'Publics Shit'

Why is ecological sanitation not more ubiquitous in the developed world?

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Abstract

We deny that we shit. Vast water infrastructure is used to convey our excreta from the cities to "nature". Our faeces are not viewed as resources, but instead seen as "waste" and nuisances of which to be disposed. Ecological sanitation (EcoSan) fundamentally questions this idea and serves to reconnect faeces with agriculture. Two forms of research have emerged to address this paradigm: hypothetical Life Cycle Assessments (LCAs) and surveying actual user interaction with EcoSan. However, neither approach has proliferated EcoSan across the developed world. This research is interested in "why". *Why* is EcoSan not more ubiquitous in the developed world? Approaches taken are firmly entrenched in a technocratic viewpoint of infrastructure and control, whilst simultaneously denying that we shit. The contradiction that arises between attempting to disrupt sanitation from within the very paradigm being deconstructed is the focal point of this thesis. Unless we fundamentally acknowledge that our bodies are leaky, messy, and ooze from every orifice, EcoSan will always remain in the domain of the hippies.

Dedicated to Tyler and the bears and all their wahrnehmungsfähigkeit...

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Chapter 1

Introduction

We shit. But many of us in the West are disgusted at the very thought, and expend vast sums of money and energy on pretending that we don't (R. George, 2008). We build walls around our toilets and spend fortunes on products such as Poo-Pourri to hide the odour of excrement "spritz the bowl before you go, and no one else will ever know" (Poo Pourri, n.d.). Even speaking about shit is taboo, and is considered acceptable in only medical or comical settings (Persels, 2004). This is the paradigm which sociologist Inglis (2001) refers to as the bourgeois faecal habitus (BFH), in which we deny the excretory capabilities of our bodies, and have separated ourselves from them and from the world around us.

Under this paradigm, the world is divided into "urban" and "natural", a false dichotomy. There is no such thing as "nature", as something separate from humanity and cities (Castree, 2005). However, over millenia, scientific, social, and technical systems have evolved to distance us from food production, water provision, and waste collection. Ironically, these systems which put the urban in contradistinction to "nature" are entirely dependent upon natural resources, such as food, water, and minerals, which are manipulated and transformed to make the city (Marx, 1867).

Vast water infrastructure brings water from outside the cities into our homes, where it is used, amongst other things, to convey our faeces to back outside the city. This enables us to "flush and forget" (Drangert, 1998), whereby for a brief period of time our excretory capabilities are recognised, but once the toilet has finished flushing we go back to living in denial (Inglis, 2001). The flush water travels down the sewers, conveying our excreta to outside the city for treatment, where nutrients are extracted from the water

and viewed as "waste" (Gandy, 1999). This infrastructure reinforces the dominant paradigm of controlling "nature" and ourselves, for it means that we can forget we are excreting animals who are part of "nature". Believing that we exist independently of the world around us means we do not view our excreta nor our cities as a vital part of the food production system, and we therefore "waste" our nutrients.

The positioning of excreta as "waste" means that we do not view it as a vital part of food production, and as such the nutrient cycle has been "opened" (Esrey, Andersson, et al., 2001). The nutrient cycle is the idea that nutrients flow from plants into animals, and back into the soil after the animals excrete to enable the plants to grow again (Nelson, 1996). Human excreta was once part of the nutrient cycle as our manure used to be returned to the soil to complete the cycle (R. Jones, 2012), however urbanisation and industrialisation have put a wedge between us and "nature", and our nutrients are no longer returned to the soil – the cycle has been broken and is instead an open **loop** (Schertenleib et al., 2002). In place of excreta, artificial fertilisers are used to replace the nutrients taken, which take large amounts of energy to produce, and they have well-researched negative environmental effects (Langergraber & Muellegger, 2005).

The belief that we are distinct from "nature" not only means that we view excreta as "waste", but we also do not see cities as a place in which food can be produced. Food is framed as being grown in "nature", even by those who are proponents of closing the nutrient loop (Esrey, 2001). Growing food within cities has been shown to have numerous advantages, including reducing fossil fuel emissions from transportation costs, and releasing pressure from land outside cities, land which is increasingly scarce and prone to degradation from over-use of fertilisers (Mok et al., 2013).

One attempt to close the nutrient loop is Ecological Sanitation (EcoSan). EcoSan encapsulates a variety of social and technical approaches which capture the urine, faeces, or both, for reuse in agriculture. It has been championed across the developing world as a way to improve health and sanitation outcomes without using capital-heavy infrastructure and copious amounts of water (e.g. Esrey, 2001; Guzha et al., 2005; Jimenez et al., 2006; Langergraber & Muellegger, 2005; Morgan, 2004), but the value of cities as a locus for food

production is not generally recognised (Esrey, 2001). Although closing the loop is widely perceived to be beneficial, studies undertaken have surprisingly indicated that EcoSan has many negative social and environmental effects (e.g. Benetto et al., 2009; Fittschen & Niemczynowicz, 1997).

There are two main strands of research in EcoSan: the practical and the computer model-based. The practical studies have assessed user satisfaction with various types of EcoSan technologies, and have found that users are disappointed with the toilets and have ceased using them (e.g. Fittschen & Niemczynowicz, 1997). The computer models have analysed EcoSan from an environmental emissions perspective using an engineering tool called LCA, and have found that EcoSan can contribute more to global warming, water pollution, and air pollution (e.g. Benetto et al., 2009). These two different approaches to EcoSan explore the real world and the projected real world as conceived by a computer modeller. Both the imagined and real scenarios contradict the theoretical idea that EcoSan has positive social and environmental benefits (e.g. C. Werner, 2004). This thesis is interested in *why*.

1.1 Why I am interested in "why"

I am a computer scientist; brought up in a world of numbers, maths, and logic. If a decision could not be made rationally, then it should not be made at all. When I started my degree two years ago, I came with the mindset that the environmental crisis is a problem to be solved, and that there must be a technical way to do so. If only we could develop models, or a new form of toilet, or a new way of making people think differently, then something could really be done. But there is no one way of looking at the world. People have different values and notions of what is important, and it's unlikely that there are many people who share my passion for toilets and shit.

Problematising concepts leads to ideas that there are "problems" and "solutions", but only in the tidy world of maths does this make sense. The "problem" depends upon the perspective and framing. The algae who benefit from aquatic eutrophication do not see a "problem" with their existence. There is no "solution" to sanitation. There are just ideas and perspectives. This thesis is my attempt to grapple with these concepts.

1.2 On the use of the word "shit"

David Inglis notes that it is a part of our culture that it is an insult to call someone "shit", because the bourgeois faecal habitus (BFH) defines faeces as being dirty (Inglis, 2004). As such, euphemisms have been developed in order to render the subject matter appropriate in polite circumstances (Hill, 2013; Inglis, 2001). However, as pointed out by James (2011), talking about the problems with "shit" and sanitation have been made the more difficult by these euphemisms: "shit" is too offensive to be printed or spoken, and the other euphemisms such as "poop" are considered to be silly enough such that the seriousness of the topic is undermined. Additionally, the word "waste" is often used as a euphemism for faeces, but as Hawkins (2005) has shown, this means we view faeces as a "waste", when in reality it is far from being such. The decision to use the word "shit" is therefore to provoke the reader, and to ask them to question how they feel about the word and why. In order to maintain the shock factor of the word, it has been used infrequently, in places where the maximum amount of controversy can be attained.

The title of the thesis is one such place, and is taken from Hawkins who argues that, in the West, "publics don't shit" (Hawkins, 2005, p.47), only individuals do, and the act of defecation is a very private affair. However, one of the central tenets of this thesis is that publics *do* shit, and until there is a wider recognition of this fact in the West, Ecological Sanitation (EcoSan) will not present the benefits so desired by its champions.

1.3 Research Objectives

I am fundamentally intrigued with why Ecological Sanitation (EcoSan), despite its many theoretical benefits, has been unsuccessful in the developed world. Why does so much research indicate that it has negative social and environmental effects? Why do we dislike the fact that we shit so much, and why do we do everything in our power to mask the fact that we do from ourselves? There are therefore two main objectives to this thesis:

- To show how research undertaken in EcoSan is firmly embedded in the notion that our excretory capabilities must be denied, and that we are

separate from the world around us.

- To identify and critique the engineering paradigm which is used to guide the research that is undertaken in EcoSan.

EcoSan and urban agriculture shatter the illusion that our excreta is "waste" and that we are not animals. The engineering paradigm which addresses EcoSan fails to take into consideration the fact that we feel this way, and it fails to consider what it means to be human living in the bourgeois faecal habitus (BFH). The practitioners who research the trials and Life Cycle Assessments (LCAs) may recognise that shit smells and that it makes us uncomfortable, but there is a prevailing belief that if only we can find the right technology or the right solution, we can optimise away our deep discomfort. Through undertaking a deep thematic discourse analysis (Taylor & Ussher, 2001) of the research that has been done in EcoSan, this thesis will show how this is the case. To tell this story, the thesis is divided into four chapters:

1.4 Thesis Structure

Chapter 2 Literature Review: Literature review exploring the bourgeois faecal habitus (BFH), Ecological Sanitation (EcoSan), and Life Cycle Assessment (LCA).

Chapter 3 Methodology: Introduce and explain thematic discourse analysis, why it was chosen, and how it will be applied to reveal the habitus.

Chapter 4 Results and Discussion: Results of the thematic discourse analysis applied to the practical trials and LCAs, under the guidance of the BFH and revealed engineering mindset.

Chapter 5 Conclusion: Concluding remarks and suggestions for areas of future research. This thesis will show that unless researchers become aware of the BFH and how firmly it is entrenched in their mindsets, EcoSan will never proliferate.

Chapter 2

Literature Review

The BFH is a set of cultural practices which have arisen to determine when, where, and how humans are allowed to defecate (Inglis, 2001). These practices have arisen over the past several hundred years in response to moral, religious, health, cultural, and psychological concerns which have caused humanity to become increasingly repressed, particularly about shit (Elias, 2000). Large water infrastructure has been constructed in order to separate us from our excreta, but this infrastructure is having negative ramifications on society and the environment, including water pollution and extremely high energy consumption (Narain, 2002). To that end, an alternative sanitation paradigm which questions the use of vast wastewater infrastructure as the only method of handling excreta has been born. EcoSan aims to reduce the negative effects of reticulated sanitation systems on society and the environment, as well as to reuse the nutrients in urine and faeces (humanure) (Esrey, Andersson, et al., 2001). However, despite being promoted for many years, EcoSan has not proliferated throughout the developed world.

This thesis is concerned with critiquing the "engineering mindset" in which EcoSan is embedded, and to identify how that contradicts the BFH. To that end, the first section of this chapter will introduce the BFH, how it arose, what it means, and how it is relevant today. The second section of this chapter will introduce and critique one of the tools which engineers have used to research EcoSan: LCA. LCA is a predominantly *theoretical* approach which compares hypothetical situations in order to assess their environmental effects (e.g. Remy, 2010). The second section of this chapter will therefore assess LCA and its applicability to EcoSan.

2.1 The Rise of the Bourgeois Faecal Habitus

Like sex and eating, defecation sits at the uneasy margin between biological necessity and cultural practice (Al-Mohammad, 2007). According to sociologist Inglis (2001), over the past several hundred years a set of practices have arisen to separate us from our shit. Drawing on Bourdieu, he names these practices the bourgeois faecal habitus (BFH). The central premise of the BFH is that we are ashamed to be corporeal, and ashamed of the noises, mess, and diseases that our bodies can produce. We are "dirty" and "bad", and use water and centralised infrastructure to keep us as far as possible from the reminder that we do, in fact, have bodies which "leak" (Ogden, 2013). Shit has been branded as a "waste", as a nuisance, the responsibility of someone else, for the individual to flush and forget about. As society has become increasingly repressed around its excretory practices (Elias, 2000), we have deflected our struggles at controlling our bodies onto trying to control nature by dictating where water and shit are allowed to be (Karvonen, 2011).

However, these attempts to control "nature" and to control ourselves mean there are uneven power distributions (N. Smith, 2008). If we deviate from the practices dictated by the BFH, we are socially reprehended and feel shame and guilt for having broken a taboo. Those who cannot adhere to the practices feel, or are, ostracised (Chelvanayagam, 2014). For example, the developing world is a place where open defecation and waterborne diseases are common, and they are viewed with derision or pity by the developed world, and we feel we must clean them up (R. George, 2008). In the developed world, these power balances are hidden, buried underground in the sewers and pipes. However, they emerge in public toilets which are spaces in which issues of class, race, gender, and abilities are enacted (Gershenson & Penner, 2009).

The "waste" produced by the defecating public is regarded with "great distaste", which precludes the general public from seeing it as a resource (Jewitt, 2011a). For thousands of years, ancient civilisations used their humanure in agriculture (R. Jones, 2012). Up until one hundred years ago, it was common for night-soil men to collect people's excreta to sell to farmers (Dolly Jørgensen, 2008; Medina, 2007). However, since the construction of

the modern sewer system, this paradigm and way of viewing excreta has all but disappeared (Drangert, 1998). We are now in a linear mindset, whereby food is grown, eaten, and excreted, without being returned to the soil, and nutrients are returned by means of artificial fertiliser (Esrey, Gough, et al., 1998).

This chapter will set the background for the BFH. It will explain the ideas of "dirty", "corporeal denial", "cleaning with water", "health", "conventions", "sectionalism", "publics don't shit", "infrastructure", "controlling nature", and "waste".

2.1.1 We view ourselves as "dirty"

Mary Douglas ([1948] 2003) believes that the concept of "dirt" arises from the idea that the natural world has somehow been disordered. The human brain divides the world into categories which are imbued with meaning as it very quickly allows us to decide what course of action to take when faced with a new situation (Ito & Cacioppo, 2000; Macrae & Bodenhausen, 2000; E. R. Smith & DeCoster, 2000). This process happens subconsciously and is deeply connected to our emotions which means we have very visceral responses to certain situations (Kahneman, 2011; Slovic et al., 2004). We have learned to communicate these reactions and categories with each other (Bellah, 1964) by developing cosmologies, or narratives containing lessons for how to live, how the world was created, and how humanity fits in with the natural universe (Alford, 2010; Bellah, 2011). Anything which fits within the defined order of the cosmology is "right", and anything which does not is "wrong" (Inglis, 2001). From this, morality arises, and anything which is "wrong", or out of place with the natural order, is a pollutant – "dirty" – and can contaminate or endanger the tribe (Speltini & Passini, 2014).

Douglas shows that in order to prevent contact with "dirt" and "wrong", taboos were developed (Kwieciński, 2009). The word "taboo" comes from the Polynesian for "marked off" or "set aside" (R. A. Jones, 2012; Troyer, 2003). Something which is taboo is deemed sacred, which means that it is treated differently to how its intrinsic properties may suggest (D. A. Marshall, 2010). However, something being set aside is morally ambiguous, as it may be set aside for being dirty and dangerous, or for being too clean to be marred by

human contact. Therefore the tabooed entity may be too holy and pure to touch, too evil and impure to touch, or both at once (Herbert, 2002). The moral ambiguity of the taboo provides its enforcement mechanism as taboos elicit both fear and awe: people are simultaneously desirous of, and averse to, the tabooed object.

The anxiety generated by these conflicting emotions ensures people adhere to the tribe's morality (O'Doherty, 1960). People internalise the anxiety and become fearful of breaking a taboo as it may morally taint them (Steiner, 2013). They may also fear external repercussions such as divine retribution, ostracism, death, or legal action (DePalma, 2015; Fershtman et al., 2011; Steiner, 2013). The anxiety can be so intense that a person can be disgusted, ashamed, or guilty at even the thought of transgression (Highmore, 2015). These are important for maintaining the taboo, and thus the BFH.

Disgust is a powerful emotion which can prevent someone from coming into contact with faeces, which becomes framed as morally repugnant. It is thought that disgust evolved as a safety mechanism to ensure we avoid dangerous items (Knapp, 2003). However, Knapp (2003) undertook research with feral children and showed that children must be taught disgust by an adult. Interestingly, not everything that disgusts an adult will translate to a disgust response in a child, so there is a certain element of nature and nurture in its acquisition (Valerie Curtis & Biran, 2001). Much work has shown that disgust is our moral compass, whereby the more disgusted we are, the more morally wrong a transgression will be judged (e.g. A. George, 2012; Schnall et al., 2008). Faeces is viewed as "disgusting" and therefore morally wrong.

O'Hear (1976) has posited that guilt and shame are also important to our concept of morality. Shame is the fear of exposing oneself to others and guilt is the feeling of not living up to one's own expectations (Wong & Tsai, 2007). Individuals with irritable bowel syndrome, for example, often feel shame at their condition because it is a form of non-conformity to the social norms (Thompson, 2013). They may also feel guilty, as an accidental bowel discharge can be perceived by the person as morally wrong, and they incorporate those negative connotations into their being (Chelvanayagam, 2014). Thus emotional responses to taboo bind the individual to the tribe's morality and set the tribe apart (Young & Whitty, 2012).

However, group identity can be co-opted into "othering" and marginalisation. Defined shared sets of boundaries act as a method of distinction from other tribes, helping a group to maintain its identity (Davies, 1982). Those who do not align with the tribe's morality and break taboo are met with moral outrage, characterised by harsh behaviour toward the offender, and enthusiastic support for those who maintain norms (Tetlock et al., 2000). This can be used to marginalise people, as othering can create hierarchies of distinction around class, race, gender, abilities, and age (Shove, 2003a). For example, in India, the people who handle and clean other people's excreta are known as the "untouchables" and they are despised in their society, despite being essential to those who scorn (R. George, 2008). So, from the positive action of ordering the universe to find meaning, separating the "other" as dirty can arise to marginalise people. Douglas explains that concerns over group boundaries are mapped onto concerns over the body and its boundaries.

Faeces is dirt. It is matter out of place, a dirty thing which traverses the orifices of the body and destabilises the categories within society which are held as sacrosanct (Tilbury, 2006). Faeces represents disgust felt at not only the dirt of the object itself, but its representation of incivility (Derges et al., 2012). Excreta reminds us that we ourselves are dirty and that our bodies do not obey us; we are ashamed of the smells, sounds, and matter that they produce. By framing faeces as dirty, we have to accept that we ourselves are dirty, for we are the bodies who produce it. We therefore engage in a cognitive dissonance, whereby we reject the notion that we are corporeal, that we are capable of producing faeces. In so doing – in denying that we shit – we have to reject our own bodies so as not to be associated with dirt (Inglis, 2001).

2.1.2 We deny that we are corporeal

Denial of the body is important to understand, because it explains the practices we undertake when defecating. We perceive ourselves as unclean beings, and therefore disassociate from our bodies (Inglis, 2001). We cover up in shame and revile at the substances that our leaky bodies create (Weinberg & C. J. Williams, 2005). Under the BFH, the ideal human is immaterial, so we

would not have our bodies and the corresponding guilt and shame attached to them (Hinze, 2001). We believe in ourselves as pure mind, as rational beings who can overcome the limitations of our bodies. For our material bodies remind us of our mortality (Al-Mohammad, 2007).

Humans and our corporeality haven't always been viewed as such. The Greeks adored the naked (male) form and devoted much time to its perfection by exercise (Pomeroy, 1982). Pagans also saw the human form body as beautiful and depicted it in many works of art (Sorabella, 2000). However, the rise of Christianity and its influence on our cultural narratives gradually began to suppress the functions of the human body, resulting in a centuries-long progression toward asceticism, or the abstinence of bodily pleasures in pursuit of spirituality (Elias, 2000).

The rise in shame of the naked body is part of the Christian idea that humans are selfish, tainted, and dirty. When Adam and Eve ate from the Tree of Knowledge, they became immediately aware of their nakedness, felt shameful, and covered themselves with fig leaves. Nakedness has thus been framed as the cause of the Fall, and the origin of Original Sin. These ideas are embedded in Western thought. Early philosophers such as Locke wrote that man is selfish by nature (Wood, 1984), and Kant decreed that all men are "radically evil" (Formosa, 2007). Similarly, Adam Smith said that all men are selfish and work only in "regard to their own interest" (A. Smith, 2002, p.17). Economic models which dictate policy encode this view and work on the assumption that *Homo economicus* is selfish (Sen, 1977). The idea comes up further in discussions around ecosystem preservation, where indigenous people are marginalised due to the view that "nature" is always tainted by human contact (Dowie, 2011). In principle, therefore, nature was good and universal, the defect within her was man (Crook, 2008).

The rise in shame around the human body was happening contemporaneously with the rise in influence of mind-body duality, which has profoundly influenced the BFH. Mind-body duality was popularised by mathematician and philosopher René Descartes, who reasoned that the mind and body are separate entities, which paved the way for a philosophy based on rationality and reason rather than emotion, which placed the mind above body (Linsenmayer et al., 2009). This has meant that we decouple our thoughts from

our bodies, and thus deny our bodily experiences. Ogden (2013) explains this separation. Our bodies are not supposed to "leak", and when they do, it reminds us of their corporeality, that we are substance, rather than just thought.

This means that we are obsessed with our bodies and their imperfections. Ashamed and reviled that they are not the ideal as reflected in the billboards, we undergo surgery to change them, to tidy them up, to neaten them, to make them perfect. It's no coincidence that anorexia nervosa is on the rise (Holland et al., 2015). It also means that we go to any lengths to pretend that our bodies do not leak, do not smell, and do not do anything which cannot be considered perfect. When our bodies do leak, and we do have to defecate or urinate, or be reminded of our "dirt", we undertake extensive cleaning rituals in order to realign our disorderliness.

2.1.3 We use water to make ourselves "clean"

Cleaning is the process by which we separate ourselves from "dirt" and from our bodies. In today's society, to clean is to use chemicals to scrub the bacteria and dirt away. A key part of the ritual of defecation is the use of water to take the excreta away. Not only does it physically carry the dirt, but it also symbolises the purification of the space which had been desecrated. Understanding the role that water plays in respect to our bodies and notions of cleanliness is key to understanding how Ecological Sanitation (EcoSan) has been unsuccessful. Water in toilets is more than just conveyance of shit, it is deeply tied up with narratives around personal purity and what it means to be clean in today's world (V. Smith, 2007).

Cleaning to remove dirt is an innate part of what it means to be human. Grooming likely evolved as a form of communication before language was developed (Massey, 2002). Our early ancestors would groom each other in order to remove fleas. This released opiates which promoted feelings of happiness and attraction, keeping everyone happy and social bonds secure (Keverne et al., 1989; Massey, 2002). It also reinforced the hierarchy of social groups, as the person groomed was often the dominant one (Behrendt, 2011). As such, our desire for cleanliness and grooming is a precursor to civilisation and thus a core component of the BFH.

Moll et al. (2005) have shown that feeling morally dirty and physically dirty activate the same regions in the brain, which indicates that the two types of dirt are inextricably linked. When one feels dirty in either sense of the word, cleaning can help alleviate that feeling (Liljenquist et al., 2010; Sachdeva et al., 2009). This has been dubbed the "Macbeth effect" by Zhong and Liljenquist (2006), in which one literally washes away one's sins.

Religions have been undertaking cleansing rituals for thousands of years to relieve the moral dirt. Ancient Egyptian priests would bathe in the holy waters of the Nile four times a day in order to be pure enough for prayer (Sauneron & Lorton, 2000). Similarly, Judaism mandates the use of a bath called the mikveh, which is used to separate the profanity of the human body from spiritual purity, particularly for women who have finished menstruating (Jewish Virtual Library, 2008). Perhaps the most well-known example of this is baptism, in which newborn babies are ritually cleansed in water, to absolve them of the sin in which they are born (Ryan-Lopez, 2009).

However, cleaning and bathing has also historically been perceived as morally dirty. The Greeks constructed large gymnasiums for the youth to exercise to attain the perfect body, with large bathhouses to wash after a day of hard work (Dillon, 2007). At the same time, the bathhouses were derided for corrupting the youth who would waste hours bathing instead of exercising (Trümper, 2013). More famously, the Romans spent much time bathing, using the bathhouses to socialise (Sinclair, 2007). Some Romans considered bathing to be healthy, and Emperor Nero is thought to have coined the phrase *sanitas per aquas* (health through water) (I. Bradley, 2012). However, they were not considered to be the most moral of places, as one tombstone pithily noted: "wine, sex, and baths ruin our bodies, but they are the stuff of life" (p.241 Beard, 2010). Marcus Aurelius similarly disapproved, and said "what is bathing when you think of it – oil, sweat, filth, greasy water, everything revolting" (p.48 I. Bradley, 2012). There is something contaminating about the human body which profanes the water it comes into contact with. Spaces in which physically cleaning occurs are thus tainted by association.

This view of bathhouses as spaces of debauchery was one held by the Church during the middle ages. During this time, the popularity of bathing did not wane, and there were plenty of women and wine (Porter, 1999). The

Church saw this nudity and sensuality as a sure path towards sexual excess (Goody, 2012; Squatriti, 2002), and as a distraction from prayers and moral living (V. Smith, 2007). They also saw bathing as a distinctly Jewish practice, with associations of the mikveh, and were keen to disassociate from those connotations (Franklin et al., 2014; Ryan-Lopez, 2009). The relationship between bathing and immorality was clinched when an outbreak of syphilis and gonorrhoea swept across Europe, and bathhouses were seen as the locus of infection (Blom, 2012). Bathing was thus decried as sinful, and using water to clean went out of fashion.

These times of no bathing have been labelled the "sanitary dark ages" (Lofrano, J. Brown, & Feo, 2012). There has been a debate, however, over what the definition of "clean" meant to the non-bathing people of the medieval age. According to Archibald (2014), there has been a lot of misconception at those times which we now view with derision. As long ago as 1928, historians were disputing the notion of the great unwashed, and Thorndike (1928) argued that they took great pride in their appearance and their bodies. They would change their linen regularly in order to keep the vermin and mud off themselves (V. Smith, 2007), and scrub their bodies vigorously with a towel (M. Bradley, 2012). So whilst there may have been a lapse in sanitation by modern standards, and the era was characterised by "filthy rivers" and plagues (Lofrano, J. Brown, & Feo, 2012), it seems that hygienic dirt has been conflated with moral dirt. That is, modern germ theory was unknown, but people still took care to clean themselves, enacting on the innate desires evolved over millions of years.

Cleaning with water only came back into fashion in the mid-nineteenth century, ushering in the modern definition of "clean". Piped hot water and the development of soap made it a private enterprise, and a growth in economic prosperity with the advent of the industrial revolution saw bathing become more luxurious (Twigg, 1997). A rise in the use of water-closets also came with this. For the first time in modern history, one could defecate in completely privacy and not have to be concerned with the handling of their excreta (Quitzau, 2007). As the availability of water grew, so too did changing conventions of cleanliness (Shove, 2003a). The use of water increased greatly, and it is now a societal mandate to use water to be clean, and to

flush away the dirt of excreta.

However, the other side of clean water to purify is when the water has been tainted and becomes "dirty" and needs somewhere to go (Tarr, 1996). After showering and defecating, the water has been marred and is now no longer something which can clean, but has become "dirty" and "bad" (Kaika, 2004). Modern bathrooms therefore raise questions about what it means to be dirty and clean (P. Cooper & Oldenziel, 1999). They are the site at which water goes from being "good" to being "bad". "Bad" water has the capacity to cause disease and sickness (R. George, 2008).

2.1.4 We are preoccupied with health

One of the major concerns which has led to the labelling of faeces as "dirty" is its capacity to cause disease. Fears and social anxieties around faeces have connotations with boundary transgression, but they are also embedded in modern understandings of pathology. Historically, diseases were thought to be spread by miasmas, or bad smells. As science improved in the late nineteenth century, the modern interpretation of disease arose and changed the way faeces and water were viewed. Faeces have been reclassified as dirty for both moral and hygienic reasons, and the view of them as disease-ridden and dirty is key to the habitus.

The earliest theories of health were popularised by an ancient Greek called Galen. He stipulated that the body has four humours, representing the four elements, which must be correctly balanced for good health (PAEI, 2008). Galen recommended that balance be achieved through bathing in hot springs, one of the first known associations of health with water (I. Bradley, 2012). His ideas were lost after the collapse of the Roman empire, until they were reintroduced from the Islamic world in the eleventh century, and once again became very popular (PAEI, 2008). However, the interpretation of humour theory changed. It was believed that opening the pores of the body through bathing would expunge the bad humours (Cartwright, 2010), but it would also allow pestilence and disease into the body (Cavallo & Storey, 2013). The Church was keen to capitalise upon this idea, given its view of bathing as licentious (Ryan-Lopez, 2009). Thus, the belief started spreading that bathing was bad for the health, and its popularity diminished (Simons, 2011).

With the advent of medicine, however, this started to change, and medicine was heavily influenced by Cartesian duality. The idea that mind and body are separate entities was revolutionary at the time. Despite the many philosophical criticisms of dualism (e.g. Mohammed, 2012; Ryle, 1992), it paved the way for a new kind of thinking. Previously, the Church had decreed that body and soul are one entity and that disease was caused by a bad mind, or wrongdoing (N. Mehta, 2011). However, duality decoupled the mind from the body and enabled material explanations of disease to be posited and anatomy to take place for the first time (N. Mehta, 2011). Thus mind-body duality has thus serviced two aspects of the BFH: that of corporeal denial, and that of influencing the development of medicinal treatment of disease.

The definition of "clean" once again changed as hygienic theories of dirt became science-based, and the understanding of pathology improved. Rapid urbanisation was happening across Europe, and the problem of human excrement was literally mounting. In the UK, streets and gutters were used for solid-waste disposal of horse manure, animal entrails, and latrine contents, which caused river blockages and impassable streets (Jørgensen, 2008). Cesspools under people's houses would frequently overflow into neighbouring properties, causing people to live in their neighbour's excrement (P. F. Cooper, 2001). Entire families would asphyxiate from the hydrogen sulphide emanating from these cesspools (P. F. Cooper, 2001). To solve the problem, prohibitions were issued to make dumping into streets illegal and householders and shop owners were required to clean in front of their own homes (Jørgensen, 2008). Similar ordinances were decreed in France whereby property owners were ordained to pay for the cleaning of the sewers of their building, although that exacerbated the sewage as the owners thought themselves entitled to dump refuse into the sewers since they were paying for it (Burian & F. G. Edwards, 2002). Most of these ordinances, however, were impotent (Laporte, [1968] 2002).

In the midst of all of this, an outbreak of cholera swept across Europe (Snow, 2002), which meant that competing theories of pathogens were debated. The most prevalent theory was that of "miasma", which hypothesised that bad smells are responsible for disease (P. F. Cooper, 2001). However,

this theory was disproved by John Snow who observed that drinking contaminated water was the cause the of disease (Tulodziecki, 2011). This paved the way for modern pathology, which has painted faeces as "dirty" and "disease-ridden", particularly when it comes into contact with water (V Curtis, 2003).

By this time then, dirt and faeces signified disease. Cleanliness was a sign of control, social status, and breeding, whilst the unclean were vulgar and elicited scorn (R. L. Bushman & C. L. Bushman, 1988). Dirt was thus a class distinction. However, the Great Stink which started in London in 1858, and lasted for two years, changed that (Lens, 2001). The River Thames, filled with the faeces of the population, stank so badly that sessions in Parliament were only just made bearable by hanging sheets of chlorine from every window (Melosi, 2008). It became a public duty to clean up the streets of London and to sanitise the disease-ridden streets (Harvey, 1997). New standards of cleanliness and hygiene were imposed upon the poor by the bourgeoisie. Dirt was associated with danger and disease, which threatened the rich, who could not be isolated from the ramifications of disease (Inglis, 2001).

2.1.5 The BFH defines "normal" conventions

As charted by Elias (2000), for hundreds of years, society has been subject to ever more stringent rules and regulations concerning what it means to be "civilised". This "civilising process" has seen every aspect of society become regulated, from table manners to faecal manners. The rules started out amongst the bourgeoisie, who increasingly subjected themselves to self-repression. One theory proposed by Inglis and Holmes (2000) is that this happened because urbanisation and an increased population density redefined the previously feudal society into a mercantile one. People had to learn to navigate entirely new spaces and so defined rules in order to help them do so. Over time these rules became more stringent and elaborate, making toilet conventions increasingly so as well. The elite therefore increasingly imposed social prohibitions and manners upon themselves, and they internalised the repression. The self was thus partitioned into "the judged" and the "non-judged", which was marked by pervasive feelings of guilt and shame (Moglen, 2008).

"Manners" and "dirt" thus distinguished the bourgeoisie from the poor. Up until the nineteenth century, dirt was a symbol of one's status, but as the rich became threatened by the dirt and lack of hygiene, they took it upon themselves to clean up the masses (Inglis & Holmes, 2000). With these changes, they defined conventions around how, when, why, and where one is permitted to defecate (Inglis, 2001).

Open defecation was standard practice until the nineteenth century (Elias, 2000). Manners books of the sixteenth century attempted to subject this practice to scorn, but to no avail. In 1530, polite people were instructed that "it is impolite to greet someone who is urinating or defecating" (ibid. p.130). Two hundred years later, the practice was still evidently common enough such that in 1731 people were still being advised "if you pass a person who is relieving himself you should act as if you had not seen him, and so it is impolite to greet him" (ibid. p.133). However, as faeces became viewed increasingly as "dirty" hygienically and morally, and the upper class became less tolerant of smells than they had previously been, defecation was increasingly relegated to the private sphere (Inglis & Holmes, 2000). Today it would be unthinkable to openly defecate, and those who are forced to endure the experience are filled with shame and disgust (Al-Mohammad, 2007). The practice has even been legislated, and in many developed countries, it is illegal to urinate or defecate in public.

At the same time as open defecation was becoming obsolete, a group of rebellious young men called the Dandies were pushing the boundaries of societal taboo (Lane, 1994). With it they ushered in new standards of cleanliness, personal hygiene, and definitions of "civilised". The leader of the Dandies, Beau Brummell, would spend hours a day bathing and dressing, wearing tailor-made suits that eschewed the gaudy styles of his contemporaries for simple, gorgeous clothes that enraptured the young Prince Regent, and spread across the nobility (Kelly, 2006). He did this to separate himself "from the ordinary herd of men" (Pappas, 2008), so continuing the theme of separation and othering. His clothes and body were always meticulous and he prided himself on being too clean to require perfume (Lambert, 1988). The Dandies used their style and wit to climb the social ladder as the aristocratic class declined (Nicolay, 2002). Bathing thus made a resurgence, and

the use of water for cleaning started to come back into fashion.

This was synonymous with the rise of the water closet. As water became associated with cleanliness, the popularity of the privy increased (Stone, 1979). The history of the water closet is documented in *Clean* by V. Smith. By the mid-nineteenth century, large indoor baths oozing luxuriance became common, and porcelain became a standard feature in bathrooms, with indoor plumbers devising ingenious methods to pump hot water upstairs. Indoor toilets were frequently discussed in the press as sanitation became a household name, and the sale of water closets soared. City infrastructure developed to keep up with the demand, and by the end of the first world war, nearly every home in England had an indoor toilet (Muthesius, 1984).

With the rise in the toilet, then, came increases in standards of comfort and cleanliness (Shove, 2003a). There is now a level of expectation that everyone have a running-water toilet. It is expected to be clean and comfortable. Most users now expect to go to the toilet and have minimal responsibility (Hill, 2013). We expect that defecation is whisked away in water, and we "flush and forget" (Drangert, 1998). The invisibility of the plumbing means that we can ignore the "invisible Venice of shit" which is continually flowing beneath our feet (Pickering, 2010). With an increased rise in convenience, comfort, and cleanliness, we have also formed habits around how to use the toilets.

There are many conventions now that are largely taken for granted. In perhaps the one space where women have dominance when it comes to toileting, the toilet seat must remain down (Choi, 2011). Unless, that is, one knows that each flush emits so much faecal matter and urine that it's best to always close the lid (R. George, 2008). Flushing practices are usually such that each time one uses the toilet, it is flushed; however in times of drought, or if someone dislikes excessive water consumption, they make stick with the refrain "if it's yellow, let it mellow, if it's brown flush it down", a phrase that was invented in New York in the 1970s during a drought (Teh, 2015). The difference between urine and faeces as emphasised by this phrase is not, however, evident in the way we generally treat both faeces and urine as one waste stream. It has been proposed by Drangert (1998) that we have a "urine blindness", in which we consider the two resources to be the same,

and therefore treat them as such. Hiding the toilets is another common convention. Bathrooms are decorated to disguise the toilet in the middle, and fans are used to extract the smells (Pickering, 2010). Smells are also covered by perfume and other odour-controlling products (Pickering, 2010). Finally, there is the convention that one must defecate behind closed doors (Inglis, 2001).

Thus, conventions around excretion arose. The more the bourgeoisie viewed excreta as dirty, the more it regulated practices around excretion (Inglis, 2001). Those practices and conventions have now become normalised and codified into the fabric of society. They are held in place by taboo and its associated emotions of shame, guilt, and disgust. However, the codes have also served to change the fabric of power, and to cause divisions and frictions in society.

2.1.6 Toilets are a space of sectionalism

Toilets, in particular public toilets, are places where inequalities are enacted (Gershenson & Penner, 2009). They are one of the last few openly segregated spaces in the developed world (Gershenson & Penner, 2009). The most obvious manifestation of this is sex segregation, whereby men go into one place, and women to the other, which not only changes the framing of public spaces as gendered, but is also trans-exclusionary (Cavanagh, 2010). Toilets also separate the able-bodied from the disabled, with poorly designed toilets severely restricting the freedom of those who are wheelchair-bound, or the elderly (Kitchin & R. Law, 2001). Access to a toilet is also reflective of one's socioeconomic status. Homeless people do not have access, forcing them to violate social conventions and relieve themselves in forbidden spaces (Kawash, 1998). So, even though Miller (1998) sees the anus as "a democratiser", the spaces in which we undertake excretion are not democratic.

Sex segregation in toilets is a relatively recent phenomenon and has resulted in fewer available facilities for women. The first sex-segregated toilets appeared in a restaurant in Paris in 1739 (Wright, 2005). One hundred years later they were mandated by legislation (More, 2007–2008). Women need cubicles for when they are menstruating (Anthony & Dufresne, 2007). They also tend to crouch over the toilet seat (Moore et al., 1991), or cover the

seats with paper, so as to not come into contact with other people's excretions (Banks, 1990–1991). Women are also usually responsible for child-care and so need space in which to change nappies that is also sufficient for a pram (Kitchin & R. Law, 2001). Given this, there have been calls for public toilets to be designed such that women can urinate comfortably without sitting down (Brooker & Weinthal, 2013). However, men have traditionally been in charge of providing public toilets, and have neglected the needs of women as a consequence (Anthony & Dufresne, 2007; Cavanagh, 2010). Men are also provided with urinals which means that there are more spaces for them to excrete, although their needs are usually less (Case, 2010). As a result, women frequently have to queue in order to use the toilet in public (J. Edwards & McKie, 1996). Public toilets thus facilitate disparities between the sexes, where the needs of women are neglected.

In part this could be due to cultural narratives around the female body, for "women don't shit" (Munt, 1998). Effluents from the female body have long been met with fear (Weinberg & C. J. Williams, 2005). A woman who transgresses the confines of her body is immodest and therefore less of a lady. In popular culture, we never hear much about women and their desires: their faecal odour kills the male desire, but never the other way around (Miller, 1998). The passivity of women and their excretions is further reflected, according to Beauvoir et al. (2011), in the fact that women are taught to crouch, and men are taught to stand when relieving themselves. Until recently, demands for equal treatment were met with dismissive, trivialising comments such as "potty parity" (Shah & Kesan, 2007).

Public toilets are also badly designed for disabled people. As explained by Greed (1996), the criteria for being disabled are not, strictly speaking, physical impairments. In addition to people in wheelchairs, they extend the definition to include the elderly, pregnant, those with heart problems, bowel dysfunction, those with prams, or any other type of person who could not easily use a public facility. They also explain that people with incontinence may need the quickest access to disabled toilets, yet they are unable to get a key, because incontinence is not recognised as a disability. For disabled people, the design of public space and toilets may be the difference between leaving and not leaving the house that day (Kitchin & R. Law, 2001). This

ableism is largely invisible (Kitchin & R. Law, 2001), much like other social injustices enacted in the public space.

Class discrimination is another example of a social injustice reinforced by toilets. Public toilets have become spaces in which illicit activities which the dominant class do not approve of take place (P. Cooper & Oldenziel, 1999). They are often considered to be dirty, containing physical dirt as well as moral dirt (Barcan, 2013). Before the legalisation of homosexuality, it was common for upper-class homosexuals to "rough it" with the lower classes, which was a chance for the blue-collars to earn some money (Allan & Burridge, 2006). Social differences are also enacted by the fact that the number of public toilets have diminished over the past few decades, and that means that homeless people have less and less access to the vital facilities (Anthony & Dufresne, 2007).

In addition to class discrepancies in public toilets, sanitation itself is a class issue. The developing world has very little access to centralised water infrastructure, and open defecation and waterborne diseases are rife (R. George, 2008). This is reminiscent of the social reforms undertaken in the nineteenth century, whereby the bourgeoisie made a concerted effort to clean up the poor, and imposed the bourgeois faecal habitus (BFH) under which we live today (Inglis, 2001).

The developed world is predominantly white, and the developing world is predominantly not. This racial segregation used to be seen a lot more in the developed world, as public toilets were segregated by colour (Case, 2010). However, now the segregation is less blatant, and plays out in employment: cleaners are inevitably poor, non-white, and women (Hinze, 2001). These jobs tend to be viewed as the "dirty" jobs (Brody, 2012), and so this inculcates a view of the people who clean as "dirty". The view of immigrants and non-white people as "dirty" is nothing new. At the turn of twentieth century, middle-class Americans blamed immigrants for the spread of disease because of their perceived dirtiness, a long-standing tradition which coupled Africans with sexual deviance and dirt (P. Cooper & Oldenziel, 1999).

Thus there is a complex relationship between different types of discrimination and segregation played out in the space of public toilets and sanitation. Gender, ability, class, and race are key elements which are reinforced by the

existing toilet and sanitation system in the developed world. The infrastructure which maintains these divides also maintains the difference between us and "nature".

2.1.7 Infrastructure separates us from "nature"

Vast water infrastructure has been constructed to bring water into the cities which enables us to "flush and forget" (Drangert, 1998). Excreta is conveyed through a complex network of underground pipes which render faeces invisible and enable us to pretend that we shit (Gandy, 1999). This infrastructure not only renders faeces invisible, but it also positions the domain of excreta as outside the city, away from our homes and where people live (Kaika, 2005). It reinforces the dominant paradigm of controlling "nature" and of controlling ourselves. The use of infrastructure to separate us from "nature" has existed for thousands of years.

Approximately ten thousand years ago, humans started to tame crops and animals, sparking the first agricultural revolution (Pääbo, 1999). Previously nomadic, agriculture and the storing of surplus food provided the opportunity for permanent settlements (Lev-Yadun et al., 2000). They began to cultivate plants, domesticate livestock, produce ceramics, and use timber; this transformation marked the start of the Neolithic period (Tegel et al., 2012). For the first time people began to fundamentally transform the environment into a cultural landscape (Tegel et al., 2012). This process presented two problems: how to ensure an adequate water supply, and how and where to dispose of waste (Angelakis & Rose, 2014).

Ancient water and waste technology gradually evolved over thousands of years as populations and cities grew. Early water and waste technology consisted of primarily hot springs (Erfurt-Cooper & M. Cooper, 2009), wells (Peltenburg et al., 2000; Tegel et al., 2012), and middens (Guttmann, 2005; Waltner-Toews, 2013). Next came dams and irrigation systems for agriculture and water supply (Angelakis & Zheng, 2015) Finally, elaborate drainage systems evolved (Gohary, 2014; Jansen, 1989; Orkneyjar, n.d.). As trade routes opened up between the Indus valley and other civilisations such as the Greeks, technology transfer took place and the advanced water and wastewater technologies spread (Angelakis & Zheng, 2015).

Greece was a dry country, and water was scarce, so vast water infrastructure was needed to feed the bathhouses (Angelakis, 2005; Angelakis & Rose, 2014). They built elaborate rainwater harvesting systems, underground terracotta pipes, and aqueducts (Angelakis, 2005). As they improved their knowledge of physics and hydrology, they pressurised parts of the aqueducts and rainwater systems to pump water uphill (Koutsoyiannis et al., 2008). They also built underground sewer pipes to take wastewater from the gymnasiums and people's houses to outside the city (Angelakis, Koutsoyiannis, et al., 2005). Sewer pipes were considered a vital public service and were built by war captives (Angelakis, Koutsoyiannis, et al., 2005).

The Romans inherited some of the Greek technology, but they further developed it to such an extent that it became the defining status symbol of the empire (V. Smith, 2007). Every city had a public water supply and public baths (Archibald, 2014). They were open to everyone for a moderate entry charge, and maintaining them was considered a public duty (Archibald, 2014). Massive aqueducts supplied between 200 and 500 L of water to each citizen daily, primarily used for bathing (De Feo et al., 2014). The water from the bath-houses was recycled to use to flush latrines before being discharged into waterways and sewers (Lofrano & J. Brown, 2010). A key part of the vast water infrastructure was the Cloaca Maxima which started life as an open-air freshwater canal and eventually evolved into the largest sewer ever built at that time (Hopkins, 2007). The Cloaca Maxima was built by slaves, which has led historians (e.g. Höglund et al., 2001) to infer that the perception of humanure was one of disgust, as a free-man would not deign to be involved.

After the collapse of the Roman empire, European water infrastructure gradually fell into disrepair, and this has been linked to a general decline in the quality of cleanliness (De Feo et al., 2014). Whilst some cities did maintain the infrastructure, populations started to move out of cities to be near waterways and drinking water (De Feo et al., 2014). Sanitation and excretion removal became a private affair, and excreta was usually discharged into waterways or collected and used in back gardens whilst other rubbish was stockpiled and fed to pigs (Burian & F. G. Edwards, 2002; De Feo et al., 2014). However, as populations grew and urbanisation spread, new methods of water and wastewater handling were required as disease spread.

The "bourgeois reform movement" undertook a massive effort to clean up cities, as, according to Harvey, they had an idealistic vision of a modern city which would pacify alienated sections. Edwin Chadwick, an English social reformer, started to investigate how improved sanitation could eliminate disease (Ciecieznski, 2013). In his report of 1842, he recommended supplying water to every house, using water-closets, discharging to sewers not cesspits, and conveying sewage outside of town for reuse in agriculture (P. F. Cooper, 2001). He strongly believed in centralised governance, paid inspectors, and high quality public infrastructure (Melosi, 2008). However, his reforms did not go through because of the Great Stink of 1858, in which the River Thames smelled so bad that Parliament had to close session. It was a combination of the water closets being conveyed directly into the Thames and the summer heat which caused the smell (P. F. Cooper, 2001). Once the politicians became disturbed by the sanitation problems of the poor, they went into action. The person put in charge of the sewers, Joseph Bazalgette, opposed Chadwick's humanure reuse plan (P. F. Cooper, 2001), and so 83 miles of sewers were laid, carrying raw sewage directly into the Thames, downstream of London (Halliday, 2001; Melosi, 2008). Like the development of the Cloaca Maxima, London's sewage systems were an emergency, built in response to a perceived crisis (Bracken et al., 2007). Wastewater management still behaves as such today (Mueller, 2009).

According to Dunn (2007), extending the sewers was about maintenance of power and control. The modern State promises to remove the filth from the city and to ensure the cleanliness of the urban environment. As Harvey (1997) explains, this movement was about making the city a cleaner place in which to live. However, it was also about status and dominance. Bazalgette used the Cloaca Maxima as a prototype for the sewers of London (Zimring & Editor, 2012), indicating the reverence of the Roman empire and the desire for control and glory. This was mirrored by actions undertaken two centuries before to restore some of the Roman aqueducts to supply the growing city with water (Carlisle & American, 2005). Thus, the taming of the "good" water arose simultaneously to the taming of the "bad" water to control the outside world and bend it to our will (Kaika, 2004).

2.1.8 Controlling "nature"

Defecation symbolises not only physical determinism and boundedness but the fate as well of all that is physical: death and decay (Becker, 2007). Faeces remind us that we die. But we want to make ourselves immortal and to be heroic (Al-Mohammad, 2007). We do that by setting ourselves apart from that which dies, and from that which reminds us that we're dirty. So, not only do we clean, but we physically and mentally remove ourselves from "nature".

One of the driving forces behind the control of "nature" was Christianity. Early scientists believed that we could return to Eden by learning about God's creation and how to manipulate it (Grant, 2001; Grant & Crosby, 1997; Hannam, 2011). Francis Bacon believed that gradual accumulation of scientific knowledge over long periods of time would grant us the ability to recreate Eden (Harrison, 2007). This could be achieved by understanding how God acted in creating the universe, and how still acts in maintaining it (Davis, 1991). Bacon's beliefs gave rise to natural theology, which says that God speaks to us through nature, and therefore nature is how to understand God (White, 1967). That evolved into trying to discover how God's mind itself works, through understanding how creation works (White, 1967). The Rationalists extended this and believed that since God is rational, the world must embody orderliness and reason, so we can use logic, rationality, and reason to understand the world (Cobern, 2000; Davis, 1991; Markie, 2015).

Over time, this transmuted into viewing "nature" as something to control and to dominate, which was justified through the Bible. Adam was instructed to name the wild beasts (Genesis 2:19) and assert his dominance over nature by exercising his God-given rights (Matthews, 2013). Bacon believed that this dominance Adam had was lost in man's Fall from the Garden of Eden, but could be regained through science and technology (Robertson, 2013). Descartes thought this dominance would bring about human happiness (Schouls, 1987). He declared that people are "masters and possessors of nature", and that animals are machines lacking minds and are there to be experimented upon (Nash, 1989). Hobbes believed that creating political systems would allow us to transcend and conquer nature to gain this dominance (Wolf, 2005). These thinkers have heavily influenced Western

thought and political systems. They were driven by deeply religious beliefs, but industrialisation marks the point at which scientific inquiry mutated from understanding God into technological improvement to raise the standard of living of society (Hinds, 2003).

Manufacturing and mass consumerism emerged, with large populations moving from the country into the city in order to work at the mills (Wachsmuth, 2012). A wedge was thus driven between the countryside, or "nature", and the city, or people. The countryside, and the space outside the city, has become the recourse of farmers, non-humans, and what we perceive as "nature", whereas the city is civilisation and for humans (Kaika & Swyngedouw, 2000; Wachsmuth, 2012). However, the presence of non-humans in city spaces (Latour, 1993) and the effects the city has on the countryside (Rees, 1992) break down the dichotomy and reveal a contradiction in the habitus.

The definition of "nature" is contradictory. The OED defines "nature" as:

> The phenomena of the physical world collectively, including plants, animals, the landscape, and other features and products of the earth, as opposed to humans or human creations

However, the "physical world" includes, affects, and is affected by, humans. Every square inch of the planet has traces of CFCs, carbon dioxide, and other chemicals humans have released (McKibben, 1989). Thus, when a plant grows, it does so in a way that is directly impacted by humanity. Humans have seemingly dirtied "nature", which is seen as clean and pure, and now ruined by man. However, "nature" is also depicted as dirty and wild, as something to be tamed (Cronon, 1996).

The "dirt" of "nature", and the "dirt" of the city are two different entities. "Nature" is the correct location for manure, mud, and non-human entities, but they are "dirty" boundary-transgressors which must remain apart from humans (Campkin & Cox, 2012). When "nature" crosses the threshold into the city, it is met with a relentless drive to remove it. For example, stormwater infrastructure is designed to channel the water from the streets into the nearest waterway or sewer as swiftly as possible (Karvonen, 2011), and weeds are met with chemical resistance as they eke through the cracks in the pavement (Robbins & Sharp, 2003). Simultaneously, the products of city life

are viewed as dirty, particularly when they cross the threshold and enter "nature". Air pollution, smog, and discarded food packets, all shatter the image of "nature" as external from humanity (Watt, 2012). These different definitions of dirt depending upon the context reveal how the habitus posits the city and nature as distinct, each with its own order that is threatened by the presence of the other.

There are circumstances in which entities are allowed to cross the city / nature threshold, albeit in highly controlled circumstances. Global commodity chains manufacture, transport, and sell items across the globe, mediating the city-dweller's interaction with "nature". Commodities are "human creations", but they are not strictly "human" as they are the product of biophysical reactions which convert "nature", through labour, into something of value (Marx, 1867). They are therefore hybrid objects which are neither "natural", nor "unnatural", but embody both society and "nature" (Zimmerer & Bassett, 2012). Even something as "natural" as food and water are hybrids. Food is grown and processed to remove the soil (dirt), and to ensure that no blemished items reach the supermarket shelves, and that all signs of its origins are destroyed (Holloway et al., 2012). Similarly, water is bottled or piped into the city via extraction and treatment processes, hiding its initial origins (Kaika, 2005). The "natural" origins of food and water are used as marketing devices, whereby "nature" is presented as an abstract ideal. Words such as "organic" and "pure", with images depicting fields and mountains which bear no resemblance to where the products came from, are used to appeal to the severed connection that we have with "nature" (Bryant & Goodman, 2004; Ferrier, 2001).

Once purchased by the consumer, the food and drink cross another threshold, that of the external/internal divide between the body and the world. "Nature" is brought into the "non-natural" human, a crossing that is fraught with anxiety due to the lack of connection to its origins, and thus its safety (Fischler, 1988). Thus, food is a boundary transgressor in the same way that shit is, and its presence in a city is subject to similar societal rules. This is perhaps one reason why urban agriculture is so little discussed in the EcoSan literature.

By growing food in the city, urban agriculture tears down the divide

between cities and "nature". It questions the idea of the countryside as the "right" place for food, and presents an opportunity for "nature" to come into the city (Mok et al., 2013). However, the image of food as "out there" is so prevalent that the idea of urban agriculture is rarely discussed (Dana Cordell et al., 2009) and has not yet received much critical academic attention (D. Cordell et al., 2011).

Urban agriculture would have several advantages. Research by Kulak et al. (2013) has shown that transporting food from fields to cities may contribute as much as 30% to the total greenhouse gas emissions in Europe (Kulak et al., 2013). Furthermore, as the world population increases, much land is required to grow all of this food, and there are concerns about land-use and land-grabbing (Borras et al., 2011). Growing food in community or rooftop gardens (Mok et al., 2013), or in dedicated skyscrapers (Specht et al., 2013) could release the pressure on land outside the cities and reduce greenhouse gas emissions.

However, due to the lack of research there may be negative effects. One possible disadvantage is food contamination. There are many sources of pollution in cities including heavy metals (e.g. Davydova, 2005) and particulates (e.g. Samet et al., 2000). These are generally caused by emissions from cars, and it has been shown that high-traffic cities can contaminate vegetables grown in them (e.g. Säumel et al., 2012). However, there are precautions that can be taken by the urban horticulturist, as outlined by Finster et al. (2004), including testing the soil the plants are being grown in, and using mulch to trap aerial pollution.

In addition to determining the effects of urban agriculture, there are various institutional barriers which would need to be addressed. Esrey (2001) has outlined some barriers, which include philosophical, political, ecological, and technical concerns. Furthermore, legislation, consumer awareness, supply chains, entrepreneurship, and open dialogue with academics will be required, with new tools for facilitating those conversations. It is clear that urban agriculture will fundamentally question the division between "nature" and cities and the idea that food is produced away from humans.

2.1.9 Summary of BFH: Publics shit

There is an artificial divide between humans and "nature", and between our bodies and our shit. To maintain this divide, defecation must take place behind closed doors (Inglis, 2001) When behind the walls of the bathroom, one is permitted to defecate, but when sights, smells, or sounds escape the confines of the walls, we feel shame (Dellström Rosenquist, 2005). The boundary between public and private is mediated by pipes bringing water from the "public" realm into the "private", and sewage taking it away again (Kaika, 2005). Thus there is no such thing as "private" as the outside world is directly affected by how many times a person flushes and how much curry they ate that day.

Once shit enters the public domain, it is disassociated and abstracted from the individual such that it becomes a public problem (Dunn, 2007). The public demands that the State handle their excreta, which has in turn expanded its realm of control through the infrastructure built (Dunn, 2007). By entering into a contract with the State, we have forgone some of our freedom to ensure that our faeces are handled in a pathogen-free way (Turton, 2002). This involves a large amount of wastewater infrastructure, hidden pipes, and keeping the elements at bay.

The rendering of shit as a public problem has had the effect of endowing us with, as coined by Slater (1990), the "Toilet Assumption", or as Rafkin (1999) calls it, the "sweep-under-the-rug culture". We make mess, ignore it, and then believe that the unpleasantness ceases to be our concern, or even exist, once flushed down the toilet. The mess can be anything we do not want to see, such as racism, poverty, or shit. Very often the people who do have to clean up the mess, or live with its consequences, are the most disadvantaged in society (Bullard, 1993).

Sewage has become a public entity, divorced from its private creation (Hawkins, 2005). When individuals become a public, it involves abstracting oneself into the collective, such that the individual ceases to exist (Warner, 2002). This suspension of self leads to the contradiction whereby people can call for an end to a problem of which they are contributors, without acknowledging their involvement in the process. That is, the illusion persists

that publics don't shit, but, as the title of this thesis states, the reality is that publics **do** shit.

Technology and wastewater infrastructure has allowed us to separate ourselves from our own excreta and from "nature". It emerged in response to rapid urbanisation, whereby faeces needed to be quickly and efficiently removed from its place of origin as it caused diseases and smells, and conflicted with our "civilised" ideals of "clean" and "dirty". However, this handed control of sanitation over to the engineers, in whose hands it has remained since the early nineteenth century. We are thus living in a paradigm whereby engineering and infrastructure are the default responses to sanitation. The BFH and the idea that we don't shit has created and reinforced this mindset, precluding attempts to implement alternatives. Therefore, even when "radical" alternatives that seem to contradict the technical paradigm are introduced, they are so heavily influenced by the engineering mindset that they are not really different.

2.2 Redefining "waste" through Ecological Sanitation (EcoSan)

We are currently living in a "cradle-to-grave" paradigm, in which resources are extracted, used, and disposed of, with little consideration to reusing those resources (McDonough & Braungart, 2010). In short, we are enacting a "waste culture". One manifestation of this culture is in how urine and faeces (humanure) are treated as "waste" (C. Werner, 2004). However, there is growing awareness that this is fundamentally untenable given the finite limitations of the world's resources, and so a competing paradigm – *EcoSan* – is emerging that attempts to redefine humanure as a useful resource (Langergraber & Muellegger, 2005). In addition to returning nutrients to the soil, EcoSan has other benefits including: preventing disease, conserving water, and preventing pollution from entering the environment (Esray, 2002). To accomplish this, a paradigmatic shift entailing social, technical, economical, and cultural adjustments is required (Montgomery & Elimelech, 2007). There is no "one-size-fits-all" approach to ecological sanitation, and each implementation will depend upon the community in which it is introduced (Rosemarin et al.,

2008). However, EcoSan has been approached from a engineering perspective, which has framed the way in which it has been discussed.

One example of an engineering perspective that has been applied to EcoSan is Life Cycle Assessment (LCA). According to the official standardised methodology of LCA, ISO (1997), LCA is used to analyse the environmental consequences of the waste culture, and to identify ways in which products and processes can be altered such that they minimise waste production and resource consumption. It has been used to compare reticulated sanitation systems with imagined implementations of the EcoSan philosophy (e.g. Remy, 2010). Theoretically, the use of LCA is compatible with the philosophy of EcoSan, however, as this section will show, LCA is still argued to be entrenched in the technical mindset, and its use reinforces the dominant way of thinking. Whilst EcoSan seeks to address both social and technical implications of sanitation, LCA's focus on the technical is argued to neglect the social. This section will analyse LCA and its applicability to EcoSan from a philosophical perspective.

2.2.1 What is the goal of LCA?

According to Weidema (2000), LCA has become one of the most important methods for assessing environmental impacts. It has been embraced by policy makers as a key tool for advancing sustainable production (Bauman & Tillman, 2004). LCA is defined as a holistic technique which addresses the real and potential environmental impacts of "a product's lifecycle from raw material acquisition through production, use, end-of-life treatment, recycling and final disposal" (ISO, 1997). Essentially, every component of a product or service is assessed across its lifetime, and the emissions are quantified to determine how "environmentally friendly" the product is.

Proponents of LCA, such as Klöpffer (1997), argue that it is the only environmental assessment tool that avoids "shifted burdens". When the entire life cycle of a product is taken into consideration, improvements made in one part of the cycle that have negative ramifications on other parts of the system cannot be counted positively towards the environmental impact of that product. For example, a life cycle referenced by Duda and Shaw (1997) found that disposal nappies have less environmental impact than cloth-based

nappies. Whilst disposing nappies took up space in landfills, overall the energy and water which went into producing the disposables was more than half that of the cloth nappies, and the process released significantly less air pollution. Having a holistic overview of the system under study means that burdens cannot be shifted from one part of it to another, and so all negative effects are accounted for.

Another benefit of LCA is that it can reveal environmental concerns in the system under study before it has even been built (Duda & Shaw, 1997). For example, Yu et al. (2001) used LCA to develop a framework in which they modelled different refrigeration systems based on a mathematical model. They were able to identify parts of the production which may cause environmental harm, and thus come up with alternative products. Lagerstedt et al. (2003) argues that not only does this improve environmental outcomes of products, but it also can save considerable amounts of time and money.

LCA is also used to compare different systems. For example, the environmental effects of wastewater systems can be compared to environmental effects of EcoSan implementations such as urine separation toilets (e.g. Remy, 2010). This enables comparisons to be made between different products such that the one most suitable for a given situation can be chosen.

However, criticisms of LCA indicate that it might not provide the benefits that are being stated. There are epistemological concerns with LCA, as modelling complex sociotechnical systems will, by definition, need to be reduced in order to be modelled so the holistic benefits are downplayed (F. Werner & Scholz, 2002). It has been further criticised for over-emphasising the use of technology, or "techno-fixing" (Morozov, 2013) to achieve "efficiency", and for attempting to scientify a process which is inherently subjective (Heiskanen, 1997).

2.2.2 Escaping reductionism?

LCA is often lauded for being a holistic framework which can take a multitude of effects into consideration, however, several researchers such as Garnett (2014) and Sala et al. (2013) have argued that LCA is, in fact, reductionist. Reductionism is a principle which assumes that the world can be understood as a machine and each part can, in theory, be analysed and understood in

isolation from every other piece (Kirkman, 2002). However, viewing the world in this way makes it very difficult to account for the complexity of unification, as emergent behaviour is not explained by understanding separate components (Grosholz, 1991). The criticisms of LCA argue that LCA cannot model complex sociotechnical systems and must necessarily make simplifications. These criticisms are that LCA takes a "black box" approach, that it ignores the "cycle" in life cycle, that it cannot account for dynamic processes, and that it converts multi-dimensional processes to one dimension.

2.2.2.1 The "black box" approach

Latour (1999) defines and critiques "black boxing" as a process by which science obscures processes such that only inputs and outputs are considered, whilst ignoring the internal mechanisms of the process. However, explain Callon and J. Law (1997), entities are not black boxes. They are not discrete nor easily delineated. Instead they are sets of social and technical relations that cannot be well-defined. Much research has been undertaken over the past few decades in order to open the black boxes that traditional, positivist science has constructed (Besel, 2011). LCA, however, constructs models and processes as if they were black boxes.

The first example of black boxing is the LCA model itself. A system boundary is drawn around the world under study, and flows such as energy and water come into the model, and pollution such as nitrogen and CO_2 flow out (Suh et al., 2004). The choice of this boundary can impact the outcomes of the results significantly, particularly when undertaking comparative LCAs (Roy et al., 2009). For example, a model may delineate the world as all the processes which handle wastewater treatment with the household at the start and the Wastewater Treatment Plant (WWTP) at the end (e.g. Benetto et al., 2009). However, if the model is examining low-flush toilets in contrast to normal toilets, then there may not be a significant difference between the results because water extraction and treatment is not included in the boundary. If they were included, then the results could be entirely different (Anand & Apul, 2011). The model will only be affected by flows into and out of the system, so processes which may affect the model that are not within the system boundary will be ignored (Lundie et al., 2008).

The second example of black boxing is modelling the individual components of the LCA. Jacquemin et al. (2012) reviewed multiple LCAs and showed that many practitioners treat the unit processes as though they were black boxes. They argue that this enabled the practitioners to treat the unit processes as though they were operating under fixed conditions, without taking local variations into account.

Latour (1999) argues that when the world is reduced to a series of black boxes, it obscures the complex social and technical relationships which construe the world. A wastewater system is irreducible to the black boxes that LCA constraints impose as individual components will overlap with each other and affect each other in a multitude of unpredictable ways (Movik & L. Mehta, 2010). In combining multiple, overlapping systems, LCA has limited application in addressing the environmental concerns of EcoSan (Garnett, 2014), as a whole range of different perspectives is lost (Gasparatos et al., 2009). Furthermore, the defining of flows through the system as if they had a start and an end ignores the "cycle" in life cycle.

2.2.2.2 Ignoring the "cycle" in life-cycle

One of the criticisms of the waste culture is that it neglects the concept that in "nature" everything is food (McDonough & Braungart, 2010). Instead, resources are treated as if they are in a one-way flow from "cradle" to "grave". LCA is a cradle-to-grave philosophy, and it therefore incorporates the concept that waste can exist. In LCA, the stages of a product or process are: resource extraction, manufacture, use, and final disposal, including the transport between the different sites where these take place (ISO, 1997).

Finnveden (1999) explains that analysing the entire life cycle is not necessary for every LCA practitioner to do if they are performing a comparison between two different systems. This is because the only parts which need to be modelled are those parts which differ. For example, if comparing two different wastewater treatments, it is not necessary to include water production in the analysis because that will be the same for the two scenarios. When comparing different LCAs, however, not including the same stages can create incomparable situations. For example, Zabalza Bribián et al. (2011) were

analysing brick production and they found that the global warming potential of their study was significantly higher than other studies because they included stages of the lifecycle other researchers had not.

Practitioners have to be careful, therefore, to ensure that they include a sufficient number of stages in order to ensure that fair comparisons are being made. If all stages of the lifecycle are considered, it is still not a "cycle" due to the inherent nature of LCA as a cradle-to-grave philosophy. Even if all stages were considered in a cycle, the model itself would still be static.

2.2.2.3 Accounting for dynamic processes

The world is a dynamic consortium of overlapping and interwoven processes which continually define and redefine each other (Kaika & Swyngedouw, 2000). When modelling something as complex as sanitation, changes in one part of the system will affect other parts of the system, which in turn will affect the original entity which was changed (Pehnt, 2006). Sayer (1976) critiques the attempts at static modelling in economics by arguing that they cannot sufficiently encapsulate the complexity of the global economic system. A static model is applicable at one particular time and space, and so its application is limited.

LCA as defined in the standard (ISO, 1997) is static. It takes a snapshot of a particular system configured for one place in time (Lundie et al., 2008). However, feedback mechanisms inside the system under study may impact the results in the real world which are not reflected in the model. Soimakallio et al. (2011) explain how changes in electricity consumption may affect the price of electricity, which in turn will affect how electricity is consumed. Since LCA is not dynamic, these feedback mechanisms cannot be accounted for.

The external world is also assumed to be constant (Lundie et al., 2008). This means that all things other than the system under examination are assumed to be unchanging, so no technologies or market forces will change outside the system. In effect the system under study is removed from the rest of the world. However, there are many temporal components which will impact an LCA of EcoSan, for example the weather affecting water flow into a WWTP (Karvonen, 2011). Furthermore, as explained by Bedford (1999), LCA is unable to account for cumulative effects over the course of

its operation, for example acidification impacts change as the ecosystem's capacity for holding nitrogen is exceeded. Reap et al. (2008) gives another example of emissions interacting with background pollution leading to worse impacts than expected, for example seasonal variation in the water quality of a lake.

There are attempts at making LCA dynamic which could incorporate some of these feedback mechanisms. For example, Levasseur et al. (2010) incorporated temporal factors in global warming, Pehnt (2006) considered future impacts of renewable energies, and Stasinopoulos et al. (2011) assessed cumulative effects of car production. However, these attempts are not yet mature nor standardised and there is no general consensus on how to make LCA dynamic.

By defining the world in a particular place and time, LCA is unable to account for the multitude of cumulative and temporal effects which arise as a result of complex sociotechnical systems. Whilst there are attempts to bring dynamism into the model, dynamic LCAs are not yet mature enough to be used by decision makers. In generating a static snapshot of the world, LCA is also converting multi-dimensional processes into one dimension.

2.2.2.4 Multi-dimensional processes in 1D

Kidner (2001) explains that a photograph is a snapshot of the three-dimensional world which has been compressed and shown as a two-dimensional object. As much as what the photo is showing, it is also not showing what is outside the picture, nor the depth or full story of the experience that was captured. Modelling the world is like taking a photograph: the multiple dimensions and sensory experiences are reduced to a mere representation of their complexity.

LCA takes the multiple dimensions of a system and presents a one-dimensional overview of the environmental "performance" of a system. One of the first steps in undertaking an LCA is to define the functional unit, which states what the system will be studying, for example "kilograms of humanure per year" (ISO, 1997). However, an EcoSan system produces more than just humanure; it can produce energy, heat, or even food. Thus, argues Garnett (2014), constructing a system such that it models just one output cannot sufficiently encapsulate it. Some LCA practitioners such as Hayashi (2012)

are attempting to provide a framework to incorporate multiple functional units into LCA. There are already practitioners doing so in agriculture, as reviewed by Roy et al. (2009), whereby multiple functional units are chosen for land use and product output, such as "1 hectare and 1 ton milk". However, these create additional work for the practitioners as they lead to problems with how to compare two fundamentally different metrics.

Once the functional unit and black boxes have been chosen and constructed, the next reductive step is to undertake an **inventory analysis**. The inventory analysis is the data collection and modelling component of the LCA (Hsu, 2009). A flowchart is created from the unit processes, and the flows are scaled to the functional unit. For example, water may flow from the ecosphere into the household, to the WWTP, and finally into waterways. The ISO (1997) says that an inventory is supposed to tabulate all inputs and outputs of a given system with respect to the functional unit. This includes energy, raw materials, emissions to air, discharges to water, and other environmental aspects. In reality, however, as Fleischer and Schmidt (2000) explain, it is very difficult to quantify some of these inputs and outputs, so the inventory stage is often reduced to just examining resource consumption. Thus a complex system is scaled from multiple emissions and effects to just those which can be examined as resource consumption.

The results of the inventory analysis are aggregated in the **impact assessment** in order to determine how the flows affect the ecosphere. Fleischer and Schmidt (2000) explain that this stage is often omitted entirely due to a lack of consensus on how to undertake one, and the difficulties inherent with reducing the inventory to a series of comparable metrics. However, if it is undertaken, each flow in the inventory will be sorted into a category (Golsteijn, 2014). An indicator is then calculated which reflects the process under consideration has on that particular category (Owens, 1996). The indicator can either be a **midpoint** or an **endpoint**. Midpoint indicators are taken at the point at which an emission starts to effect the environment (Golsteijn, 2014), whereas the endpoint is the final result of the emission's effect on the environment (ISO, 1997) (Figure 2.1). For example, if a WWTP releases a certain amount of nitrogen, then that will contribute towards both eutrophication and nitrification at the midpoint level, and human health and

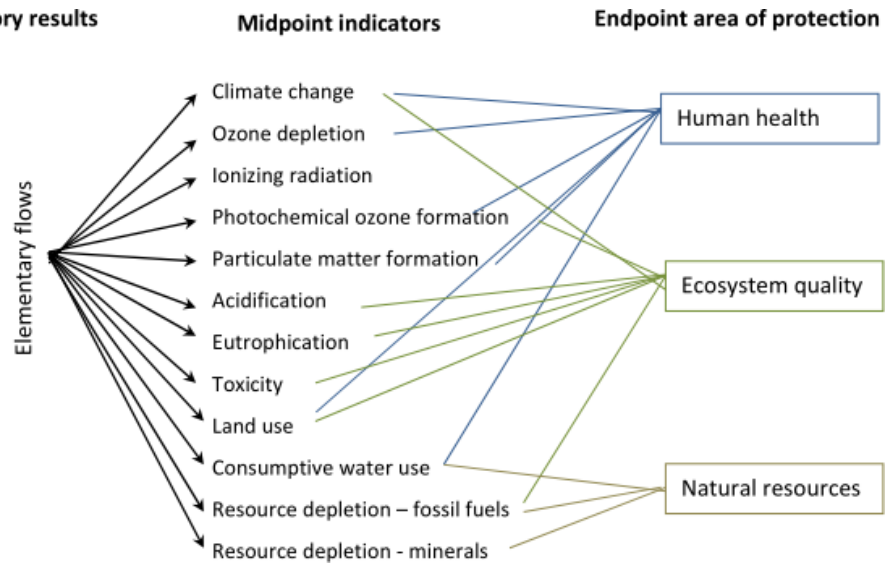

FIGURE 2.1: The difference between midpoints and endpoints (Renouf et al., 2015)

ecosystem quality at the endpoint level.

This choice of indicator will have ramifications on the results. Endpoints are more error-prone by nature because they extrapolate environmental effects beyond raw emissions, and they simplify the data in the process (Bare et al., 2000). For example, raw CO_2 and nitrogen emissions into a lake would be extrapolated to the category "human health", and a number presented for how the model impacts "human health". This, however, obscures the origin of the health impacts as neither CO_2 nor nitrogen are included in this figure (Horne et al., 2009). This could seem like a benefit of endpoint modelling, as it makes for easier decision-making, as the decision-maker only has to consider a few variables (Bare et al., 2000). Whether one models at the midpoint or the endpoint level, it is still reducing a multi-dimensional process into a one-dimensional scale, and is thus reductionist.

Thus, LCA is like a photograph and takes a snapshot of a multi-dimensional system to present it in one or two dimensions. These one or two dimensions are then used to compare different systems with each other (ISO, 1997). However, this leads to the next topic of criticism in the literature which is that of attempts made to "scientify" LCA.

2.2.3 Attempting to "scientify"

"Scientifying" is the attempt to turn a subjective process into an objective one in such a way that it can be studied in a positivist fashion (Heiskanen, 1997). Anderson (2003) argues that making something scientific which is inherently value-laden means that there is always for choice in what is determined to be scientific, and so the process of scientification can never be objective, which is antithetical to the purpose of scientification. Böhme et al. (1983) corroborates this idea and argues that scientification is undertaken for the sole purpose that it is seen to be "good" to be scientific. This process of choosing what is determined to be scientific is often determined by those who have the power to undertake the exercise, and therefore, argues Swyngedouw (2009) and Vos and Everson (2009), it has the effect of privileging the technical view over other forms of knowledge. Finally, as shown by Schaltegger (1997), the creation of universal "scientific" methods has the capacity to strip out all local context. This section will explore these ideas in more detail and how they relate to LCA.

2.2.3.1 Making global comparisons

Schmidt and Sullivan (2002) explains that one of the arguments for scientifying LCA is that it enables global comparisons to be made between different systems. To achieve this, databases have been compiled with averaged industry values for many different processes one could model (Heiskanen, 1997). The databases ensure consistency in data quality and can save a lot of time (Heiskanen, 1997). For example, the ecoinvent database (Weidema et al., 2015) contains data for a WWTP with data averaged across Europe which could be used in place of collecting data on a WWTP, thus saving time and money.

Universal weighting measures have also been developed for global comparisons (Schmidt & Sullivan, 2002). For example, researchers have tried to universally determine that "human health" is more important than "freshwater toxicity", which enables comparisons to be made universally. However, Schmidt and Sullivan (2002) elaborate, this process is inherently value-laden and what is applicable in one country will not be applicable in another. They

show that there are a multiplicity of different values in each country and that attempting to impose a "one-size-fits-all" methodology onto LCA will strip the method of its applicability in the local context.

Schaltegger (1997) have agreed that these decontextualisation methods has emptied LCA of local meaning and usefulness. However, they dispute the concept of impact assessment rather than weighting and explain that aggregating local emissions into a category "eutrophication" or "nitrification" does not reveal anything useful about the potential or even actual environmental impacts. The example they use is that one kilogram of mercury emitted in one hour at one place may kill many people, but the same amount emitted over a year at a hundred places may not have any discernible consequences. There is an inherent value-laden approach in all of these attempts to make LCAs comparable.

2.2.3.2 Scientification is value-laden

Jamieson (1995) says that we tend to think that reasons and emotions must be either subjective or objective and that objective "facts" are rooted in the way things are, whereas subjective "facts" are grounded in how the individual perceives something. However, as Nagel (1974) famously argues in his essay "What is it like to be a bat?", we can only be sure of our own experiences as we perceive them and that there is no such thing as objectivity. Therefore, Anderson (2003) argues, any attempt that we make to objectify something subjective will always incorporate elements of the way in which we see the world and so the process can never produce something wholly objective. This means that attempts to scientify LCA will always incorporate the practitioners' own subjectivity.

Researchers have attempted to scientify LCA in an attempt to overcome the epistemological concerns of reducing a complex sociotechnical system to a model (Heiskanen, 1997). Standardised methodologies and procedures to follow have arisen, in order to guide practitioners on how to undertake an LCA scientifically (ISO, 1997). These methodologies attempt to ensure that the procedure is complete, relevant, scientifically robust, transparent, reproducibile, and applicable (Curran, 2012). However, uncertainties in this process mean that the same researcher at the same company can perform two

LCAs on the same product and obtain different results (Güvendik, 2014). Furthermore, argues Hsu (2009), unless strict rigour is followed, the numbers can be massaged to produce any desired result.

In addition to the methodological concerns with scientification of LCA, there is a process known as "weighting" which determines when a product is more or less "harmful" than another. However, Finnveden (2000) argues that it is not possible to show that one product is more or less "harmful" than another. He explains there are several reasons for this: not all relevant environmental impacts can, or will, be considered; and the definition of "harmful" involves ideological and ethical elements which are not objectively determined. The consideration of environmental impacts will be a result of the practitioners' implementation of the model, which is inherently subjective. He further argues that when determining which product is more less "harmful", one has to decide what that means to them, and that in general it is not possible to say that "eutrophication" is more or less "harmful" than "nitrification" as it is entirely context-specific.

This process of weighting is thus controversial because it is value-laden and not objective (Bengtsson & Steen, 2000), and Schmidt and Sullivan (2002) argues it should not be used due to the lack of objectivity. However, others acknowledge that it is useful for decision-makers and those who know its limitations, but it should not be presented to members of the general public (Bengtsson & Steen, 2000; Johnsen & Løkke, 2012). Work is currently being undertaken to improve the efficacy of weighting (Johnsen & Løkke, 2012), but the central concern remains: universal weighting methods involve ideological and ethical considerations which are not, and cannot be, objectively determined (Finnveden, 2000), as it is like comparing apples with oranges (Schenck, 2001).

LCA is a descriptive tool – it describes the world as it currently *is*. However, interpretations of LCA are about what one *ought* to do. This is a classic philosophical conundrum as described by philosopher David Hume, who argued that we cannot derive an "ought" from an "is" (Hume ([1739] 2012) cited in Herrmann (2012)). Yet, LCA presents the "right answer" as an ought which comes from an is, masking the value-laden choices of that decision (Anex & Focht, 2002). Indeed, as pointed out by Steen (2006),

the term "scientific" is often used synonymously with "correct". In order to circumvent this, LCA practitioners have divided the technique into the "objective" stage of inventory, and the "value-laden" stage of impact assessment (Bengtsson & Steen, 2000). However, as argued by Anex and Focht (2002), attempting to eliminate the value-laden parts of LCA will, in effect, eliminate LCA altogether, as a perfectly objective LCA is impossible.

Thus, attempting to make LCA scientific obscures the value-laden process of objectifying the technical. F. Werner and Scholz (2002) argue that the methodology as defined in the standards (ISO, 1997) does not define an exact science, which means that decisions made by practitioners are subjective and will reflect the way in which they view world. For these reasons, Ehrenfeld (1997) has called the methodology of LCA flawed and unrepresentative of objective truth. He says it is impossible to separate the objective from the subjective, that the procedures are opaque, the assumptions are arbitrary, and the process is too expensive to apply in any but the most useful instances. As Heiskanen (1997) argues, this means there is politics embedded in the process of LCA which means that LCA will represent and reinforce the prevailing viewpoint of the researchers.

2.2.3.3 Privileging the technical

Privileging the technical means that other forms of knowledge which aren't scientified are considered as less worthy of consideration (Vos & Everson, 2009). This has the effect of policing and silencing those who are not experts in science, and reinforces existing technocratic power structures (Fischer, 1990). However, as Swyngedouw (2009) argues, unless this viewpoint is reframed, questions of environmental justice and egalitarian social situations will be unattainable.

Heiskanen (1997) argues that the process of undertaking an LCA is embedded in these politics which has the effect of privileging the technical. These politics are often obscured beneath a mask of objectivity, and not only will the model itself reflect the view of the modellers, but the LCA will represent and reinforce a particular opinion. Schweber and Harty (2010) articulate that one LCA might mean something completely different to one person than to another. To that end, Thabrew et al. (2009) has argued that

stakeholders must be consulted when undertaking an LCA as it is the environmentally responsible approach to take. According to them, stakeholders must be able to participate in the process of the LCA, and understand the results, which practitioners must explain. However, Mathe (2014) found that there is no defined way of including stakeholders in the process of LCA and that participation is often limited.

Heiskanen (1997) argues that by accepting the subjectivity of LCA, it can be extremely useful as a tool to spark debate amongst the stakeholders. He says that the technique should not be seen as a tool to present an accurate representation of the world with one correct answer, but rather to show what is important to stakeholders, and to facilitate them in ascertaining what their assumptions are, and what course of action, if any, they wish to take. This is a view reflected by F. Werner and Scholz (2002), who note LCA's power lies in its ability to be used as a decision-support tool. As Garnett (2014) says, everybody wants "sustainability" and an end to world hunger, but what that means is open for debate, often leading stakeholders to be at cross-purposes to each other. By using LCA, it is possible that these differences can be discussed and worked out. As Heiskanen (1997) argues, LCA should not be used for the results themselves, but for what the process of undertaking the exercise can reveal. By not including stakeholders and by not recognising the inherent politicalisation of LCA, it is likely that the dominant paradigm will not be disrupted.

2.2.4 Achieving "efficiency"

Eco-efficiency is the philosophy in which we can "produc[e] more with less" (M. Huesemann & J. Huesemann, 2011, p.120), however there are criticisms of this on several grounds. The idea is that by making technological adjustments to production methods, the environmental impacts of that process can be minimised whilst still enabling business to carry on as before (M. Huesemann & J. Huesemann, 2011). Complex sociotechnical systems are reduced to their technical components, without acknowledging the social and political forces which are part of the systems under study. As well as a lack of focus on the social and technical, eco-efficiency has some epistemological problems. It may even contravene the laws of thermodynamics, making it a physically

impossible goal (Huppes & Ishikawa, 2005). There is also an over-focus on measuring increases in eco-efficiency, rather than an examination of how to alter practices to fundamentally challenge the status quo (Freidberg, 2013).

2.2.4.1 Not grounded in reality

The idea that one can produce more with less is based on an optimism that is not grounded in reality. Currently, neo-liberal economic theories assume that all resources are infinite, and that the economic system can continue to grow indefinitely (Pacheco-Torgal et al., 2014). This, however, contravenes the first law of thermodynamics, which states that one cannot get something from nothing (Townsend, 1992). There is also an assumption that the waste produced can be managed to the extent that it does not cause environmental problems (Pacheco-Torgal et al., 2014). However, as Georgescu-Roegen (1977) has argued, this could contravene the second law of thermodynamics as highly complex human structures will always result in disorder to the environment, thereby making a waste-free industrial system impossible (M. H. Huesemann, 2004).

To some extent, EcoSan is prone to the same rhetoric. There is a belief in the EcoSan community that it will be possible to use fewer resources, but to still achieve development goals (Langergraber & Muellegger, 2005). The difference is that EcoSan is not based upon creating *more* goods and services, but rather recycling the nutrients that are already coming from humans (Esrey, Andersson, et al., 2001). Thus, EcoSan does not promote growth, so much as a steady-state paradigm.

2.2.4.2 Techno-fixing

One of the prevailing opinions for how growth can be accomplished with less is to use technology, or to "techno-fix" (Morozov, 2013). Techo-fixing is the notion that there are easy, quick fixes to achieve social and environmental progress simply by finding the right technology to facilitate it (Carr, 2013). However, this mechanistic, reductionist approach towards society is insufficient to encapsulate the complexity of people and the environment, and technological solutions alone cannot be sufficient (M. H. Huesemann, 2001). Furthermore, the view that there is a techno-fix for everything is

being deployed to lessen concerns about natural resource consumption; it is assumed that there is a technical fix for shortages too (Sauvé, 1996). Even if the techno-fix approach were sufficient to bring about efficiency drives, any growth in population would ensure we would need to do the same again (M. H. Huesemann, 2004), so it would be running just to stand still (DeSimone & Popoff, 2000).

Another concern with techno-fixing, as argued by Tenner (1997), is that it will always have unforeseen consequences. The Earth's ecosystems are very poorly understood, and even simple interventions are likely to have outcomes which we cannot predict; complex technologies will have even less understandable results (Nicholson, 2013). If techno-fixing were the only recourse, then the problems that arose in the future would, in turn, need to be techno-fixed, and, once again, it would be running just to stand still (Fazey et al., 2010).

In theory, EcoSan recognises that environmental and social progress is brought about by an understanding of all components of the sociotechnical world, and so goes beyond the narrow confines of the technical view (C. Werner et al., 2009). A review of failed EcoSan projects by Esrey, Gough, et al. (1998) found that projects failed because contractors built toilets without community participation. Participants did not know how to use the toilets, nor why they should, and they certainly did not know how to maintain the toilets. The sanitation projects were undertaken in a techno-fix mindset, without due consideration to possible ramifications. Some researchers are discussing sanitation systems which are built with resilience to problems that may arise (e.g. F. Marshall et al., 2008), but there is little acknowledgement of this in the literature thus far.

2.2.4.3 What does "efficiency" mean?

In order to determine how "successful" eco-efficiency drives are, simplistic one-dimensional metrics have been developed. Focusing on these numbers precludes looking at the bigger picture to identify where the system could be restructured to fundamentally challenge the status quo (Freidberg, 2013). For example, as noted by Garnett (2014), an LCA was undertaken to determine if growing lettuce out of season in Spain was more or less efficient than

growing them in Britain. However, the researchers never questioned whether or not lettuces should be grown out of season at all. Improving the single metric has become the focus, but that ignores a multitude of perspectives which could be assessed (Gasparatos et al., 2009).

Another concern with the single metric focus is what "efficient" means (Holmberg & Karlsson, 1992). For example, EcoSan encourages not defecating in water since it is "inefficient" (Esrey, Gough, et al., 1998). However, water is an extremely efficient method of transporting nutrients (Hvitved-Jacobsen et al., 2013), and so a single metric loses the nuances of these differing views. LCA has single metrics which are the results of the impact assessment (Bengtsson & Steen, 2000), and they are often deployed to show that one system is more "efficient" than another (e.g. Benetto et al., 2009). There have been calls for multiple functional units which can present the results of the LCA from a multitude of perspectives (Roy et al., 2009), but these are not widely used by practitioners in the EcoSan community.

Eco-efficiency is thus a poor focus for improving sustainability. It is too heavily reliant upon the notion of techno-fixing, which has been widely criticised (e.g. M. Huesemann & J. Huesemann, 2011). LCA is firmly entrenched in techno-fixing, whilst EcoSan acknowledges that techno-fixing will not achieve its goals, but some researchers have attempted to techno-fix anyway. Environmental protection goes beyond the technological challenge of finding the right fix (De Wilde, 2008).

2.3 Summary of literature review

The bourgeois faecal habitus (BFH) is a set of rules and conventions around how, when, why, and where we can and cannot shit. It mandates the use of water and vast infrastructure to maintain a distance between us and our excreta. However, in this process, we lost sight of the fact that humanure is a valuable resource in agriculture. Thus the current water-based sanitation system is being increasingly criticised for its wastefulness, as well as the fact that it is costly and has negative environmental effects. A new paradigm, Ecological Sanitation (EcoSan) has emerged as a possible alternative to the conventional system. One of the methods which has been used to examine

EcoSan is that of Life Cycle Assessment (LCA). However, LCA is embedded in an "engineering mindset", which limits its applicability to EcoSan. The next chapter will introduce various LCAs which have been undertaken in the EcoSan world, as well as some more practical trials, in order to demonstrate and critique the prevalence of the "engineering mindset" in EcoSan.

Chapter 3

Methodology

EcoSan is a philosophy which stipulates that closing the nutrient loop is an important endeavour to undertake (C. Werner, 2004). Over the past several decades, the literature published on EcoSan has consisted of two main strands: analysis of EcoSan implementations with user satisfaction surveys, and computer-based models in the form of LCA. The user satisfaction surveys recognise the principle that in order for EcoSan to be accepted, users of the toilets must be content to use them. However, the LCAs rarely contain mention of the social element in implementing EcoSan, and focus on the technical and objective components of such a system. There is therefore a branch of literature which focuses on the quantitative, and another which focuses on the qualitative. Both strands have revealed that there are many social and environmental concerns with EcoSan, which contradicts its theoretical benefits that less water is consumed by toilets, and that fertilisers will not be required to save energy and eutrophication. In order to understand why there is a contradiction, it is necessary to analyse the attempts at implemented EcoSan to reveal if the lack of success lies with EcoSan itself, or in how it is implemented. This has not yet been done, and it is the aim of this thesis to fill that gap. To do so, a qualitative analysis of the literature has been undertaken.

The choice to undertake a qualitative analysis was determined by the question being asked, and by the type of data there is to analyse. Qualitative analysis brings together the collection and the analysis of data such that the identification of data leads to its analysis which guides the way in which the data should be re-analysed. This iterative approach culminates in developing new ideas and theories in a way that is not possible with quantitative

methods. Furthermore, it permits the objects under analysis to be interpreted according to the meanings that people bring to them, rather than the quantitative approach which separates the research from its context (Denzin & Lincoln, 1998). This is ideal for analysing how the BFH and engineering mindset are enacted in the EcoSan literature, as they are paradigms which can be revealed through their context. The method of qualitative analysis chosen was thematic discourse analysis (TDA).

This chapter details and justifies the choice of TDA. It explains how the two types of EcoSan literature were chosen. Finally, this chapter will detail how TDA was applied to the literature.

3.1 Thematic Discourse Analysis

The major benefit of thematic discourse analysis (TDA) is that it is eminently flexible (The University of Auckland, 2016). Many qualitative methods require first-hand narratives, whereas TDA is applicable to many kinds of data. This is ideal for this research as Life Cycle Assessment (LCA) and user satisfaction surveys are neither first-hand nor alike. TDA identifies themes and discourses inherent in the data.

Discourses are conversations with a purpose. They produce knowledge which is used to influence how individuals experience the world. Discourses exist "out there" in society, but are also interacted with and moulded by the individuals in a dynamic dialectical relationship (Singer & Hunter, 1999). We actively construct and interpret these discourses and use them to determine our own realities (Taylor & Ussher, 2001). Talk about faeces and sanitation is not therefore noise to be stripped away, but rather the discourse, and the speakers of the discourse is the focus (Peel et al., 2005). The bourgeois faecal habitus (BFH) is a narrative around our bodies, our selves, and our excrement. We use it to construct our reality on the meaning of shit. Each time we break a taboo, or the pipes burst, we are actively participating in, and changing the story. Similarly, the engineering mindset is a narrative around how we control our bodies and our shit. Whenever a pipe bursts or a new sewer is built, this dominant paradigm is actively reinforced. TDA is a

technique to consider common themes and contradictions embedded in these narratives (Singer & Hunter, 1999).

TDA focuses on both the rhetorical structure of these themes and their accompanying assumptions (Armstrong et al., 2012). The approach consists of two phases: a search for patterns in the data, and an analysis of those patterns. This "goes beyond the semantic content of the data, and starts to identify or examine the *underlying* ideas, assumptions, and conceptualisations – and ideologies – that are theorised as shaping or informing the semantic content of the data" (Braun & Clarke, 2006).

3.2 Literature search

This thesis is concerned with how researchers are undertaking their research and how they think about Ecological Sanitation (EcoSan). To that end, secondary data was used. The University of Auckland (2016) recommends collecting 10 – 20 data samples for a masters thesis thematic discourse analysis (TDA). To collect these, the practical trials and Life Cycle Assessment (LCA) literature was searched. This process revealed 22 different papers, all of which have been included in this thesis. This section details the collection process for the two different branches of literature.

The practical approach to EcoSan has entailed researchers or businesses installing EcoSan toilets for users, and then assessing how users felt about their experience. There are several different types of EcoSan toilet which could be in use, and several different terminologies for EcoSan toilets. Therefore the search terms "EcoSan", "ecological sanitation", "composting toilets", "urine separation", "dry sanitation", and "source separation" were chosen in order to include as many different trials as possible. Additionally, there are several synonyms for "satisfaction" which are "acceptance", "satisfaction", "experiences", "experience", "opinion", and "acceptability".

The LCAs undertaken in EcoSan were found by using the same search terms for the toilets, namely, "EcoSan", "ecological sanitation", "composting toilets", "urine separation", "dry sanitation", and "source separation", in order to ensure consistency. The terms were then permuted with "life cycle assessment" and "lca".

Scopus was used to search for these terms, as it is the largest online collection of peer-reviewed literature (Elsevier, n.d.). This suggests it may offer the most representative selection of literature, in comparison to other databases which may have their own biases due to their smaller size.

In total, 177 practical trials and 50 LCAs were retrieved. Given that this thesis is concerned with the developed world, nutrient reuse, user satisfaction, and LCA, only papers which met those requirements were considered. The filtering process left 11 key practical EcoSan trials and 10 key LCAs. During the course of this research, an additional trial on emergency use of composting toilets was found, which was also included (WREMO, 2013). The papers and their code names are shown in Table 3.2.

Paper	Code-name
Practical trials	
Kreissl (1986)	Kreissl
Wynia et al. (1993)	Wynia
Fittschen and Niemczynowicz (1997)	Fittschen
Berger (2003)	Berger
Bregnhøj et al. (2003)	Bregnhoj
Berndtsson (2006)	Berndtsson
Davison et al. (2006)	Davison
Jönsson and Vinnerås (2007)	Jonsson
Starkl et al. (2007)	Starkl
Lienert and Larsen (2010)	Lienert
WREMO (2013)	WREMO
Dimpfl and Moran (2014)	Dimpfl
LCAs	
Tillman et al. (1998)	Tillman
Lundin et al. (2000)	Lundin
Kärrman and Jönsson (2001)	Karrman
Remy and Jekel (2008)	Remy
Benetto et al. (2009)	Benetto
Remy and Jekel (2011)	RemyEnergy
Lehtoranta et al. (2014)	Lehtoranta
Spångberg et al. (2014)	Spangberg
Thibodeau et al. (2014)	Thibodeau
Ishii and Boyer (2015)	Ishii

TABLE 3.2: Code names for literature

3.3 Performing the analysis

An approach was taken similar to that described by Braun and Clarke (2006) and Taylor and Ussher (2001). The papers were thoroughly read to become fully acquainted with their content. Next, they were loaded into NVivo (2015) and coding was performed. In NVivo a code is referred to as a "node". Initial nodes were created with themes from the bourgeois faecal habitus (BFH) and engineering mindset, for example "controlling nature" or "attempts to scientify". As the papers were coded, each sentence or phrase was assigned to one or more of these nodes. The nodes and themes were then checked for patterns, consistency, and ideological implications, and refined as necessary. They were then interpreted by reference to supporting literature. The structure of the results chapter follows the themes identified.

3.4 Summary of methodology

A thorough literature search was performed in order to discover secondary-data on practical Ecological Sanitation (EcoSan) implementations and Life Cycle Assessments (LCAs). Thematic discourse analysis was applied to the literature, and dominant themes identified. The next chapter will present the results of this approach.

Chapter 4

Results and Discussion

Shit is a boundary transgressor. It moves from inside the body to outside the body, in a process that we like to pretend doesn't exist. Once outside the body, it is swiftly taken away into the public sphere, where it ceases to have any connection to the private individual who created it. It is then taken outside the cities, even further from the individual, where it is processed and transformed. Finally, it ends up in landfill or an incinerator, far away from where people live. We have everyday practices, conventions, and technology which keep this system in place. Anything which deviates from the "norm" is a boundary transgressor. The trials and LCAs attempted to disrupt this normalcy, but they have been largely unsuccessful at doing so. This chapter will posit that the reason is because they are both being influenced by the bourgeois faecal habitus (BFH) and engineering mindset, without due recognition of that fact. Until researchers focus on these aspects, it seems we will never be saying Goodbye to the Flush Toilet (Stoner, 1978).

4.1 Overview of trials

A description of the literature surveyed is in shown in Table 4.2. The practical trials implemented either composting toilets or urine diversion toilets. However, the Life Cycle Assessments (LCAs) modelled a variety of different technologies. An overview of the nutrient flows they embodied is in Figure 4.1. It shows that urine, faeces, wastewater, brownwater, blackwater, greywater, and faeces and greywater were collected and sent to one of four types of treatment. From there, the nutrients either went to agriculture, landfill, or biogas.

Trial	Description
	Practical trials
Berndtsson	Urine separation toilets in a hostel in an urban environment
Berger	Composting toilets in an ecological settlement
Bregnhoj	Composting toilets in a garden allotment
Davison	Ecological toilets in a rural environment
Dimpfl	Composting toilets in a rural area
Fittschen	Composting toilets in an eco-village
Jonsson	Source separating systems in residential areas
Kreissl	Biological toilets in rural areas
Lienert	Review of urine separation across Europe
Starkl	Ecological sanitation in a rural environment
WREMO	Emergency trial of composting toilets in a city
Wynia	Composting toilets in a rural area
	LCAs
Benetto	Compare advantages and disadvantages of EcoSan compared to conventional sanitation in office building
Ishii	Compare environmental emissions of struvite production, urine separation, and conventional systems in two buildings
Karrman	Compare four alternative systems in hypothetical settlement
Lehtoranta	Analyse potential tradeoff between reduction of local emissions and increase in environmental impacts for one house
Lundin	Compare environmental loads from wastewater systems with different technical systems in two towns
Remy	Compare ecological sustainability of conventional and source-separation urban sanitation systems
RemyEnergy	Compare cumulative energy demand of conventional and source-separation urban sanitation systems
Spangberg	Asses environmental impact of source separation on arable land compared to wastewater treatment in a planned housing district
Thibodeau	Compare blackwater separation to conventional system in urban town
Tillman	Environmental consequences of changing from centralised to more local systems in two towns in Sweden

TABLE 4.2: Description of secondary data sources

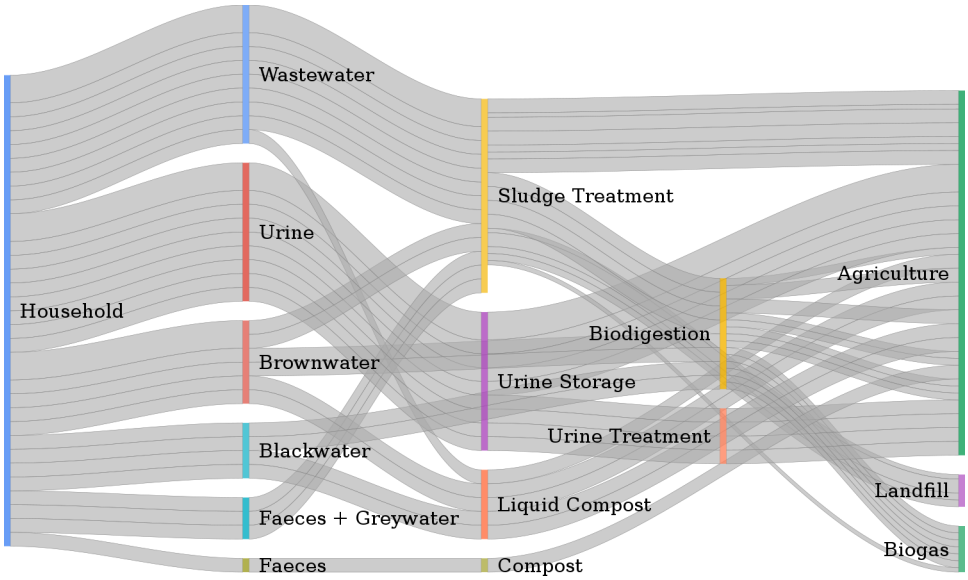

FIGURE 4.1: Sankey diagram of nutrient flow in LCAs under study

4.2 Embedded in the habitus

The results of the thematic analysis reveal that the bourgeois faecal habitus (BFH) is a predominant driver of conceptions of Ecological Sanitation (EcoSan). Over the past hundred years, increasing drives towards "civilised" behaviour have shaped the way in which we view ourselves and our excreta (Inglis, 2001). These have driven increased standards of comfort and cleanliness (Shove, 2003b), standards which EcoSan threatens. Predominant themes uncovered to this effect were user discomfort, researcher discomfort, the idea of "nature" as "out there", and controlling "nature".

4.2.1 User discomfort

User comfort with the toilets is one of the primary concerns of this research. Our discomfort and shame with our bodies means that we have come to believe that we don't shit, and when we are reminded of this fact, it makes us deeply uncomfortable, a phenomenon (Inglis, 2001) refers to as the BFH. Discomfort and disgust precluding the implementation of new technology is a well-researched phenomenon and is referred to as the "yuck factor" (A. George, 2012). However, Russell and Lux (2009) found that sufficient education with the benefits of recycled wastewater would enable users to overcome this "yuck factor".

The results of this analysis revealed that users are deeply uncomfortable with EcoSan toilets. Two types of toilet were used in the practical trials: composting and urine diversion. Composting toilets are not connected to a mains water supply and store excreta on-site to compost (Porto & Steinfeld, 2000). Urine diversion toilets separate the urine and faeces so that the urine can be stored and used in agriculture, whilst the faeces are generally flushed away (Krebs, 2013). User satisfaction was significantly higher for the urine diversion toilets than it was for the composting toilets. Their discomfort was primarily based around their conceptions of "dirt", problems they had in cleaning the toilets, and discomfort with maintaining the toilets. The results also reflect that sufficient training and education on the benefits of the toilets could, however, enable this discomfort to be overcome. This shows that whilst the BFH plays a central role in user experience, education and adequate support in the use of the toilets may be sufficient to increase the uptake of EcoSan.

4.2.1.1 Conceptions of "dirt" inhibit user acceptance

Douglas ([1948] 2003) argues that the concept of "dirt" arises from our desire to order the world around us, and that anything which does not fit in this imposed order is "dirty". Inglis (2001) extends this to show that there are two main types of "dirt" in the BFH: hygienic and moral. Moral dirt implies that something is, in and of itself, "bad"; hygienic dirt is the kind which can make us ill. However, the results of this research indicate that users are predominantly concerned with moral dirt. The ways in which this discomfort manifest were in the use of public toilets, maintaining the compost, and the ability to clean the toilets with ease. Surprisingly, health was not a major consideration of "dirt" in these results.

Public use of toilets was uncomfortable

Defecating in public is a boundary transgressor on several levels. Smell, noise, and sight are major concern that people have when defecating in public, as found by Chelvanayagam (2014). Laporte ([1968] 2002) says this is because it signifies to other people that forbidden bodily functions have occurred. When private shit is brought into the public sphere, people become ashamed

of what they produce and do not wish for others to see it (Thompson, 2013). This discomfort was reflected in the research.

The **WREMO** participants were deeply uncomfortable with trialling composting toilets in their office blocks. They did not wish their colleagues to see, or to smell, their effluent. They were also concerned with the idea of their colleagues emptying the bins and handling their faeces. Outside the office, one participant even hid his composting bin so neither he, nor his neighbours, would have to look at them and be reminded of their contents. There was therefore a perception that compost is "disgusting".

Maintaining compost was "disgusting"

Managing the compost process was declared "disgusting" by users in the **Fittschen** trial. Nearly all of the users they surveyed ultimately replaced the toilets with running-water toilets. Prior to that, they had hired external companies to extract the compost so they did not have to handle it themselves. The problems the users had with composting were due to the fact that they had not received sufficient training on how to ensure the process actually composted. Additionally, the toilets they used had been designed poorly and made emptying the chambers extremely difficult.

Lienert found people were more comfortable with the idea of urine diversion toilets in public than at home. This speaks to the idea that they are happier with other people handing their excreta, or that they do not wish to have the dirt inside their own homes. In private, composting toilets do not permit the luxury of maintaining anonymity for the user (Pickering, 2010).

One user in the **Dimpfl** trial felt that his spirituality was affected by the composting toilets:

> *Her husband explained the difference in terms of what he described as the "purity" of the lake. For him, it was a "spiritual place", and sharing domestic space with this type of waste was at odds with his aesthetic and emotional expectations of lake life.* (p.731)

This indicates that he objected to the toilets on moral grounds, rather than on hygienic ones. The idea that shit disrupts spirituality is a predominant theme of the BFH, as shit reminds us that we are corporeal, whereas the ideal is to never be reminded that we are (Inglis, 2001). Composting

toilets remind us of the "uncomfortable fact that... bodies... smell, leak, and push back into the space they inhabit" (Dimpfl & Moran, 2014, p.732).

These experiences reveal that user discomfort with compost can prevent them from using the toilets. Users' boundaries were transgressed with faeces being something that they never handled to being something which they had to consider daily. These results reveal that the perceived dirtiness of the toilets is moral. When questioned, users were not overly concerned with health.

Health was of little consequence

There was little evidence to suggest that users felt the toilets were unhygienic. The **WREMO** trial gave users composting toilets to trial in their own homes for a month in a mock emergency situation. Users of the toilets perceived that the toilets were quite hygienic and were perfectly satisfied. **Lienert**'s survey found similar results with urine-diversion toilets: users felt they were hygienic, and only a very small number of people were concerned with the risk of pathogens. They also found little evidence that people would be averse to using urine in agriculture. **Starkl** found that there was a risk of groundwater contamination from the use of urine in agriculture, but the results of their user survey showed that users were unconcerned with the contamination, and were mostly concerned with ecosystem effects and micropollutants.

The fact that users were not overall concerned with their health was surprising. Modern infrastructure was constructed in order to remove faeces as quickly as possible away from the site of defecation so as to prevent cholera and other waterborne diseases (P. F. Cooper, 2001). There is therefore a historical notion of the idea that faeces is unhygienic and can cause harm. This was reflected in a study undertaken by Teh (2015) to identify user comfort with alternative sanitation. They found users repeatedly said that they were concerned with health implications of alternative toilets. Therefore the lack of concern with health in these results appears to be an anomaly. It could be because once the users had familiarised themselves with the toilets, they realised that they would not get ill. Alternatively, users of the toilet were more likely to be eco-minded, and could thus be more aware of the utility of faeces. This would be an interesting area for future research.

This lack of concern with pathogens was reflected in the methodology of the Life Cycle Assessments (LCAs). Pathogens and their ability to cause disease are an important consideration of the BFH, and it is one of the main reasons why we use water to remove excreta (Inglis, 2001). They were mentioned by the majority of the LCA practitioners, but only to justify the length of time for which urine was stored. "Human health" was considered by **Benetto** and **Thibodeau**, but not from a pathogenic perspective. Instead, human health was modelled as a result of emissions from various sources including fertilisers and fossil fuels.

Whilst waterborne diseases are rare in the developed world in comparison to the developing world (R. George, 2008), a breakdown in the sanitation system could change that. Therefore, it is important to know the risk of pathogens for a given sanitation system, or at least to highlight that it's an important point to consider. There is work being undertaken to include pathogenic risk in LCAs (e.g. Harder et al., 2014), and so incorporating this into future LCAs would be a useful endeavour in order to determine other possible risks of EcoSan.

Easy cleaning made users more comfortable

Cleaning is a way of washing away perceived moral and hygienic dirt (Zhong & Liljenquist, 2006). The users developed new cleaning rituals in order to separate themselves from the dirt. However, if cleaning the toilets was difficult, users were distinctly uncomfortable and their satisfaction with the toilets decreased.

The cleaning rituals varied across the trials. They ranged from extra scrubbing (**WREMO**) to simply using the long flush in a urine separator instead of the short flush (**Berndtsson**). When the toilets were broken (**Fittschen**), or when there were strong odours or flies (**Kreissl**), the cleaning rituals became more elaborate. **Lienert** found that 60% of respondents reported that urine pipes blocked after less than one year of use. The deposits left rather unpleasant smells (**Berndtsson**), which made cleaning particularly laborious. Composting toilets could also be blocked, and faeces could get stuck in the pipe if it was too narrow to cope (**Fittschen**). Although composting toilets can be emptied every other day, many people emptied their

buckets daily, and cleaned them after emptying, sometimes increasing their time spent cleaning by up to as much as half an hour per day (**WREMO**). These cleaning rituals and user comfort were also related to how much it affected their daily routines.

4.2.1.2 Altered routines caused discomfort

According to Elias (2000), being a "civilised" member of society entails following a set of rules dictated by the conventions of the day. These rules include how one must sit at the table, how one must conduct oneself, and how one can and cannot shit. When these rules are challenged or contradicted, people feel distinctly uncomfortable, either because a taboo has been broken (O'Doherty, 1960), or because their standards of comfort and cleanliness are threatened (Shove, 2003a). Thus, any deviation from these standards leads to ostracism, shame and guilt (Chelvanayagam, 2014). The deviations included additional expenses, maintaining the compost, changing toilet habits, and explaining the toilets to guests.

Additional running costs

Some composting toilets needed fans to take the smell away, and heaters to ensure good composting, and the cost of the electricity for this was often quite high (**Fittschen**, **Kreissl**, **Wynia**). Whilst there was no direct evidence that the costs were prohibitive or affected user satisfaction of the toilets, it would seem likely that this could impact user acceptance. Research into barriers of "green" electricity by Ozaki (2011) suggests that even people who consider themselves to be "green" find that increased cost is a significant prevention to their use of the electricity. Therefore, it seems that extra running costs of EcoSan would likely be a barrier. This was reflected by the **Wynia** survey, which asked users if they would pay over a thousand dollars for a toilet and 60% of those surveyed said "no".

Maintaining the compost was a chore

One of the biggest complaints about composting toilets was the maintenance of the compost. Emptying the toilets was difficult for the elderly or weak, as carrying the bucket was heavy (**WREMO**). If the compost chamber was

in an inaccessible, or hard-to-reach location, then it was made even more difficult (**Fittschen**).

"Extra moisture was a major problem with early composting toilets" (**Wynia**). Too much moisture can cause the compost to anaerobically digest, which is undesirable because it releases methane, which is explosive, and smells (Jenkins, 2006). It can also cause the toilets to leak, as the participants in the **Dimpfl** trial found. Those participants were also affected by the leaking toilets because their leisurely activities included "a cold beer on the dock, lemonade on the deck, frequent rehydration in the summer sun", activities which were marred by the fact that they were "adding more urine than the toilets could effectively process". The problems with moisture matched experiences reported by Stoner (1978), who found that people sometimes asked their guests to urinate outside so as not to disrupt the compost process.

Other important types of maintenance included achieving the correct carbon to nitrogen ratio and temperature. Those in the **Berger** trial were advised to take one hour per month to maintain the compost pile, which involved levelling it with a special tool and to bring in "structural aids", and many of the users complained about having to do this, particularly since the conditions were so unfavourable, and they requested better technology. Compost is also very susceptible to the contents of humanure, and people who were on antibiotics were advised not to use the toilets, since the bacterial composition of the compost would be disrupted (**Dimpfl**). If the composting toilet was the main toilet for the users, then this would impact their daily routine significantly.

Changing toilet habits caused discomfort

The trial participants were expected to change their normal routines, sometimes quite disruptively. Alterations to their toilet routines depended upon the type of toilet in use. Composting toilets require the lid to be shut after use, so as not to let the smell emerge (Jenkins, 2006). Urine separating toilets require men to sit to urinate, and toilet paper to be thrown in a separate bin (Lienert & Larsen, 2010). They must be urinated into in the correct place, or else they do not work (Pahl-Wostl et al., 2003).

Children, the elderly, and disabled people, found it difficult to use the urine separation toilets, because the toilets were designed for the "average user" (**WREMO**). The toilets also had two separate flush levels: one for urination, and one for defecation. Many people – women in particular – would always use the longer flush, as the shorter flush did not always get rid of the smell of urine (**Berndtsson**). In contrast, composting toilets did not have handles to flush, which took some adjustment (**Dimpfl**).

Explaining to guests was shameful

Explaining the lack of a handle to guests became tedious, although one family would make flushing noises as a way to diffuse the situation (**Dimpfl**). This reflects concerns that users had in the **Fittschen** survey explaining to guests how to use the toilets. The reasons the users did not like to explain the toilets were not articulated, but it is likely that there was an element in shame in revealing that they were disrupting societal toilet conventions. Strong social norms as a barrier to acceptance of "green" technology have been observed in the electricity sector (Ozaki, 2011), and building sector (Hoffman & Henn, 2008), although this is an additional barrier to overcome due to the psychological burden of shame associated with faeces. However, user involvement in the implementation of the toilets could mitigate this effect.

4.2.2 Researcher discomfort affects the methodology

The BFH is a very prominent habitus in which we are living and affects our daily lives (Inglis, 2001). Under the BFH we have come to expect a certain level of cleanliness and comfort (Shove, 2003a). However, whilst we are living the habitus on a daily basis, it is not prominent because it has become so normalised. The extent to which it has become so is revealed by how the researchers of user satisfaction and LCA did not question the BFH. Even though they designed their research around EcoSan, the normalisation of the BFH precluded digging deeper.

Both the trials and the LCAs reinforced the notion that the human body is incapable of excreting (Inglis, 2001) in the way they discussed the products, not the process, of excretion: "wastewater", "effluent", "nutrients", "sewage", "faeces", and "urine". The public who created the effluent were abstracted to

numbers, with the results of the models or surveys generally being presented as divorced from the participants. When the word "excretion" was employed, it was in a passive sense "after excretion it contains" (**Spangberg**), or "at excretion" (**Jonsson**). This discomfort was further revealed in the design of the questionnaires and the assumed dirtiness in the LCAs.

4.2.2.1 Design of questionnaire was shallow

Users were predominantly asked questions about their comfort with the toilet, how easy the toilets were to clean, and whether or not there were problems with odour or flies. Whilst these questions are important to analysing user comfort with the toilet, there was no evidence that the researchers had probed deeper. Questions such as "why are you uncomfortable?" were not asked, they were limited to "are you uncomfortable?". "Why" was a question missing from the research. Perhaps this was due to the researchers being ashamed to ask, or perhaps it simply did not occur to them that there is a "why" to be asked. This highlights the prominence of the BFH: composting toilets are disgusting, that's a given! The assumed dirtiness was also prevalent in the LCAs.

4.2.2.2 "Dirtiness" assumed in LCAs

All the LCA scenarios apart from one in **Lehtoranta** assumed the use of water in the imagined EcoSan implementations. More than a quarter of the LCAs were even titled in terms of "wastewater" treatment. This idea of using water to wash away the dirt of shit is a fundamental component of the BFH (Inglis, 2001), but its use was rarely questioned. If water use was discussed, it was to minimise its consumption, rather than eliminate its use altogether. For example, **Ishii** says "wastewater treatment must... be treated as the opportunity to recover valuable, depleted resources, such as water". The notion is that of recovering water, rather than eliminating its use altogether.

Dirt was also implicit in the discussion of pollutants caused by the systems under study. Emissions and their contributions to eutrophication, acidification, and global warming, were considered to be "dirty" and "bad". The first two are usually discussed in terms of "dirty water", as they cause algae

blooms, kill fish, and emit odours (Sharma, 1994). Odours are a fundamental assault to the BFH, given our strong reactions to them (Laporte, [1968] 2002), and algae blooms and dead fish impinge on our strong connection with water and its associations with "cleanliness" (Coughlin, 1976). Similarly, global warming is associated with "dirty industries" (Haines & Reichman, 2008), being countered with "clean energy" (Jewitt, 2011b). Thus the researchers, the LCA methodology, and the LCA framework are complicit in the framing of sanitation as "good" and "bad", or "clean" and "dirty". For example, **Karrman** discusses discharging "wastewater effluent"; many of the papers use the term "blackwater"; and **Remy** talks about water being "contaminated with faecal pathogens".

4.2.3 Nature as "out there"

A core component of the BFH is the cultural narrative that people are not part of nature. Nature is conceived as this concept, simultaneously wild and tamed, which resides somewhere outside the city (Cronon, 1996). Food is grown outside in the dirt, our wastewater and faeces are sent out into it, and our only relationship with "nature" is mediated through how we can control her. However, as argued by Castree (2005), there is no such thing as "nature", although the false dichotomy was actively reinforced by the trials and the LCAs.

The geographical locations of the projects and LCAs were outside the city. All the trials except one were in ecovillages, or in rural areas disconnected from the mains. The trial which did occur in a city (**WREMO**) was to simulate an emergency situation, and so sent the message that EcoSan is permissible in a city, but only within the context of an emergency. The LCAs were in cities, but the Wastewater Treatment Plants (WWTPs) and ultimate destinations of the humanure was outside the city. They were modelled under the assumption of mirroring the status quo to the greatest possible extent, whereby fields and "nature" reside outside the cities of people.

The separation between "nature" and people is maintained by the LCA terminology. There exists the "ecosphere", from which resources are extracted into the "technosphere", where they are transformed and used before being

emitted as pollution back into the ecosphere (Hofstetter et al., 2000). Discussing the world as such reinforces the idea of "nature" as separate from people. It also maintains the idea that humanity taints "nature", in the words of John Muir, man is a "blighting touch" (Rockwell, 1990).

4.2.4 Controlling "nature"

Faeces remind us that we die (Becker, 2007). But the BFH dictates we set ourselves apart from death and "nature", for they remind us of dirt; so we attempt to control the dirt by controlling "nature" (Inglis, 2001). This discourse was prevalent in the LCAs.

Many of the system boundaries of the models explicitly excluded water production, instead starting from wastewater collection (Figure 4.1). Water scarcity indexes (e.g. A. Brown & Matlock, 2011; Koehler, 2008) were not applied to determine the effects of extraction, nor was there discourse on the potential social implications. However, emissions *to* water were considered by all models. This reinforces the notion that "nature" is infinitely exploitable, and that humans do nothing but make waste and dirt, which "nature" will process. The separation between "nature" and people is maintained by the LCA terminology. There exists the "ecosphere", from which resources are extracted into the "technosphere", where they are transformed and used before being emitted as pollution back into the ecosphere (Hofstetter et al., 2000). Discussing the world as such reinforces the idea of "nature" as separate from people. Additionally, it also reproduces the assumption that "nature" is a provider of resources to be exploited (Pelletier, 2010).

In this framing, "nature" is something from which we can extract for our purposes, use, and then dispose the unneeded remnants into the biosphere (Shepard, 1998). Of the LCAs studied, the majority stated that they were looking to minimise resource consumption in one way or another, be that reducing energy and water consumption, limiting the extraction of phosphorus, or just generally being more efficient. For example, **RemyEnergy** uses LCA to explore the implications of reducing energy consumption of sanitation systems; **Benetto** aims to "reduce the pollutant[s]"; and **Spangberg** looks to lower the use of "energy and chemicals".

However, this narrative was not reflected in the impact assessments which were undertaken. There are types of indexes which can be used to quantify the effects of over-extraction from the environment, and these resource scarcity indexes have been developed for a number of resources (e.g. L. Schneider et al., 2014). However, none of the LCAs undertook an assessment using one of these indexes, nor was there a discussion about the impacts of resource extraction. There seemed to be a prevailing viewpoint that extraction from the environment was possible ad infinitum.

The hypothetical nature of the LCAs is representative of how eco-efficiency is not grounded in the real world. Current neo-liberal economics views the world as infinite, and that all resources are such (Pacheco-Torgal et al., 2014). None of the LCAs applied resource scarcity indicators to determine the effects of extraction of resources on the environment. There was an implicit assumption that "nature" is able to provide without consequence. This was surprising because many of the LCAs were framed in terms of a resource crisis, sustainability, and the need to protect the environment. This separation between humans and "nature" is maintained by the dominant engineering mindset.

4.3 Engineering mindset

The results of the thematic analysis under the engineering mindset revealed that it dominates discussions of Ecological Sanitation (EcoSan). This was revealed in reductionism, techno-fixing, and reinforcement of the status quo.

4.3.1 Reductionist

Reductionism has been applied to society and the environment, which Kirkman (2002) argues has been to detrimental effect (Kirkman, 2002). "Nature" has been broken down into its individual components, and society is reduced to individual people, both of which elevate the singleton above the whole. However, complicated systems such as EcoSan are irreducible to individual components as they will interact with each other in complex and unknowable ways (Movik & L. Mehta, 2010). By restricting the scope of study to nothing but nutrients moving through a system, an entire tranche of perspectives is

lost (Gasparatos et al., 2009), and there is limited application in addressing the environmental concerns of sanitation (Garnett, 2014). This reductionism was prevalent in the Life Cycle Assessments (LCAs) through their static approach, using "nature" as a proxy, and not considering all emissions. This section will exemplify how.

4.3.1.1 Static models can only show so much

A standard LCA (ISO, 1997) takes a snapshot of a system at a specific point in time and space, and is not designed to continually respond to updates in the socioeconomic system (Bor et al., 2011). However, EcoSan and reticulated water systems are dynamic. For example, if artificial fertiliser is no longer used, then its price will likely decrease, which will make it a more attractive option to farmers, who may then wish to switch back to artificial fertiliser. There is thus a complex assemblage of overlapping economic and sociotechnical forces which will continually impact and affect the results of the LCA (Kaika & Swyngedouw, 2000). None of the LCAs were sufficiently able to encapsulate these dynamics, which limits the scope of their applicability. The example of artificial fertilisers is also relevant to the idea that "nature" is often proxied.

4.3.1.2 "Nature" as a proxy

According to M. H. Huesemann (2002), there is a tendency to assume that "human capital" and "natural capital" are equally interchangeable. However, human capital is created from natural capital, and so there is only so long that human capital can substitute for natural capital (M. H. Huesemann, 2004). Many of the LCAs engaged in the idea that human capital can be used as a proxy for natural capital. One way in which this substitution is made is in determining avoided production: **Thibodeau**, for example, considers the "potential environmental impact" of "nutrients available" by substituting blackwater for the "production and spreading of synthetic fertilisers". However, this is based on economics and market costs, i.e. human captial, and assuming like-for-like between synthetic and organic fertilisers. **Benetto**, **Ishii**, **Lundin**, and **Tillman** made similar assumptions.

Instead of discussing direct impacts of resource extraction and emissions on the ecosystems, many of the LCAs used energy as a proxy. This is consistent with other LCAs in the construction sector, for example (Ortiz et al., 2009). From a mathematical perspective, there is evidence to suggest that this gives a reasonable approximation of the environmental effects (de Haes, 2006). However, from a subjective point of view, they are incomparable. To a given community or ecosystem, the effects of mining phosphorus will be completely different to the effects of extracting water from a river; it is like comparing apples and elephants (Margni & Curran, 2012). The idea that energy or cost can act as a proxy for resource extraction is a long-standing criticism of current economic practices (Desaulniers, 1995). The researchers were thus reinforcing the status quo of reducing "nature" to nothing but its individual components.

Similarly, humanure was reduced to its simplest possible forms. For example, many of the LCAs only considered nitrogen and phosphorus as beneficial elements of humanure. When urine and faeces were reduced to their constituent parts, urine was considered to be much more valuable because it has a higher nutrient content than faeces (Krebs, 2013). However, faeces is a very useful soil conditioner and provides other benefits that artificial fertilisers do not such as structure and resilience to weather (R. Jones, 2012). Soil science has long-since recognised that soil cannot be reduced to its individual components, and that it's a very complex entity with many different benefits (Bouma, 1997). Drawing conclusions from LCAs which still treat urine as more important on nutrient content alone would be ill advised.

4.3.1.3 Not all things considered

The ISO (1997) says that an inventory is supposed to account for all inputs and outputs of a given system. This includes energy, raw materials, emissions to air, discharges to water, and other environmental aspects. In reality, however, as Fleischer and Schmidt (2000) explain, it is very difficult to quantify some of these inputs and outputs, so the inventory stage is often reduced to just examining resource consumption. Thus a complex system is scaled from multiple emissions and effects to just those which can be examined as resource consumption.

Not all emissions and wastes were considered. For example, nitrogen and phosphorus emissions were considered by all of the models, but pharmaceuticals, micropollutants, and pathogens were not considered by any. In addition to excluding certain emissions arising from faeces, there was no acknowledgement that the users of the system would impact the levels of emissions. Different diets will affect the humanure and wastewater compositions, which in turn will affect the amount of emissions released during treatment (Muñoz et al., 2007). Using average diets and average faeces composition decontextualises the results. Whilst the difference may not turn out to be significant, it is still an important assumption to note, and it was not noted.

4.3.2 Techno-fixing

The LCAs and practical trials exhibited signs of "techno-fixing" (Morozov, 2013), which is an opinion that there are quick, easy fixes to environmental concerns which can be achieved by finding the "right" technology (Carr, 2013). However, this mechanistic view of society does not sufficiently encapsulate the complexity of people and the environment, and cannot be sufficient to address EcoSan (M. Huesemann & J. Huesemann, 2011). Privileging the technical means that other forms of knowledge which aren't scientified are considered as less worthy of consideration (Vos & Everson, 2009). This has the effect of policing and silencing those who are not experts in science, and reinforces existing technocratic power structures (Fischer, 1990). However, as Swyngedouw (2009) argues, unless this viewpoint is reframed, questions of environmental justice and egalitarian social situations will be unattainable. The LCAs and trials exhibited signs of "techno-fixing" and privileging the technical above all else. This was manifest in not including stakeholders, and excluding the end users. This section will discuss in more detail how the LCAs and practical trials exhibit techno-fixing.

4.3.2.1 Stakeholders were not included

According to (Abdelnour, 2015), it is important to consider who gains and loses in a techno-fixed situation because it helps with analysis when the systems fail. The more involved with a given techno-fix someone is, the less likely they are to blame the technology itself for the failures, and the more

likely they are to blame end users, governance, corruption, or technical issues which can be designed away. That is, the less likely they are to critically assess the technology under examination.

Standard LCA methodology as described in ISO (1997) specifically states that all relevant stakeholders must be enumerated. This could include building managers, legislators, and users of the toilets. In addition to present users of the system, when considering sustainability, future generations must be considered as stakeholders (Paragahawewa et al., 2009). Additionally, Thabrew et al. (2009) has argued that stakeholders must be consulted when undertaking an LCA as it is the environmentally responsible approach to take. However, only the **Benetto** LCA mentioned stakeholders. There was no information on how the systems were chosen, who chose them, for whom the systems were designed, and who would benefit or lose from a change in the sociotechnical regime. This neglect of the social was reflected in how end users were an afterthought.

4.3.2.2 End users were an afterthought

A study undertaken by Russell and Lux (2009) on wastewater recycling found that the "yuck factor" encountered when considering wastewater recycling is not "hardwired" and can be overcome. This reflects research undertaken in other sectors such as new forms of electricity (e.g. Weber, 2003) and increased acceptance of technology by elderly people in their homes (e.g. Clark & McGee-Lennon, 2011) There is thus a diverse branch of literature which indicates that user involvement is vital in the success of uptake of new technology.

This was reflected by several of the user surveys. In particular, users in the **Bregnhoj** trial took the initiative to install their own composting toilets and were extremely satisfied with the outcome. This matches experiences found by Cordova and Knuth (2005b) in Mexico whereby those users most engaged with the use of the toilets were significantly more likely to be pleased with the results. It also corroborates findings by Stoner (1978) who found that users who installed their own toilets were extremely content.

In contrast, users who were not involved with the installation and design of the toilets were unsatisfied. The **Fittschen** trial is a good example of this.

Participants lived in an eco-village, and studies have suggested that residents of an eco-village are more knowledgeable and engaged with "green" living (e.g. E. Schneider et al., 2015). Cordova and Knuth (2005b), Lienert and Larsen (2010), and Stoner (1978) have also found that people who identify more as "green" are more likely to be willing users of alternative sanitation. Therefore, the fact that users in the **Fittschen** trial were extremely unhappy with their toilets shows the importance of user involvement. They were given insufficient training on how to maintain the compost and they became increasingly dissatisfied until they opted to switch to water toilets. Their discomfort was such that it overcame their desire to use more "eco-friendly" toilets.

4.3.2.3 User concerns were not considered

The LCAs and practical trials privileged the technical over the social and silenced the concerns of users. LCA practitioners focused on energy consumption and global warming, which does not align with the concerns the surveyed users had. For example, **Lienert**'s survey found that users are concerned with micropollutants and pharmaceuticals in humanure, yet none of the LCAs considered these. The lack of inclusion of micropollutants and pharmaceuticals in LCAs has been noted by Renou et al. (2008), who explain that there are few databases which consider their existence. There is work underway to develop models for pharmaceuticals (e.g. Igos et al., 2012), and micropollutants (e.g. Wenzel et al., 2008) in LCAs of wastewater, but it seems these concerns have been largely neglected.

This gap between scientists and user concerns is well-known, particularly in the climate change sector (G. Marshall, 2014). Kiem et al. (2014) explain that scientists tend to follow a linear pathway of research which focuses predominantly on greenhouse gas emissions and their impacts. End users, on the other hand, find that too abstract and uncertain to reason about or to fully envisage. This means that the focus on greenhouse gas emissions in the LCA will likely obscure the results to the end user, when and if the end user is considered.

In addition to neglecting concerns of end users, the LCAs were not undertaken to help identify more comfortable technology. LCAs have been used to

identify environmental effects in the design stage of products, and there are emerging methods in the LCA community which are being used for product design (e.g. Pialot et al., 2015). However, the primary focus for the practitioners was environmental effects, whilst user satisfaction was ignored. This reflects similar debates in the social justice space whereby public toilets are not designed for user comfort, but are simply a space in which to defecate (Gershenson & Penner, 2009).

User comfort was also not considered in the implementation of the practical trials. Many of the users surveyed who had their toilets provided were deeply uncomfortable with the toilets (**Fittschen**, **Kreissl**). They were not given sufficient training in how to use the toilets and oftentimes the toilets broke or clogged (**Lienert**, **Fittschen**). **Berndtsson** found that a third of users didn't know how to use the urine diversion toilets, and were deeply unhappy at using them. It seems unlikely that an on-the-market toilet developed in close conjunction with various users would cause so many problems, and it appears as if the toilets were designed and marketed without due consideration of the users throughout the design process. There was no critique of the technology which was given to users, and several of the conclusions were that education was sufficient to overcome any problems faced.

This contravenes everything recommended by a design guru (Norman & Berkrot, 2011), who says that the user is the central component of any piece of technology. These criticisms of alternative toilets are also levied by another designer, Virginia Gardiner, who developed a new type of toilet, the Loowatt (Loowatt, 2015) in order to address some of her concerns with the way alternative toilets were being designed without the end user in mind.

4.3.3 Maintaining the status quo?

Ignoring the social dimensions of EcoSan is also part of the trend in the LCA community to turn LCA into a science, when it fundamentally is not a science (Heiskanen, 1997). Practitioners have attempted to universalise LCA methodology, which has stripped the results of their local context (Schaltegger, 1997). This has the effect of privileging the scientific paradigm over the social concerns of users, which in turn reinforces the status quo. This

has been revealed by discourses around "better", "normal" use of toilets, and radical paradigms not being considered.

4.3.3.1 Better for whom?

LCA has been heavily criticised for ignoring the fact that many practitioners do not acknowledge the values that they hold, and instead focus on technical and environmental outcomes as if they were truth (Panebianco & Pahl-Wostl, 2006). However, all LCAs are undertaken by researchers with values, including how they see and reason about the technosphere and ecosphere, which are supposedly objective (Hofstetter et al., 2000). There is no one universal set of standards which researchers adhere to when undertaking LCA (Finnveden, 1997). There are sets of indicators which can be used, but the researchers will choose them according to their needs, as recommended in the official guide (ISO, 1997). Practitioners decide what is important to include and exclude, and they build a model to represent their world view (F. Werner & Scholz, 2002). This was reflected in the discourses around "better".

As shown in Table 4.3, many of the papers reported that the alternative scenario was "better" than the other. This was not strictly accurate as many caveats and assumptions were employed in order to determine these results. In fact, it is more revealing to present results as "X is better than Y for these particular stakeholders in these particular categories". The exclusion of the stakeholders, however, meant that the results were presented as better for the practitioners, which is only a concern because that was not explicitly stated.

LCA	Better	Worse	Neutral
Benetto	Small US	Large US	
Ishii	US1	US2	
Karrman	LC US		
Lehtoranta	DT		
Lundin	LC US		
Remy			US
RemyEnergy	US		
Spangberg			BC US
Thibodeau	BC		
Tillman	US		US

(BC) Blackwater collection; (DT) Dry toilet; (LC) Liquid composting; (US) Urine separation

TABLE 4.3: Reported results in the abstracts of the LCAs

In order to determine which system was "better" than the other, data were aggregated. Two papers undertook endpoint impact assessment, and they reached opposite conclusions. **Benetto** found that EcoSan had better "ecosystem quality" outcomes, whilst being worse than an optimised conventional system for "human health" and "climate change". **Thibodeau**, on the other hand, found differing results for different iterations on a liquid composting scenario, although "ecosystem quality" was always comparable, or better, for the alternatives. Endpoint impact assessment is a notoriously difficult problem because it entails making assumptions about future results of impacts that have not yet happened (Bare et al., 2000). Human health, for example, is a qualitative measure which can be quantified in many ways, by looking at carcinogens, respiratory irritants, radiation, ozone depletion, or water scarcity to name a few (Boulay et al., 2011; Renou et al., 2008). It is used in decision-making, to turn midpoints such as "eutrophication" and "acidification" into measures which are easier for non-engineers to understand and reason about (Bare et al., 2000). This over-simplification means that nuances are lost in the assumptions and caveats employed to make a statement like "EcoSan is better than conventional sanitation".

4.3.3.2 Not for "normal" people

All the trials and LCAs were positioned in alternative lifestyle situations. Trials were undertaken in ecovillages, hostels, holiday homes, garden centres, emergency situations, and green buildings. LCAs were developed either based on entirely hypothetical scenarios, or were prepared as decision tools for green buildings, areas with no connection to the mains, or for new housing developments. Moreover, the LCAs did not overlap with any EcoSan project, and were undertaken as hypothetical examples, rather than assessing the environmental performance of existing systems. This sends the message that EcoSan is for hippies, "roughing it", the outdoors, emergencies, or the future, rather than for the everyday. The prevailing discourse is thus that EcoSan is simply too difficult for "normal" use, which is a position held even by the people running the trials and performing the LCAs.

4.3.3.3 Radical paradigms not considered

The use of existing technical regimes to maintain the division between people and "nature" meant that radically new paradigms were not considered by either the practical trials or the LCAs. Figure 4.2 shows a reinterpretation of Figure 4.1, with the mixed wastewater streams removed, landfill taken away, and food production to household included. If EcoSan were truly being considered, this is the type of system that would be expected.

Over-emphasis on pipes

Pipes are a fundamental component of wastewater infrastructure, as they keep the dirt underground and hidden, which allows us to continue labouring under the denial that we are part of "nature", or that we shit (Gandy, 1999). As shown in Figure 4.1, most of the LCAs were of urine separation with faeces sent to the Wastewater Treatment Plant (WWTP). One common implementation of the urine separation was to install extra pipes from the toilets to urine storage. Constructing the multiple pipe networks had negative environmental effects, including more CO_2 released and more waste being created due to higher construction requirements than the conventional system. These results sparked discussions on the overall utility of urine separation, but never questioned whether or not pipes were necessary, as there

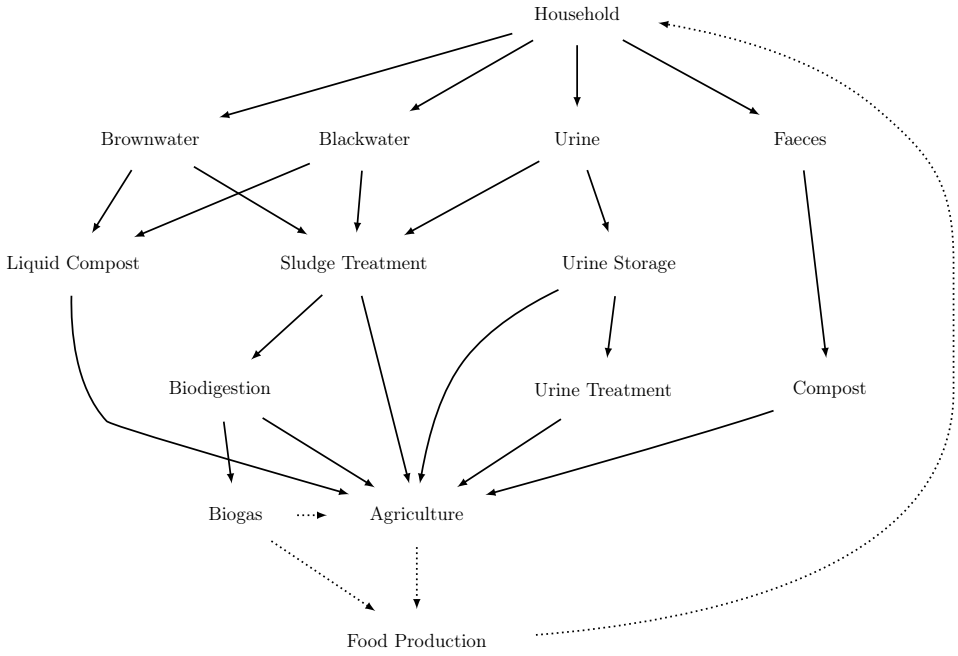

FIGURE 4.2: Closed-loop system

was an implicit assumption that pipes will be required in EcoSan projects. Only **Lehtoranta** modelled an entirely different system, which considered composting humanure on-site with no extra pipes or capital infrastructure. The other practitioners were looking to make small tweaks to greywater or sludge treatment. None of the alternatives questioned the use of pipes as a way of removing excreta from the site of defecation. It was simply assumed a priori that technology is the best way to approach sanitation (Jollands, 2003).

This also had the effect of maintaining the centralised nature of the wastewater infrastructure, and thus the "sewer state" (Dunn, 2007). Decentralised treatment was considered in three of the models, but only as part of a larger, centralised system. Humanure was still treated as a public responsibility – divorced from the individuals who created it. The idea of state domination of wastewater treatment and pipes was so embedded in these discourses that radical new ideas which question the division of cities and "nature" such as urban agriculture was not discussed.

Urban agriculture not considered

Urban agriculture is the idea that food can be grown inside a city (Esray, 2002). By growing food in the city, urban agriculture tears down the divide

between cities and "nature". It questions the idea of the countryside as the "right" place for food, and presents an opportunity for "nature" to come into the city (Mok et al., 2013). However, the image of food as "out there" is so prevalent that the idea of urban agriculture is rarely discussed in the context of EcoSan (Dana Cordell et al., 2009) and has not yet received much critical academic attention (D. Cordell et al., 2011). This was reflected in its lack of inclusion in the LCAs and trials.

The use of humanure for fertiliser was discussed, but there was no discourse around food production, nor how the nutrients would be used. Participants of the trials were asked about how they felt about food, but there was no follow-up for whether or not the humanure was even being used for food, or if it was simply left to compost away. Similarly, the LCAs modelled linear systems whereby nutrients went from the household to agriculture, but there was no discourse on food production nor the efficacy of the reclaimed nutrients at growing food. **Benetto**, for example, determined that using fossil fuels in trucks to transport urine from people's houses to storage and treatment meant that the urine separation system emitted more pollutants than the conventional system. Other models also displayed this sensitivity, although the **Benetto** model was more pronounced. However, rather than question the idea that trucks should be travelling 40 km outside the city, they concluded that urine separation was less environmentally friendly, and that a highly optimised traditional wastewater system would convey more environmental benefits. By framing the scenarios as such, urban agriculture was ignored.

4.3.3.4 Challenging the status quo?

Toilets, particularly public toilets, are one of the last few openly segregated places in the developed world (Gershenson & Penner, 2009). The most obvious manifestation of this divide is by gender: women go one way, men the other, which not only changes the way we speak about public spaces in terms of gender, but is also trans-exclusionary (Cavanagh, 2010). They also separate the able-bodied from the disabled, severely restricting the freedom of those in wheelchairs, or the elderly, for example (Kitchin & R. Law, 2001). Less obviously in the developed world, access to a toilet is a reflection of

one's socioeconomic status. Homeless people do not have access to toilets, forcing them to violate social conventions and relieve themselves elsewhere (Kawash, 1998). Alternative modes of sanitation have the potential to deconstruct these divides, but importantly they also have the potential to reinforce them.

Tearing down gender divides

Challenges to traditional gender roles may arise in one of two ways: necessitating that men sit to urinate, and requiring that we ask "who handles the excreta?" Urine separation toilets require men to sit, who were less likely to do so than women, and who were more likely to find the toilets uncomfortable (**Berndtsson**). However, if urine separation were to proliferate, this cultural phenomenon may get redefined, and forever put an end to debates over whether or not the lid should be up or down. Composting toilets, however, may spark new debates around who would be responsible for their maintenance.

Traditionally in developing countries, women are responsible for the handling of excreta, and the cleaning of latrines (R. George, 2008). Since the introduction of the flush toilet in the west, however, the handling of excreta has become a man's job, with sewer workers and plumbers predominantly responsible (R. George, 2008; A. Williams, 2013), whilst the cleaning of toilets remains a woman's job (Coles et al., 2015). **Dimpfl** found that responsibility for the composting toilets inevitably was delegated to one person. They found that either "Mother takes care of this", or the alpha-male said "don't touch it; I'll maintain it". There is little research in the developed world which addresses how this might change, which may be because there is little concern in the developed world about who maintains compost piles. Since there is no predefined "script" (Oudshoorn et al., 2002), or codified gender norms for this, there is a good opportunity for future research to ascertain how gender roles may be rewritten with EcoSan.

Disabled people overlooked

The **WREMO** study found that handling the compost could also be an able-bodied problem. The elderly and disabled were unable to carry the bucket

for it was too heavy, and children and the elderly had trouble urinating into the urine collector. No other study mentioned disabilities as a fact which had been considered, which corroborates the notion that the disabled are largely ignored from conversations around toilets (Kitchin & R. Law, 2001). A flush-and-forget system requires such little maintenance from a user that it is easy for most everyone. Changing that sociotechnical regime could have further consequences for those who already find toilets to be inaccessible.

Class maintained

Finally, toilets are a marker of class distinction. Many of the LCAs discovered during the literature search for this thesis were in the context of the developing world. There has been a lot of interest in dry sanitation for poorer nations, which frames waterborne sanitation as for the wealthy, and dry sanitation for the poor (Cordova & Knuth, 2005a). Whilst that appears to be the case on a global scale, on a local level in the developing world, dry toilets, particularly urine separators, are expensive (**Ishii**). The **Wynia** trial asked users if they would be willing to spend $1200-1500 on a toilet, and more than half of the respondents said no. Their price means that they can only be attractive to the wealthier members of society who want to be environmentally-friendly – the "greenies" (Sandercock, 1990). However, EcoSan is the most affordable option for people in rural communities as connecting to a sewer, or installing septic tanks, or transporting waste to a centralised WWTP is expensive (**Starkl**). Therefore it seems that retrofitting is outside most people's price range, but for those starting afresh, EcoSan is very affordable. However, most people do not live in circumstances whereby they are not on mains (Knoema, 2015), and therefore retrofitting EcoSan would be prohibitively expensive for many.

4.4 Summary of results

Themes from the bourgeois faecal habitus (BFH) and engineering mindset were prevalent throughout the Life Cycle Assessments (LCAs) and user surveys assessed. Thus, the trials and the LCAs are still firmly entrenched in the habitus which must be undone in order for the paradigm they are promoting, Ecological Sanitation (EcoSan), to become ubiquitous. They both maintain

the notion that "publics don't shit" (Hawkins, 2005), and that the individual need not be concerned with the effects of their defecation. When the users were faced with challenges to their toilet rituals, they became distinctly uncomfortable, due to cultural notions of "dirt". Sanitation systems were modelled as morally "dirty", as all pollutants are considered to be negative and bad. The prevailing viewpoint is that excreta belongs elsewhere, outside of the cities, and is the responsibility of someone else. Engineers have taken on that responsibility, which is a paradigm that was unquestioned throughout this analysis.

The LCAs were academic exercises, undertaken with little-to-no stakeholder involvement. In a sense, they were products of the researchers' imaginations, without being grounded in the real world, and were therefore limited in their ability to say much about the sociotechnical effects of EcoSan. Were the LCA researchers working in conjunction with end-users of EcoSan toilets, they could have developed models describing existing trials and worked with users of the toilets to make the experience more acceptable for them, as well as for the environment. Particular areas which could have been addressed were water consumption and micropollutants, as well as developing models which could approximate smell and comfort. Undertaking an LCA is time-consuming and labour-intensive, and many parts of the sociotechnical system were excluded for simplicity. However, it has utility at identifying areas of a process which could be improved upon within the given goals of the stakeholders. By more fully integrating user concerns with EcoSan, LCA could be a powerful tool to aid the sociotechnical shift toward EcoSan.

Chapter 5

Conclusion

This thesis used a variety of literature on EcoSan to explore the question "why is EcoSan not more ubiquitous in the developed world?". The following objectives were achieved:

- To show how research undertaken in EcoSan is firmly embedded in this notion that we cannot shit and that we are separate from the world around us.
- To identify and critique the engineering paradigm which is used to guide the research that is undertaken in EcoSan.

A theoretical framework of the BFH and engineering mindset was developed, drawn from a wide range of academic literature. Specifically, the work of Douglas ([1948] 2003) was used to develop a framework of what it means to be "dirty", and the work of Inglis (2001) was used to show how that has been harnessed and gives rise to the BFH. The engineering framework was built by way of analysing the LCA literature to reveal specific criticisms of the engineering mindset when applied to a tool that is theoretically holistic.

The framework was applied to LCAs and practical EcoSan projects in order to identify common themes and discourses around EcoSan. The themes related to the BFH were: "how we view ourselves as dirty and clean", "contradicting normal conventions", "redefining sectionalism", and "controlling nature"; themes related to the engineering mindset were: "reductionst", "eco-efficiency", and "attempts to scientify". These themes were used to show that EcoSan is not more ubiquitous in the developed world because it is being approached from the perspective that we do not shit, and that engineering is sufficient to alter the sanitation paradigm.

If EcoSan is to become more ubiquitous in the developed world, it is necessary to address that this is the direction from which research is being undertaken. The practical projects asked users how they felt about the toilets that they were using, but the majority of the participants were not involved in the development nor implementation of the EcoSan toilets. The toilets were considered to be "dirty" and made the participants feel transgressed and ashamed. Instead of designing or developing toilets in conjunction with the users, a "techno-fix" approach was taken whereby the users were given a toilet to use without adequate support or understanding. This lack of stakeholder involvement was reflected in the LCAs, which were undertaken without specific reference to stakeholders and seemed merely to reflect the wishes and desires of the practitioners. Therefore, neither of the approaches fully encapsulated the philosophy of EcoSan which is to include a wide range of social and technical perspectives in a local context to close the nutrient loop. Neither of the approaches accounted for the "dirt" of the habitus, nor did they analyse why and how we may feel the way we do about nutrient recycling.

Additionally, the LCAs showed that EcoSan may have negative environmental consequences. However, as shown, the LCAs did not incorporate the entire lifecycle of an EcoSan system. Instead, they focused solely on the wastewater collection and treatment, and many excluded water and food production. By not including water extraction and treatment, one of the main environmental benefits was ignored. Food production was also neglected, even though that is a core component of EcoSan. Substitutes were made for nitrogen and phosphorus in the poo which did not reveal the multitude of benefits of using humanure that are not reducible to the elements nitrogen and phosphorus.

Finally, neither the practical trials nor the LCAs included a mention of urban agriculture. The division of "nature" and cities is so prevalent that the thought of growing food inside the city walls did not occur to the researchers. It is becoming more acknowledged that cities might be a very good locus of food growing, so as to reduce the global warming emissions of transporting food from the fields to the cities. By integrating EcoSan with urban agriculture, it might be possible to have cities which no longer treat

nature as a boundless resource to control, but to start respecting the limits of the system as dictated by the second law of thermodynamics.

In short, EcoSan is not more ubiquitous in the developed world because it contradicts our view of ourselves as non-shitting creatures living in our cities separated from the whims of "nature". Unless that viewpoint is addressed, EcoSan will in all likelihood continue to be a fringe technology frequented by the hippies and disaster-relief communities, and flushing water toilets will remain the status quo.

5.1 Future research

This analysis has also revealed several areas for future research. The concerns of the users were largely neglected by the Life Cycle Assessment (LCA) practitioners. There is therefore a need to incorporate aspects of Ecological Sanitation (EcoSan) which were highlighted as concerning to users. Micropollutants and pharmaceuticals are the two main examples of this. Furthermore, researchers could start to design toilets that are more comfortable and do not block, following design principles as laid out by people such as Norman and Berkrot (2011). Finally, one of the most promising and fruitful areas of research would be urban agriculture.

Urban agriculture has many potential benefits. By minimising the space between cities and food, it could drastically slash environmental emissions. Furthermore, were EcoSan to be completely integrated with urban agriculture, the distance between people's shit and food would also be drastically decreased. This has the potential to fundamentally challenge the way in which we view ourselves and our cities. It could tear down the arbitrary divide between "nature" as "out there" and people as cocooned in concrete. There is also a potential that by bringing "nature" into the city, we could redefine our relationship with her and cease viewing her as an infinitely exploitable concept, and start showing "us" the respect we deserve.

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