of nature: "*I love the sound of the sea*". However, Beth focused on the enjoyment she gained from the natural environment being dominated by the sound of other people's voices and laughter when discussing the differences between swimming in a group and swimming alone.

> *It depends on your personality as a swimmer and what times you go, actually. I was thinking about this today actually because I don't usually swim on Monday. I usually swim on the weekend. And usually there's like a massive mob of us on Saturday morning who are like, "erm, ahh I got out of bed for this." Then afterwards it's like yeah, got out of bed for this (laughs). Then you have a cup of tea or coffee afterwards and you just kind of talk about life and since you are kind of like a group of ten and you're all a bit nutty and like to consider it to be a very productive Saturday morning. There's also a group on Friday afternoon or Thursday lunchtime. A lot of them are single parents who might have that particular day off. They leave their child in the nursery or babysitter and off they go and it's like their one burst of freedom. But today (laughs) it wasn't a very popular day for swimming as I was on my own. So, on your own it's kind of like your brain's just sort of floating - just sort of like, "ooh, ahh, I wonder about that…". But there's no one to bounce that thought off like there is when you're in a group - You're sort of a bit loud and giggly*

and stuff. It's just... I don't know… But the swimming itself is pretty much the same. you're very focussed on yourself because you're having to pull yourself through the water.

The fact that sound was only discussed by 2 participants lends support to the claim that it is subordinate in relation to the other senses when engaging with environmental pollution (Rodaway, 1994).

5.4. Conclusion

This chapter has shown that most participants were familiar with the broader and the environmental dimensions of AMR. However, despite being more vulnerable to contracting serious antibiotic-resistant infections than other publics according to the emerging scientific discourse, none of the participants said that they would give up surfing and open-water swimming because they felt that the benefits of enjoying the water – alone and as part of a group - were greater than the risks that they were most concerned about, such as drowning. However, when carrying out their recreational activities in various bodies of water, their senses enabled them to reflect on environmental pollution caused by human activity as well as produce strategies that enabled them to mitigate risks from pathogens that cause illness. Although their experience of the environment was multisensual, sound, smell, taste, and touch were subordinate to sight for both male and female participants which challenges the claim that, in western societies at least, men are more invested in the gaze. Furthermore, when engaging with the environment, sensual experience was closely connected to emotional experience and, thus, participants' focus was not only on risk, but also emotions such as joy from being immersed in the water and anger about environmental pollution. As will be explored in the next chapter, this could be useful information for scientists and policymakers who want to produce AMR public awareness campaigns that consider environmental publics' pre-existing knowledge, values and beliefs that have been acquired *ex situ* and through

practically engaging with the environment as they take part in their recreational/leisure activities.

Chapter 6. Conclusion

6.1. Introduction

In Chapter 1 I explained that, according to scientific discourse, the issue of AMR is primarily caused by the overuse and the misuse of antibiotics in human health and animal agriculture and that this is something that scientists have known about for decades (Hall *et al*. 2018). I also explained that over the past decade politicians, policymakers and social scientists have also researched and expressed concerns about this issue. However, outside of the scientific community, discourse on the emerging environmental dimensions of AMR remains scarce, particularly in relation to 'One Health.' In this project, my main aim was to contribute to the 'One Health' framework by exploring the emerging environmental dimensions of AMR from a human geography perspective. I have done this by (1) by discovering how scientific experts imagine lay publics in relation to the emerging environmental dimensions of AMR; (2) how surfers and open-water swimmers make sense of the emerging environmental dimensions of AMR and (3) how public participation exercises can help scientists, policymakers and lay publics understand each other's perspectives and knowledge bases in relation to the environmental dimensions of AMR.

In this final chapter, I will evaluate how my findings contribute to debates about 'One Health' and other debates related to science and technology (6.2). My recommendations for further research will be presented in 6.3 and in 6.4 I will explore the implications and my recommendations for policy and practice. The limitations of this research project will be explored in 6.3.

6.2. Evaluating my findings

As explored in Chapter 1, tackling AMR from the perspective of 'One Health' is legitimate because it calls for different organisations and academic disciplines to collaborate at a local, national and global level to raise awareness of the connections

between the health of humans, animals and environmental pollution (WHO, 2015). My findings of how environmental publics are imagined by scientists and how they make sense of the emerging environmental dimensions of AMR (see below) can make a valuable contribution to the 'One Health' perspective by helping to improve public engagement mechanisms and identify areas for further research in relation to AMR.

6.2.1. How do scientific experts imagine lay publics in relation to the emerging environmental dimensions of AMR?

One of the main findings of my research reveals that the social science research on 'deficit model' over the past two decades (see Chapter 2) has had little impact upon scientists working on the environmental dimensions of AMR in the sense that it was common for them to imagine lay publics as being deficient in knowledge about the environmental dimensions of AMR. The transfer of scientific knowledge was perceived as the best way to remedy their lack of understanding. It was common for participants to argue that the media as much better at communicating scientific information about the environmental dimensions of AMR to lay publics than the scientists themselves who are more used to communicating with other members of the scientific community. Lay publics were also primarily viewed as being a monolithic mass with homogenous views. However, scientists who had experience of taking part in public participation mechanisms were more inclined to recognise that there are multiple publics with heterogeneous views and that the emphasis was on scientists to get out into different communities to engage with those views and build upon the trust in science and scientists that had been built during the Covid-19 pandemic. Children were imagined as the most important public to engage with because they are seen as being most able and willing to engage with scientific knowledge on AMR in the environment.

Some scientists imagined lay publics as difficult to define because even though they may not possess academic credentials, they are still able to gain detailed knowledge

of AMR in the environment from practically engaging with the issues *in situ* - particularly those who work in a farming environment - and *ex situ* via the media. This finding further problematizes the 'lay/expert' dichotomy that was explored in Chapter 2. The dichotomy of 'good' and 'bad' publics was also present in discussions about how lay publics can contribute to tackling AMR in the environment. Although some scientists imagined lay publics as lacking in knowledge about AMR in the environment, they were also characterised as 'good' publics (see chapter 2) in the sense that they can help tackle the problem of AMR in the environment by changing their behaviour and practices, particularly in relation to buying products that contain antimicrobial compounds. However, as explored in Chapters 2 and 5, placing too much emphasis on individuals as consumers shifts the focus away from the structural causes of AMR that individuals have little or no control over such as how their food is produced. Some scientists discussed creating a food labelling system that would help consumers distinguish between meat that does and does not contain antibiotics. Previous research has shown, however, that food labelling approaches have little impact in relation to changing people's behaviour and practices (see Chapter 2). Paradoxically, scientists argued that consumers are manipulated by the advertising industry and, thus, have little power to change things.

Farmers were imagined as 'bad' publics with fixed views and too much power to shape public participation events that enable lay publics to be part of the decision-making about how the environmental dimensions of AMR should be addressed. Some scientists acknowledged that lay publics should be part of the decision-making process in relation to tackling AMR in the environment, but they also expressed doubts about whether this would be possible due to their lack of scientific training. As discussed in Chapter 2, debates about increased public participation in the decision-making processes have their origins in 'deliberative democracy'. There was little awareness of public participation exercises that enable increased public participation such as town meetings, citizens' assemblies, and task forces etc (see Chapter 2). There was some enthusiasm for 'citizen science' projects that enable lay

publics to carry out activities that are time-consuming such as collecting water samples, but some scientists expressed concerns about how reliable these samples would be. Within the framework of citizen science, lay publics are imagined as fieldworkers who remain subordinate to scientists. As explored in Chapter 2, fieldworkers are often unpaid and have few opportunities to work closely with paid scientists in laboratories. Thus, the spatial boundaries that separate 'amateur' publics from paid 'professionals' remain intact. This supports Eden's (2017) claim that in relation to tackling environmental issues, once one scratches the surface, public participation mechanisms often remain near the bottom rungs of Arnstein's (1968) 'ladder of citizen participation' that was explored in Chapter 2. As will be discussed in the following sections, my research as shown that surfers and open-water swimmers are able to contribute to debates about the emerging environmental dimensions of AMR. Creating participation exercises that enable them to do so at an early stage could help to establish trust between lay publics, scientific experts and policymakers by eroding the barriers between them.

6.2.2. How do surfers and open-water swimmers make sense of the emerging environmental dimensions of AMR?

My engagement with surfers and open-water swimmers contributes to the research that has challenged the 'deficit model' in the sense that it reveals that they are not blank slates. On the contrary, they possess pre-existing knowledge, values and beliefs about health, disease (including Covid-19), globalisation and the environment that they draw upon to make sense of environmental risks, including those related to AMR. Although most participants (like the scientists themselves) did not have an expert understanding of all the pertinent issues, they were by no means completely ignorant about the environmental and wider dimensions of AMR. Indeed, some explicitly agreed with the scientific consensus that AMR refers to strains of bacteria becoming resistant to the antibiotics that are currently available due to them being overused and misused in human health and animal agriculture. There was, however, some confusion about whether bacteria or humans become resistant to antibiotics and whether antibiotics can be used to treat influenza and other viral infections.

Most participants did not realise that antibiotics should not be used to treat viruses and that doing so could contribute to AMR, for example. Tension between scientific and lay knowledges clearly emerged in relation to how AMR in the environment should be tackled. This was most apparent during discussions about the overuse and misuse of antibiotics and other antimicrobial compounds - such as hand sanitisers. It was common for participants to express arguments that resemble the hygiene hypothesis (see Chapter 2) in the sense that, in contrast to the scientific recommendations of influential organisations such as the WHO (see Chapter 1), they felt that people should be less obsessed with hygiene practices, including handwashing, and instead embrace a 'natural' outdoor lifestyle. This, they argued, protected them against serious illness. These findings are novel because, even though the main focus of AMR research has focused on antibiotics (see Chapter 1), without being prompted, participants also discussed the importance of other antimicrobial compounds such as antiseptics and disinfectants.

In relation to identifying the causes of AMR, some participants blamed individuals - primarily those who demand antibiotics and doctors for prescribing them too easily. However, in contrast to scientists in this research, there focus was more on the structural causes of AMR and how they should be tackled. This included expressing anger about pharmaceutical and water companies being more interested in maximising profits than investing in new antibiotics and more modern sewage systems that can deal with the influx of holidaymakers to Newquay during the summer months. Participants also talked about the onus being on local and national government rather than on individuals in relation to tackling AMR in the environment. They also expressed concern about how tackling the issue of AMR in ways that try to persuade surfers to change their behaviour as they engage with the environment could have a negative impact on the local economy if they become more aware of the risks of contracting a serious infection and, thus, decide to stop or limit their surfing.

However, most participants made it clear that they would continue to surf and swim because the benefits of being immersed in the water outweigh the risks. In relation

to mitigating the risks of contracting an infection from the water, it was common for participants to take precautions such as avoiding coming into contact with sewage and limiting their time in the water after heavy rainfall. They also drank cola, even though there is no scientific evidence that reveals this has any positive effects. Their main concern, however, was on protecting themselves from more perceptible risks such as drowning and hypothermia. This research is also novel because it draws attention to importance of embodied practice and sensory experience in relation to how surfers and open-water swimmers make sense of the risks related to AMR in the environment. Participants' discussions about the joy they gained from being immersed in various bodies of water and the anger they felt when they encountered environmental pollution as they carried out their swimming and surfing activities, also reveals that sensory experience is also closely connected to emotional experience which lends support to the claim that 'the public' do not easily change their views or behaviour when they are presented with 'rational' information about the environmental dimensions of AMR (Horlick-Jones *et al*. 2007). In the next section, I will explore how public participation mechanisms need to understand how lay publics make sense of the environmental dimensions of AMR in order for them to be successful when put into practice.

6.2.3. How can public participation mechanisms help scientists, policymakers and lay publics understand and respect each other's perspectives and knowledge bases in relation to the environmental dimensions of AMR?

Arnstein's 'ladder of citizen participation' that first introduced in 1969, is still relevant if one wants to try and understand the power dynamics between 'expert' and 'lay' publics in relation to environmental planning and the decision-making processes. Placing public participation mechanisms on the ladder's eight rungs enables them to be ranked according to how much they empower lay publics. Those mechanisms that are the most empowering are on the top rungs of the ladder and the least empowering on the bottom. Since Arnstein's ladder was introduced, there has been more research carried out by social scientists that supports the claim that the quality and legitimacy of decisions will be improved if there is more public

participation. Thus, in response to the creation of an autonomous science and the independence of elites who make decisions, the calls for democratisation and technology have become more vociferous both within and outside of the social sciences (see Chapter 2).

As explored above, there are now a number of different public engagement mechanisms that have been used in relation to environmental issues. Ostensibly at least, these empower lay publics to become a central part of the planning and decision-making processes. When looked at in more detail, however, to what extent they have moved up the rungs of Arnstein's ladder remains open to debate because they still tend to be underpinned by the 'deficit model' in the sense that 'the public' continues to be imagined as ill-informed and misinformed about environmental issues, including in AMR policy documents. Thus, the didactic transfer of scientific knowledge to lay publics is still imagined as the best way to correct the public's ignorance. 'Citizen science' projects such as those that scientists in this research were familiar with do provide more opportunities for lay publics to feel empowered, but they remain subordinate to scientists in relation to what data should be collected and how it should be analysed. Engaging with lay publics on AMR in the environment has (at the time of writing) been limited to imagining lay publics as objects of information rather than subjects of communication. The 'Swab and Send' citizen's science project (see Chapter 2) is a prime example. The 'Beach Bum' study (see Chapter 1) is another example of scientific research that does not enable lay publics to define or refine what the environmental dimensions of AMR actually are and how they should be tackled. In order for policy actors, scientists, and environmental publics to understand and respect each other's perspectives, public participation mechanisms need to be developed so that scientific knowledge is not automatically perceived as having epistemological authority over knowledge that has emerged from lay traditions. Recommendations for how this could be achieved will be explored in the following sections.

6.3. Recommendations for further research

Given that national, regional, and local cultures shape the way publics make sense of scientific knowledge, further research needs to be undertaken to explore how different publics in different locations make sense of the emerging environmental dimensions of AMR. In relation to engaging with environmental publics, this research project has focused on engaging with surfers and open-water swimmers because they were identified as being two of the communities who are most at risk from AMR in the environment according to scientific experts (see Chapter 1). However, the communities who encounter the most risk are those who live near the waters – most often in India and China - that have been polluted with active pharmaceutical ingredients during the process of manufacturing antibiotics. As explored in Chapter 1, these poor communities are at risk not because of what they choose to do with their leisure time, but primarily because they have little option other than to regularly bathe and wash clothes and utensils in these waters that may contain bacteria that have evolved resistance to antibiotics. As I also explained in Chapter 1, engaging with these communities about the environmental dimensions of AMR was beyond the scope of this research. However, ethnographic studies that involve, as Spradley (1979:3) puts it, "asking questions, eating strange foods, learning a new language, watching ceremonies, taking field notes, washing clothes, writing letters home, tracing out genealogies, observing play, interviewing informants, and hundreds of other things" could provide more valuable insights into how other lay publics' pre-existing knowledge, values and beliefs intersect with science. This could also help policymakers produce strategies related to tackling AMR in the environment that are less abstract and, thus, more obviously relevant to the lives of lay publics in different locations. Such research could also contribute knowledge to debates about the contextual nature of knowing. More research exploring local knowledge gained from practical experience rather than formal education and qualifications could also address the limitations of scientific knowledge on AMR in the environment that has been taken out of the laboratory and applied to the messiness of the 'real world.'

6.4. Implications and recommendations for policy and practice

Given that all knowledge contains theoretical presuppositions (as explored in Chapter 2 in relation to Cumbrian sheep farmers and AIDS activists), it is possible that the environmental dimensions of AMR could be improved if publics with local knowledge are able to participate when it comes to defining and redefining them even in ways that might challenge the scientific consensus (Jasanoff, 2005). This will help to build trust by challenging the power dynamics between scientists, policymakers and lay publics if lay publics are able to participate in the decision-making process at an early stage, not only intellectually but also emotionally (Eden, 2017). This means that they should be able to access the sites where research is being carried out and where solutions to the problems caused by AMR in the environment are being implemented. A UK citizen's assembly on how to renew and protect nature that was launched in March 2023, shows that although publics with diverse views can reach a consensus about how to tackle some of the most important environmental issues, discussing those issues *ex situ* in hotels and online can often produce a disconnect between what participants recommend how they behave. To elaborate, despite agreeing that by 2030 that the consumption of meat needs to be reduced by a quarter, many of the 100 participants continued to choose meat for their dinner in the hotel where discussions about the environment took place (Hudston, 2023).

To help challenge the power dynamics between official experts and lay publics, public participation exercises need to be designed in ways that help to break down barriers the separate them. This is particularly relevant not only in relation to data collection and analysis, but also in relation to the arrangement of seating at meetings and consensus conferences. For example, when official experts are elevated on a stage, this can be perceived as a barrier between them and lay publics who ask questions from the 'floor.' (Eden, 2017). Arranging the furniture so that participants can sit and debate ideas in a circle would feel much less hierarchical

and, thus, more successful in relation to achieving a consensus. Consensus conferences are also more likely to be successful if they include a wide range of experts and are organised by those with local experience and knowledge. For example, when the consensus conference format was exported to Japan to debate genetically modified crops, the organisers did not take into account the cultural importance of politeness which may have been one of the reasons why controversial questions were not put to the panel of assembled experts. The New Zealand consensus conference on biotechnology also revealed lay publics are less likely to challenge accredited experts who are in agreement if they do not possess the resources to challenge what they are being told (see Chapter 2).

6.5. Limitations of this research

This study has some limitations. I have already discussed how the 'lockdown' restrictions that were put in place by the UK government (see Chapter 3), prevented me from observing and interviewing open-water swimmers *in situ* as they carried out their swimming activities in rivers, lakes and coastal waters. Although I interviewed them mostly via telephone and video calls rather than in anonymous buildings, this was not a deliberate strategy for "spatial control" (Eden, 2017: 59). However, this may still have neutralised emotional engagement as participants discussed issues related to environmental dimensions of AMR in their own homes rather than in the environments under discussion. Finally, the use of an interpretative approach enabled me to produce rich data about how surfers and open-water swimmers engage with AMR in the environment. It is important to exercise caution, however, in relation to using these findings to make claims about how other publics make sense of AMR in the environment since, as explored in Chapter 2, different people in different environments can make sense of the same phenomenon in very different ways.

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