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# **The Political Ecology of Pee and Poo**

*Peak Phosphorus and the Metabolic Rift in Discursive Struggles*

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## Abstract

This thesis investigates how the metabolic rift and peak phosphorus are represented in Norwegian media and policy documents. The investigation is done with the use of critical discourse analysis. The material investigated consists of 28 texts from Norwegian newspapers and two documents from the Norwegian Environment Agency.

The theoretical framework is based on the theory of hegemony, infrastructure lock-in and path dependency theory. The analysis shows that technology and neoliberal economics have a hegemonic role in the domain of peak phosphorus and the metabolic rift. There are discursive struggles between the hegemonic discourses and other more critical sub-discourses.

I argue that the hegemonic discourses substantiate the lock-in of the water-based sewage system. The current system is technology installed to solve a problem partly created by technology, while forging new problems. In the material, there is no discussion of the water-based sewage system as part of the problem, which underlines the argument that this is a lock-in.

Keywords: Metabolic rift, peak phosphorus, human excreta, sustainable sanitation, critical discourse analysis, Norway

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# 1. Introduction

A previous lecturer of mine said: “The wide spread use of the water closet is one of the biggest environmental catastrophes in history”. It triggered my curiosity and led to an investigation of the political ecology of pee, poo and phosphorus in an earlier paper (Lowzow 2016). In this thesis, I will dig deeper into this and look at the political ecology of pee and poo with the focus on our sewage system and the metabolic rift it creates. I will look at the seldom mentioned connection between what you shit and what you eat<sup>1</sup>. Human excreta contain nutrients that could be recycled back to the soil it was harvested from before it was eaten. In the Global North, the normal custom today is to flush away the nutrients from human excreta while substituting the fields with artificial fertilizers. Several scholars (for example McClintock 2010 and Tomich et al. 2011) address the issues of nutrients, fertilizers and human excreta. Ryan Galt is one of them and he writes:

What happens after consumption —that is, excrement [...]—also remains underexamined. The flow of materials and energy is not a linear chain, and the human body is not a final destination. Humans are enmeshed in ecological food webs; one organism’s waste is the food of another. Political ecologies of human waste regulations, composting toilets, night soil, and sewage sludge beg for attention. With coming scarcities of synthetic nitrogen with peak oil and peak phosphorous from depleted rock mining supplies [...], these nutrient loops must be closed within a matter of decades—a major feat, but one not yet on the popular radar. Thus, political ecology must draw attention to this metabolic rift [...] and help mend it (Galt 2013:649).

Currently 40 to 60 percent of the world’s population depend on food produced with artificial fertilizers (Erisman et al. 2008:637, Roberts 2009:12). Artificial fertilizers usually contain nitrogen, phosphorus and potassium, which are the macro nutrients plants need to grow. For two reasons, I choose to focus on phosphorus. The first one is to delimit my work and the second, and most important, because of the characteristics of phosphorus. Nitrogen, for example, is easier to replace in other ways, for example with new (and old) farming methods including nitrogen fixating plants. The main issue with phosphorus is the access to it and

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<sup>1</sup> Morales et al. (2014) use the word ‘shit’ to counter taboos in sanitation work. I choose to do the same and use the words ‘shit’, ‘pee’ and ‘poo’.

pollution leading to eutrophication when in there is too much phosphorus in waterways, and the main problem with nitrogen is the accumulation of reactive nitrogen in the environment (Cordell and White 2011; Oliveira and Machado 2013; Mancus 2007:269). Nitrogen is possible to synthesize from the atmosphere with the Haber-Bosh method. While this, as Galt writes (op cit.), is connected to peak oil by the fact that large amount of cheap energy is needed in the process, oil is possible to replace by other energy sources. I will not go further into nitrogen synthesizing and its negative effects here; see for example Erisman et al. (2008) or Mancus (2007) for more about this. Potassium fertilizer is also a product of mining, it is mined in the form of potash. In contrast to phosphate rock, scarcity of potash has not been noted so far (Ciceri et al. 2014:591)<sup>2</sup>. See for example Ciceri et al. (2014) for more on potassium.

Today we are mining phosphate rock to use as the phosphorus component in fertilizer products. The mines around the world are being emptied, and peak phosphorus – the point where demand is higher than what is available at the market – is projected to happen in a close future (Cordell and White 2011:2035). When it will happen is difficult to estimate and there is not a full agreement on this. It depends on, amongst other things, technology and market prices. One estimation is that peak phosphorus will happen in 2033 (ibid.:2037). Whenever it happens, it will have serious impacts on the globalized food market. The prices of fertilizers will increase, affecting the prices of food, and consequently, the millions of people that already have little. We need to find other ways of fertilizing our fields and one possibility is to recycle phosphorus from human excreta.

### **1.1. Aim and research question**

The aim of the thesis is to contribute to the discussion about human excreta, its treatment and its relation to the coming peak phosphorus and thus hopefully provide useful insights for the development that is needed to mend the metabolic rift. My contribution will be a political ecology analysis of the metabolic rift and peak phosphorus. As a basis for my work I will use Newell's (2012:29) definition of political ecology: Political ecology "examines the interrelations of politics and power, structures and discourses with the environment". As my

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<sup>2</sup> I want to add; since it is a non-renewable resource scarcity of potash will be a topic someday and we should also find other ways to handle potassium as well. However, this is not a topic for this thesis.

main tool, I will use critical discourse analysis to investigate the contemporary situation in Norway.

I choose to use *human excreta* as the notion to describe both pee and poo, and not use *human waste* as Galt and others have done (Howard et al. 2016; Anand and Apul 2014; Laporte 1993; McGee and Alvarez 2016). I will discard the use of the phrase because it goes contrary to what this thesis is trying to contribute to: A society where human excreta are not waste, but rather looked upon as a valuable resource and therefore recycled back to the soil.

My research question is:

How are the metabolic rift and peak phosphorus represented in Norwegian newspapers and policy documents?

I choose to look at Norway because of my own connection to the country. I am Norwegian and speak the language. In addition to this, my literature search did not reveal any similar studies in Norway, and an illumination of the current state of affairs is a good starting point for further research and action. I did not find any studies in social science focusing on Norway and recycling of human excreta or peak phosphorus.

## **1.2 Structure of the thesis**

The thesis consists of seven chapters in addition to references and the appendix. After this introduction follows a chapter with background information where I go into the concept of the metabolic rift, the history of water-based sewage systems and today's situation in Norway. In the third chapter I will go through the central concepts I use and the theories that I will use in my analysis. The fourth chapter is describing the methods I have used in my work. The fifth chapter contains my findings which are discussed in chapter six. In chapter seven, the final one, I sum up my conclusions and suggestions for further research. The literature review is presented throughout the thesis, mainly in chapter two, *Background information*, and in chapter six, *Discussion*, and not in a separate chapter.

## 2. Background information

In this chapter I will present background information relevant for the thesis. First I explain the metabolic rift in closer detail, then I look at phosphorus and its role before I give a short summary of the history of the water-based sewage system and the present situation in Norway.

### 2.1. The metabolic rift

Since the first agricultural revolution about 10.000 years ago, agricultural production has been a very important food supply and today it feeds most of the world's population (Harari 2014:87). Gradually humans domesticated the plants and animals that they could. Through the agricultural revolutions and the scientific revolution, we, in big parts of the world, especially the global North, gradually changed our relation to nature. We saw nature as something we could and wanted to control, and we bit by bit forgot the ecological cycles that we cannot escape from (Merchant 1989:99-100). The nutrient cycles are some of these.

By photosynthesis plants gather 95% of their weight which consist of hydrogen, carbon and oxygen. The other 5 % comes from the soil (Gliessman 2015:38). These elements are divided into macro- and micronutrients. Macro- and micronutrients are necessary building bricks in animal bodies, including humans, and whenever we harvest they are lost from the fields. To not impoverish the soil and to be able to sustain food production we need to replace these elements. Animals and humans (hunter-gatherers and nomads) that move in and around the area they eat from repatriate the nutrients to the soil, but in contemporary cities and settlements it is another story. Nutrients in the shape of food and fiber are removed from the soils and transported to the cities. This causes depletion of the soils in the countryside and pollution in the cities and the nearby environment (Foster et al. 2010:45). Karl Marx introduced the *metabolic rift*, also called a "rift in the metabolic exchange between humanity and nature" (ibid.:45). Here I will show the most important events and writings that suit the scope of this thesis; for a further elaboration around the historical development of the concepts of *social metabolism* and the *metabolic rift*, see for example Foster (1999, 2010).

Marx writes that fertility of the soil is “closely bound up with the social relations of the time” (Marx 1963:163). Today large parts of the human population rely on food produced by using artificial fertilizer to replace the elements to the soil (Cordell et al. 2009, Erisman et al. 2008). This had its beginning in what is called the second agricultural revolution in the 1800s.

In western Europe, the agricultural sector in the years from 1830 to 1880 was characterized by the rise of the fertilizer industry and a huge progress in soil chemistry (Foster 1999:373). This corresponded with the growth of agricultural properties, the decrease of the agricultural population and the growing population in industry towns, and gradually increased the metabolic rift between the food producing country side and the food eating city (ibid.:379). In 1840, *Organic Chemistry in Its Application to Agriculture and Physiology* was published. The book, written by Justus von Liebig, “provided the first convincing explanation of the role of soil nutrients, such as nitrogen, phosphorus and potassium, in the growth of plants” (ibid.:376). Liebig, who also was an inspiration for Marx’s work, wrote:

If it were practicable to collect, with the least loss, all the solid and fluid excrements of the inhabitants of the town, and return to each farmer the portion arising from produce originally supplied by him to the town, the productiveness of the land might be maintained almost unimpaired for ages to come, and the existing store of mineral elements in every fertile field would be amply sufficient for the wants of increasing populations. (Liebig quoted in Foster 1999:378).

Several scholars in addition to Liebig and earlier quoted Galt (2013) ask for mending of the metabolic rift caused by the way we handle human excreta. These are for example Anand and Apul (2014), and McClintock (2009).

## **2.2. Phosphorus**

Phosphorus (P) is element number 15 in the periodic table. It is an important part of DNA and RNA in all living organisms (Gliessman 2015:38). With phosphorus deficiency root and fruit development in plants will be seriously limited (ibid.:39). The reservoir of carbon and nitrogen is mainly in the atmosphere (as gases), while the soil is the reservoir of phosphorus (ibid.:95). For multiple reasons, we should recycle the phosphorus we have available. One is because we simply do not have time to wait for formation of new phosphorus:

Since the time necessary to build up sufficient sediments of phosphate-rich rock and to go through the geological process of uplifting is very much beyond the realm of the human time frame, and since the known easily available phosphate reserves are quite limited, current practices of phosphate fertilizer management in many modern agroecosystems can be said to be unsustainable (Gliessman 2015:96).

Phosphorus needs millions of years to circulate between the hydrosphere and the lithosphere (Cordell and White 2011:2030). Other reasons are the environmental problems that are caused through the extraction, transport and processing of phosphate rock. One example is that per ton of phosphate, five tons of phosphogypsum, a by-product with so high levels of radiation that it needs to be stock-piled, are created (ibid.:2039). You also have the destruction of natural landscape and ecosystem in direct connection with the mines and greenhouse gas emissions from the transport of phosphate rock, which is one of the worlds most traded commodities (ibid.).

Another side to the story, is that phosphorus becomes a pollutant if there is too much of it in the wrong place. If excess phosphorus is applied to fields it can end up as runoffs to nearby waterways. This can cause eutrophication and change the metabolism of ecosystems (Bogdanovic 2006:75). The enrichment of the waterways leads to growth in the biomass production (for example algae) and this leads to an unbalance between the organisms in the water and changes the water quality (Oliveira and Machado 2013:118). Both Bogdanovic (2006:84) and Oliveria and Machado (2013:117) point to artificial fertilizers as one of the main sources of excess nutrients that leads to eutrophication. Bechman et al. (2005:238) points to agriculture as the main source of phosphorus to many eutrophic lakes in Norway and states that it is the concentration of phosphorus that limit algal growth in eutrophic lakes.

I choose to not go into the geopolitical situation concerning phosphate rock. For more on this and the earlier mentioned peak phosphorus, see for example Cordell and White (2009, 2011) and Neset et al. (2016).

### **2.3. The water-based sewage system**

At all times we have been dependent on finding solutions for our pee and poo. This has been solved in different manners in different times and places, changing with type of settlement, culture and technological development. Using water to move away human excreta is not something new, already 4.000 years ago, at the Palace of Knossos on Crete, they had toilets with seats above running water that rinsed away the waste (nrk.no 2017).

The water closet, in the modern shape, was patented by Alexander Cummings in 1775, but this is said to be an improvement of Sir John Harrington's invention from 1596. The new improvement included a siphon to prevent bad smell reaching the toilet-room (ibid.). Different versions of the water closet were also patented by Samuel Prosser in 1777 and Joseph Bramah in 1778 (Benidickson 2007:78). The modern sewage system was developed in Great Britain in the beginning of the 1800s and the first systems of a considerable size are from around 1840 (snl.no 2009).

Around the mid-1800s the municipality of Oslo first started to regulate the treatment of human excreta (Berg 1988:56). Around the same time one also started to add chalk and peat to the shit, thereby it became easier to take care of and it became a better fertilizer (ibid.:57). Side tracks were built on the rails solely to take care of the transport of fertilizers based on human excreta, this fertilizer was a business in Oslo (Blytt 2017:2). Between 1900 and 1950 the establishment of water closets and a water-based sewage system replaced the job of emptying of the old toilets. The excreta were now sent directly to rivers, lakes and fjords (Berg 1988:57). One realized that the pollution of the waterways caused problems and started building sewage treatment plants between 1950 and 1980. In Norway, this was the responsibility of the municipalities and different techniques were used. The rinsed water went into the same waterways as before and the sewage sludge which was often not treated at all was dumped in the deep ocean, placed in landfills or used as fertilizer. In the period between 1980 and 2003, new environmental regulations were introduced. The regulations on hazardous agents became stricter and higher demands were put on the sewage treatment plants for testing the water and sludge. Stricter regulations on smell, amount of heavy metals, hygienization and use in agriculture and green spaces were introduced. For more on the history of sewage in Europe and the USA, see Benidickson (2007).

## **2.4. Present situation in Norway**

In Norway numbers from 2015 show that 84 % of the population is connected to the municipal sewage systems (ssb.no 2016). A normal toilet flushes the pee and poo away in a push (or pull) with water of the same quality as the one we drink from the tap. The black and grey water is mixed and sent to a sewage treatment plant where the goal is to separate contaminants from the water so the water can safely be let into the ocean or other suitable places. The regulations say that minimum reduction of phosphorus is 80 percent before the water can leave the treatment plant according to the pollution regulations in Norway (lovdata.no, 2005). This is not always done; controls done in 2014 and 2015 discovered that 44 percent of the controlled treatment plants did not comply with the treatment requirements (Miljødirektoratet 2015). The Norwegian Environment Agency has the overarching responsibility for water and sewage, but the sewage systems are a service from the municipalities. It is the Norwegian Food Safety Authority that has the overall responsibility for the use of sewage sludge and compost. The treated sludge is today seen as a resource by the authorities. It is used as fertilizers and to produce biogas for heating, electricity and fuel (Blytt 2017:2). Norway imports 41.100 ton of phosphorus each year, 8.400 of these tons in the form of artificial fertilizers (Farestveit et al. 2015:10). Of the total amount, 3.100 tons, of phosphorus recovered from sewage sludge 1.000 is recycled to agricultural fields or green areas such as parks (ibid.:11). Two-thirds of the total amount of sewage sludge are recycled to agriculture (ibid.:15). The main challenge in the recycling process is that the most common method includes the use of aluminum salts or iron salts and leaves part of the phosphorus in a state inaccessible to plants (ibid.).

## **2.5. Other issues**

In this section, I want to briefly mention other related issues that I will not go into depth with, but that I still need to mention to present a holistic picture of the situation. First, I want to look at the relation to climate change. The use of the water-based sewage system is connected to climate change in several ways. In some areas, there will be an increasing water scarcity because of the changing climate and some areas (which can also be the same) will be more prone to floods (Howard et al. 2016:253). The capacity for waterways that receive wastewater can also be reduced (ibid.). A water intensive system combined with water scarcity is not a

good combination. Floods can cause contamination of drinking water and damage infrastructure and services (ibid.:257). Climate change in relation to sanitation is also a recognized challenge in Norway. Here the main worry is increased extreme weather and precipitation (Erichsen 2013). This issue is also connected to climate change, because if we recycle human excreta there is a potential to reduce greenhouse gases from the extraction, processing and transportation of phosphate rock and other components of artificial fertilizer. It can also decrease the need for animal manure, so if we at the same time change our diets there is a potential to decrease the emissions from dairy and meat production.

The water-based sewage system, with all its pipes and large infrastructures is very resource intensive. The Norwegian sewage pipes would go around the world with its 40.000 kilometer. One-third of the pipes was installed before 1970 and have insecure or bad quality (Norsk Vann 2017). At some point, we need to upgrade the existing pipes, and that can be the time where we consider a less resource intensive and decentralized system.

Since everything that go out from houses and industries goes into the same pipes this is connected to how our society in general handle chemicals, pharmaceuticals, house cleaning products and personal care products. More research is needed on this topic (see section 6.3. on alternative solutions). Brand (2014:359) points out that we might need new approaches to prescription and consumption habits or we might want to use “green chemistry” to redesign the products we need. Peak phosphorus and the metabolic rift are also connected to food waste and our treatment of it.

### **3. Theoretical framework**

In this chapter I will explain the basics of the main concepts and theories I use in the thesis. Concepts are ‘discourse’ and ‘sustainability’ and theories are the theory of hegemony, infrastructure lock-in and path dependency theory.

## **3.1. Concepts**

### **3.1.1. Discourse and order of discourse**

Here I will lay out a short definition of discourse and order of discourse. In the methodology chapter, chapter 4, I will explain how I will use a discourse analysis as my main method. As state by Dunn and Neumann (2016:4), “. . . discourses are systems of meaning-production that fix meaning, however temporarily, and enable actors to make sense of the world and act within it”. We can see them as a relatively established pattern of meaning-making within a set area (Jørgensen and Phillips 2010:146). An order of discourse is the discourses that operate within the same social area or institution (ibid.:147). The relation between the discourses in an order of discourse are “complex, heterogeneous, and contradictory” (Fairclough 1992:219).

### **3.1.2. Sustainability**

Sustainability is, as I will argue later, a concept with no universally agreed upon definition (as many concepts and words). All sorts of companies, producers and actors are using the label ‘sustainable’. Since there is so many ways of using it, the concept has become “vague, ambiguous, and confusing” (Gliessman 2015:16). The definition is contested amongst academics and in politics as well. I do not support the sustainable development discourse in the much-used definition from the Brundtland-report (Brundtland 1987) because I believe that it delimits our choices for how we can organize our societies and I also believe that infinite economic growth is not possible in a sustainable world. Often used is a definition where environmental, economic and social dimensions are given equal importance (Ciceri et al. 2014:591). Our economic system is a social construction and not a law of nature, therefore I would give more weight to the environment and ecosystem services that we depend on. I choose to not go further into this discussion, and neither the discussion on equity and human rights in relations to sustainability, since this is not relevant for the thesis, but rather state my own definition: Something is sustainable when the act or process can continue into the unforeseeable future without negative impact (as we know, nothing lasts forever).

## **3.2. Theories**

The main theories I use in the thesis are the theory of hegemony, and the theories of infrastructure lock-in and path dependency.

### **3.2.1. Hegemony**

From Antonio Gramsci's prison notes historians have constructed his theory of hegemony (Bates 1975:351). "The basic premise for the theory of hegemony is one which few would disagree: that man is not ruled by force alone, but also by ideas" (ibid.). The basis is political leadership by consent of the led. The consent is made possible by "diffusion and popularization of the world view" of the rulers (ibid.:352). It is a cultural leadership where some ideas have more influence than others (Nealon and Giroux 2012:157).

Hegemony is a constant struggle, it is never complete, that different actors engage in to "challenge, establish or maintain hegemonic rule" (Ciplet et al. 2015:27). Ciplet et al. states that the actor does this strategic effort often in "coalitions with well-defined identities" (ibid.). Hegemony is closely related to ideology in that the hegemonic struggle is a fight over which is the ruling ideology in a group, society or nation. The ones that try to challenge the hegemonic forces can be called counterhegemonic movements (ibid.:28).

Eliasoph (1998:232) explains how the oppressed groups can accept the situation. She focuses on how people give meaning to their circumstances and how peoples everyday knowledge and intuition is connected to the ruling institutions around them:

"A society's political imagination is . . . patched together in a way that makes domination seem natural and inevitable, odorless and invisible. . . . This "hegemony" is the ongoing cultural process that gerrymanders the boundaries of perception (Eliasoph 1998:232-233).

### **3.2.2. Lock-in and path dependency theory**

Most known today is maybe the concept of *carbon lock-in* as Unruh (2000) uses it (Corvellec et al. 2013:32). He takes up the path-dependency processes that lock our economies to a fossil-fuel based system. Unruh explains the inability to take precautionary action towards

climate change with the concept of carbon lock-in (Unruh 2000:817-18). According to Corvellec et al. (2013) technological systems are part of webs controlled by industry networks, and private and public institutions. This leads to lock-in of “producers, users, and regulators in dynamic webs of technologies, legislation, standards, physical infrastructures, politics, and cultural norms, inclusive of institutionalized rules-of-thumb” (Corvellec et al. 2013:33). The concept of *path-dependency theory* is closely linked to the concept of *lock-in*. *Path dependency* focuses on “...the constraints that the past puts on present decisions” and “lock-in describes a current state of things” (ibid.).

Corvellec et al. (2013) find in their work that there are four rationales behind the lock-in of waste incineration in Gothenburg, Sweden. These rationales are institutional, technical, cultural and material. In chapter 5 I use these rationales in my discussion of the water-based sewage system and peak phosphorus.

It is possible to break free from a lock in. It can come from “a crisis in the existing technology; regulation; technological breakthrough producing a (real or imagined) cost breakthrough; changes in tastes; niche markets; or scientific results” (Corvellec et al.:33). To work intentionally towards breaking a lock-in, one needs “systematic efforts to promote alternatives, a critical mass or social and political recognition of a need for social action, and a focusing event that acts as a catalyst for concerns and initiatives” (ibid.). Corvellec et al. also points out that if a lock-in is globalized it is more difficult to break it.

#### **4. Material and Method**

I started out with a literature review to look at history, the present situation and possible solutions for the treatment of human excreta. Further I have done a discourse analysis of two documents from *Miljødirektoratet*, (the Norwegian Environment Agency, NEA) and 28 texts from Norwegian newspapers. The discourse analysis was done to investigate how the metabolic rift and peak phosphorus is represented in the Norwegian media and in institutions working with the topic. In chapter 5 I present my findings.

## **4.1. Critical Discourse Analysis**

By using critical discourse analysis (CDA) I am seeking to “illuminate the role of discourse in maintaining the social world and social relations with its different power structures, and the goal is to contribute to change and even out the power relations in communications processes and in the society as a whole” (Jørgensen and Phillips 2010:75, my translation). We need to distinguish between discursive and non-discursive practices (ibid.:77). The physical practice of recycling the human excreta to the agricultural fields is non-discursive, but the planning of how to treat human excreta and how to mend the metabolic rift is discursive. When we communicate we either reproduce or challenge the hegemonic discourse (ibid.:82).

One tricky theoretical question in discourse analysis is how to define when a discourse stops and another one starts (ibid.:148). Jørgensen and Phillips (ibid.:149) see discourses as an analytical operation, as something that the researcher is constructing as a tool. They emphasize that one still cannot take whatever and call it a discourse, and that it is important to document why this is a reasonable delineating between discourses (ibid.:150.), see section 3.1.1. In chapter 5 I document my delineation between the discourses I have identified.

There is no set way of doing a discourse analysis, but I am drawing on the work of Jørgensen and Phillips (2010) and Fairclough (1992) and I will explain here how I executed the analysis. As a starting point for my analysis I used Fairclough’s three-dimensional framework for discourse analysis. In the framework, the analysis should look at “discourse as text, as discourse practice and as social practice” (Fairclough 1992:198). These three levels can be analyzed separately (Jørgensen and Phillips 2010:93). I used chapter 8 in Fairclough’s *Discourse and Social Change* to design my mode of analysis.

### **4.1.1. The discursive practice**

When analyzing the discursive practice one looks at how the text is produced and consumed. Here I will not focus on the actual production and consumption of the text, but as Fairclough usually does, identify which discourses the text draws on and if and how the text is connected to other texts (Jørgensen and Phillips 2010:94). According to Fairclough high interdiscursivity,

a corpus that plays on many different discourses, is a sign of change. This contrasts with low interdiscursivity which is a sign of reproduction of status quo (ibid.). The questions to be asked are: What discourse types are drawn upon and how? Is there an obvious way to characterize the text? Is the text innovative or conventional? Is it challenging status quo? How is the text connected to other texts? How do they draw upon other texts (Fairclough 1992:232)?

#### **4.1.2. The text**

In analyzing the discourse as text I choose to focus on transitivity and modality. Using transitivity as a tool, I try to illuminate ideological consequences of different presentations. I look at how happenings and processes are connected to subjects and objects (Jørgensen and Phillips 2010:95) with the goal to discover “agency, the expression of causality and the attribution of responsibility” (Fairclough 1992:236). Modality looks at how the sender of the text expresses affinity to the message. By sender I mean the person who writes, speaks or otherwise pass the text on to the reader or receiver. How connected are the senders to the message, is the message presented as the absolute truth, and what authority do the senders portray themselves with (Jørgensen and Phillips 2010:95-96)? The sender can for example express categorical and objective modality which would portray the message as the truth and the sender with authority (ibid.).

#### **4.1.3. The social practice**

Looking at the social practice, I want to investigate: “the nature of the social practice of which the discourse practice is a part, which is the basis for explaining why the discourse practice is as it is; and the effects of the discourse practice upon -the social practice” (Fairclough 1992:237). The question here is how the discourse practices constitutes and are constituted by social practice (Jørgensen and Phillips 2010).

### **4.2. Choice of corpus**

In this section I will explain how I chose my corpus, my material.

#### 4.2.1 News articles and opinion pieces

I used the database A-tekst from Retriever which is an archive with printed and web-media. A-tekst have in their archive 304 Norwegian newspapers and journals. To narrow the task down to a reasonable work load for a master thesis I chose to look at only printed articles, and exclude web-articles. I first made this choice over limiting the time period, because then I kept it open to explore changes in the discourses over time. However, I had to limit the time after all to have a reasonable amount of material. I chose to limit the search to articles printed between 1<sup>st</sup> of January 2014 and 2<sup>nd</sup> of May 2017. I chose this time period because then I ended up with an amount of material that was possible to handle for a master thesis and that also was big enough to investigate the research question.

The search phrases I have used in the database are presented in Figure 1. I did test searches in both the database and at Google to find the most relevant search phrases.

<b>Search word Norwegian</b>	<b>Translated to English</b>	<b>Number of hits January 1, 2014 – May 2, 2017</b>
Peak fosfor	Peak phosphorus	3
Fosfor-toppen	Peak phosphorus	2
Peak phosphorus	Peak phosphorus	3
Avløpsslam AND resirkulering	Sewage sludge AND recycling	7
Urin AND resirkulering	Urine AND recycling	2
Fosformangel	Phosphorus deficieany	19
Fosforkrise	Phosphorus crisis	5

Figure 1. Search words used to find material for discourse analysis in A-tekst database. Search on articles printed in paper versions from 1<sup>st</sup> of January 2014 to 2<sup>nd</sup> of May 2017.

I tried out different search words and added new as a read. Then I wrote a table with the number of hits on each search phrase specified by year. As I did this, I read through the headlines of the articles and it was easy to see which search phrases were more specific and found relevant articles. Naturally, the ones that had a larger number of hits included more irrelevant hits. From here I narrowed down the list of search words to those presented above. Some of the same articles showed up under different search phrases, this could be a sign that the search phrases are precise. That you get many hits on your search phrase of course does not mean that they are all relevant, it rather means you need to specify your search. The search phrase “sewage AND fertilizer” got 753 hits for example. That is a too large a number of articles to go through and therefore this exact search phrase is excluded from the list. This method of finding search words will always have an arbitrary element. I have prepared by reading up on background information, reading newspaper articles to see what words writers use and be creative in my search phrase construction, but still I must make choices. Some of them I made because of direct irrelevance, one search word came up with no relevant hits and several articles about a person who got a pile of poo dumped outside her house, others are made simply to limit the scope of the research project. I ended up using 7 different search phrases and after sorting out the duplicates and irrelevant articles I ended up with 28 articles from 18 different newspapers. These are: *Adresseavisen*, *Aftenposten*, *Avis Nordland*, *Bergens Tidende*, *Budstikka*, *Dagsavisen*, *Glåmdalen*, *Jarlsberg Avis*, *Klassekampen*, *Morgenbladet*, *Nationen*, *Nordlys*, *Ny Tid*, *Sandefjords Blad*, *VG*, *Østlandets Blad* and *Østlendingen*. There is one text from all the newspapers apart from *Jarlsberg Avis* and *VG* where there are two texts, from *Klassekampen* there are four texts and from *Nationen* six texts. It is not surprising that the newspaper with most hits are the daily newspaper, *Nationen*, that focuses on regional politics and agriculture. See the appendix for a table of articles and search phrases.

#### **4.2.2 Documents from the Norwegian Environment Agency**

I have chosen two documents from NEA to include in my analysis. I choose these after searches in search engines combining search words with names of different authorities, at the page of the first Nordic phosphorus conference and by browsing the different authorities' web-pages. I looked at the government's webpage with the sub-pages of the Ministry of Climate and Environment and the Ministry of Agriculture and Food, the NEA and the Norwegian Food

Safety Authority. I chose these two documents because of their relevance. Fairclough discusses the need to have an overview over and adequate information on “the archive” to put together a corpus to analyze (Fairclough 1992: 226). By “archive” he refers to the totality of the discursive practice. After searching and reading I will say that the two documents I choose reflect the diversity of discursive practice coming from the NEA (cf. Fairclough 1992: 227), despite the small number of text and the similarities between them. There is not much information from Norwegian authorities on the topic and these are recent documents. The two are the NEA’s slide show from the first Nordic phosphorus conference and a report from NEA about possibilities and recommendations for utilizing phosphorus better. These are presented in section 5.1.

### **4.3. Positionality and limitations**

The chosen topic is one that interests me a lot and which I have strong opinions about, that is why I chose it. As Jørgensen and Phillips (2010:31) say, it can be hard to investigate discourses that you have a close relationship to. I have done my best to set my opinions and worldviews aside in the work with discovering discourses, but one can of course never escape oneself. Being trained for two years in seeing that our society is socially constructed I believe I have the skill to also see the discourses I take part in as such as well. I have tried to see the material as an outsider even though it belongs to my culture. However, I cannot escape from the fact that this thesis also is representing the world in one of many possible ways, and that my positionality in the world will affect what I can find and present (cf. Jørgensen and Phillips 2010:32). To counteract this I have tried to make my findings and my documentation of them as transparent as possible for the reader. My bachelor was in public relation and communication, where I also worked with discourse analysis. I am Norwegian, this makes it possible for me to analyze texts in Norwegian. English is my second language, and I have in the work with this thesis done translations from Norwegian to English. However, I believe that my use of the English language should not affect the findings and the presentation of them in this thesis.

## 5. Findings

In this chapter I will present my discourse analysis. I start out with general information about the material before I delve into the findings from the discourse analysis. I bring the findings into a discussion in Chapter 6. I started off by reading my material several times to get familiar with it. Then I made a matrix with the different titles, and went systematically through the texts with the criteria presented in the previous chapter in mind. All the quotes are translated from Norwegian to English by myself if not otherwise indicated.

### 5.1. General information about the material

Here is first general information about the opinion pieces and news articles and then general information about the documents from the NEA.

#### 5.1.1. Opinion pieces and news articles

Before limiting down the time period I got 117 hits. I want to present the years they are published in to show the development of the topicality of the issue; see figure 2.

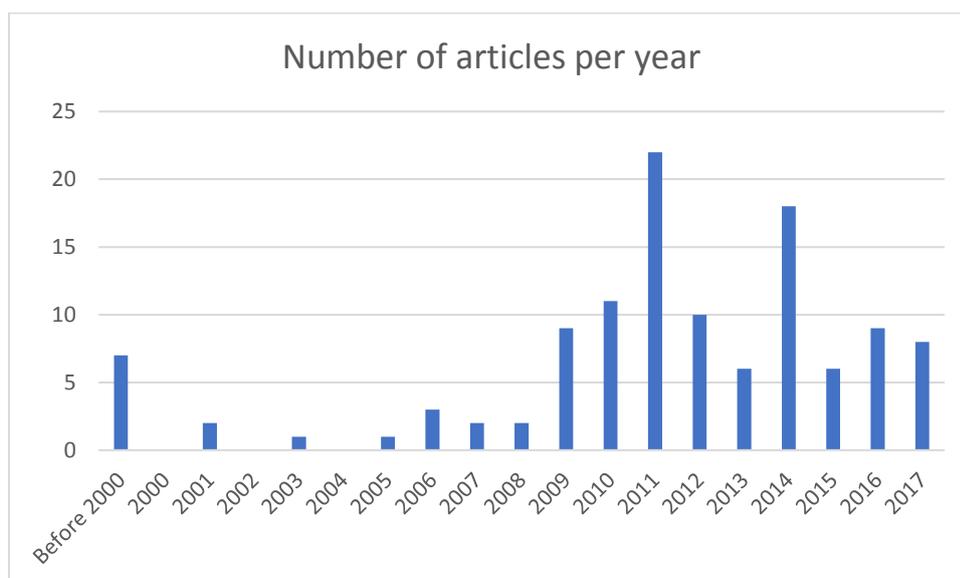


Figure 2. Number of newspaper texts found on the search phrases, hits per year. See figure 1 for search phases.

As we see there is a general tendency that my search phrases are more present in the media from 2009 and onwards. This might be connected to the 800% increase in phosphate rock prices in 2008 (Cordell and White 2011:3). There was a peak in 2011, and by 2<sup>nd</sup> of May 2017 with less than half the year gone, it has also been published more than in the two previous years (if the development continues throughout the year). As explained earlier I limited down my search and ended up with 28 articles in my material.

To systematize my work, I divided the texts into opinion pieces and news articles. This, not very specific, categorization is done to separate them by the main characteristics and make the work with many texts easier. By *opinion piece* I mean a text which is mainly the author's opinion about the issue addressed, and by *news articles* I mean an article written by journalists that position themselves (mainly) outside of the message. There are 11 texts I identify as news articles and 17 I identify as opinion pieces.

Some of the texts are about recycling sewage and others about peak phosphorus, a few mention both. In a few of the articles peak phosphorus is only mentioned as one of many problems (environmental or agricultural), in others peak phosphorus get a thorough assessment. The water closet is, to my surprise, not mentioned in any of the articles in my selection. There is no discussion of composting as a solution or alternatives to the water-based sewage system. The only concrete measures for human excreta that are mentioned are better methods for recycling sewage sludge. There is no discussion on the structural problems caused by the present system (more about this in the discussion in section 6.2. about lock-in). Only a couple of the texts can be seen to operate within a growth critical discourse. Technical and scientific solutions are discussed. Also, the senders which mainly operate within a more critical discourse (see section 5.9.), rely on technology. A few mentions change in agricultural practices or our handling of sewage sludge, but another strand see no other possibilities than phosphorus from phosphate rock. There is a tendency that the news articles operate more within a techno-optimistic and neoliberal economic discourse than the opinion pieces, but I cannot generalize from this with my limited material. Many of the senders are worried about the unsustainability of the phosphorus use and the future phosphorus deficiency, but a few take the approach that it is a long time until we run out and we will find solutions before that.

### 5.1.2. Documents from the Norwegian Environment Agency

#### *Strategies and Reuse Initiatives – slides*

Title: Strategies and Reuse Initiatives

Author: Terje Farestveit

Date: 27<sup>th</sup> of October 2016

Type: Slide presentation, 9 slides

The first document from the Norwegian Environment Agency (NEA) is their presentation from the first Nordic Phosphorus conference, “Phosphorus a limited resource – closing the loop” held in Malmö, Sweden in October 2016. The document is a slide show on 9 pages and the text is written in short, incomplete sentences. This of course affects the analysis and conclusions I might be able to draw from it, but it is still possible to analyze it. I wanted to include it since it is such a recent document and it can say something about the strategies that are worked with. I refer to this as *the slides*.

#### *Better utilization of phosphorus in Norway – report*

Title: Bedre utnyttelse av fosfor i Norge

Author: Terje Farestveit, Elisabeth Møyland and Ingrid Aarre Daae

Date: 2015

Type: Report, 34 pages

This is a report from the NEA about possibilities and recommendations for utilizing phosphorus better in Norway. The document is written as an advisory document to the Ministry of Climate and Environment. The Ministry of Climate and Environment requested an assessment of the need for and possible form of a national phosphorus platform. It goes

through different opportunities to (re)use phosphorus in a better way so the amount of imported artificial fertilizer can be reduced.

### **5.1.3. About both texts**

I identified several different discourses in the texts. And in the next sections my goal is to define and document my delineation between discourses. The numbers behind the quotes show which text it is from (see the appendix). The report and the slides from the NEA are referred to as such, and not with numbers. Page numbers refer to the report if nothing else is stated. Discourses that can be identified and potentially argued for and documented in a good way is a techno-optimist discourse, a green revolution discourse, alternative agriculture discourse, a critical discourse, green growth discourse, circular economy discourse, a bureaucratic discourse, a neo-Malthusian discourse and a neoliberal economic discourse. Since I have limited material and limited space I choose to focus my theoretical discussion on the most prevalent discourses. These are the techno-optimist discourse, the neoliberal economic discourse, a bureaucratic discourse and a critical discourse that challenges status quo. First, I will discuss the intertextuality, transitivity, modality and floating signifiers in and of the texts. Then I will delineate the discourses with examples from the texts and then in chapter 6 discuss the findings.

## **5.2. Intertextuality**

Some of the news articles and opinion pieces use the same numbers as in the report from the NEA, this may indicate intertextuality. One of the opinion pieces is also directly referring to the report from the NEA (22). There is a clear intertextuality between the two documents from the NEA. The slides from October 2016 refer to the report from May 2015. One of the co-authors of the report was also the author of the slides.

## **5.3. Transitivity**

In surprisingly many of the newspaper texts “the expression of causality or the attribution of responsibility” (Fairclough 1992:236) is not existing or very weak. This is more prevalent in the

texts which draws most on a techno-optimist discourse and the least in the discourses that challenge status quo, where a couple of the texts lay the responsibility to the growth economy. Some texts also put the responsibility on politicians and authorities, like their local municipality.

In the slide presentation there are different types of agents in the text. There are both non-existing agents, parts with a “we” as in the NEA and a “we” as in Norway as an entity, and farmers and soil producers as agents. One example is this sentence: “We recommend establishing ambition level/s”. Here the NEA recommends a non-existing agent to establish ambition levels. Since this is a slide show and more is probably said in the actual presentation this might not be an issue.

In large parts of the text in the report the agent is non-existent. Several places go on in this vein: “It must be facilitated for a market for good resource utilization. Among other things, it may be appropriate to consider synergies between national targets for biogas and better use of phosphorus” (p. 4). It is not clear, even though we can assume it is some authority that is connected to the government, who has the responsibility to do so.

Other parts are clear recommendations directed to The Ministry of Climate and Environment where they should follow up as the active agent and establish a committee working towards setting national goals for use of phosphorus in Norway.

#### **5.4. Modality**

Almost all the authors of the opinion pieces write their text in a way that give them authority and as if they have the absolute truth. Almost none of the senders give themselves part of the responsibility. One text (20) sticks out in this aspect, an opinion piece where the author asks several rhetorical questions to the reader, for example “What kind of food do you want?”. She also discusses the contradicting findings in science regarding food and food production and that it is hard to be completely sure about anything.

In the slide presentation, the modality is categorical and objective throughout all pages apart from in two sentences where new regulations for use of organic soil conditioners/fertilizers

are discussed. Here they use the words 'probably' and 'mostly', which seems natural when talking about a still non-existent, forthcoming document.

In the report the mode is not that clear. The word 'maybe' is never used. The word 'can' is used 59 times, three times together with 'should' (*kan og bør*). 'Potentially' is used six times and 'probably' zero times. At the same time the summary is written with a high degree of certainty and authority (p. 2). In the final section of the report, which summarizes the further steps, the writers give themselves a high degree of authority and give recommendations to the committee using the word 'should', and not 'can' (p. 19).

### **5.5. Floating signifiers**

Floating signifiers are words that different discourses compete to fill with meaning (Jørgensen and Phillips 2010:39). The meaning of the term is not set and can change according to who use it and how it is used. In the newspaper articles, I investigated how the concept of 'sustainability' was framed. None of the articles define what they mean by 'sustainable', but from the context it is possible to understand that not all of them necessarily put the same meaning to the concept. The texts that juxtaposes 'sustainability' with 'economic growth' most likely assign a different meaning to the concept than the ones that focus on ecosystem services and the cycles of nature.

In the report from the NEA we find this sentence: "Sustainable utilization of resources is a precondition for good environmental governance" (p. 19). This sentence does not say much if you do not know what meaning the sender puts into the different words and concepts. From the report, it is very hard to know what the NEA mean by 'sustainable'. We do not learn how they measure sustainability and when they say, "yes, this is sustainable". We do not get to understand what meaning they assign to "good environmental governance" which would be connected to what meaning they give to 'sustainable'. One interesting thing is that this sentence could as well have been translated to "Sustainable exploitation of resources is a precondition for good environmental governance". It is easy to think that "sustainable exploitation" is an oxymoron.

The authors of the report claim that better resource utilization of phosphorus is a new problem (see quote in next section). I would say that this depends on how you frame the word 'new'. 'New' can be seen as a floating signifier, which in this case is not properly defined. Cases of eutrophication caused by excess of nutrients has been reported in, what I consider a long time; two lakes in Wisconsin in 1882, Lake of Zurich in 1896 and Lake Erie in 1930 amongst others (Oliveira and Machado, 2013:118). Political action has been taken on the topic for several decades. For example, in the Coastal Zone Management Act and the Clean Water Act from 1972 in the US (ibid.). Research has been done on eutrophication in Norway at least since 1985 (Bechman 2005:239).

The struggle over which terms that are used to describe fertilizers are very similar to floating signifiers. It is not completely the same since two different terms that are being used: artificial and mineral fertilizer. According to NIBIO (the Norwegian Institute of Bioeconomy Research) and their list over terminology relevant for fertilizers the term 'artificial fertilizer' (*kunstgjødsel*) is now replaced by the term 'mineral fertilizer' (*mineralgjødsel*). Mineral fertilizer is also the term they use in the report from the NEA. Other terminology that is used in English is synthetic fertilizer, organic and inorganic fertilizer. Artificial fertilizer has a slight negative connotation, because it is something that is not natural. So, I wanted to check who used which words and how much each of them were used. In 20 of the articles one or both words were used. In four of the articles both words were used, in 10 of the articles 'artificial fertilizer' was used and in six of the articles 'mineral fertilizer' was used. It did not seem to be a pattern in who used what concept, but 'artificial fertilizer' is used slightly more than 'mineral fertilizer'.

## **5.6. The techno-optimist discourse**

In this discourse, technology is the fixer of everything (or close to everything). Highly present in the material is technology, either in the form of referral to need for new technology, the praise of technology already in use or a description of a recently invented technology. Even in the opinion pieces, where the critical discourse is the one that is most prevalent, the reference to technology is common.

Some texts refer to already existing technology. Two of the news articles are about a new factory that recycles sewage sludge and food waste into fertilizer. The new technology is praised by politicians, for example,

During the opening, the Minister of Environment Tine Sundtoft (H) calls the factory a good example of the green transition in practice (4).

We also support new businesses that work with new solutions within circular economy. The corporation IVAR did for example get support from Innovasjon Norge's technology program. The fertilizer product Minorga is produced of sewage sludge. The corporation thus gives a new life to a waste product, he says (3).

"He" in this quote is political advisor Jens Frølich Holte in the political party Høyre. Innovasjon Norge means Innovation Norway, and it is an organization owned by the government and municipalities whose goal is to develop Norwegian business.

Some of the news articles are about research on methods to make the phosphorus more accessible for plants after recycling and methods to make sure the sewage sludge is safe to use in food production.

Another issue we have been concerned with is, whether it is possible to improve the phosphorus availability from the sludge by optimizing and changing the processes that take place in the treatment plants (5).

This is technically possible, but will require the development of far better systems for recycling phosphorus from the sewers (17).

For this reason, HIAS (Hedmark Interkommunale Wastewater) has been researching how phosphorus in wastewater can be biologically extracted instead of using aluminum, which is the common method today. The difference is that HIAS then can recycle and reuse the phosphorus as a fertilizer, while the alternative is to continue to add aluminum which make the phosphorous useless (19).

In the report from the NEA, new technology is mentioned three times, for example:

Once goals and ambitions for phosphorus utilization are adopted, and there are established good framework conditions, establishing a phosphorus platform or similar forum could be appropriate. Such a forum will be able to inspire Norwegian specialist communities and businesses to use new technology to increase resource utilization, stimulate innovation, and facilitate changes in relevant industries (p. 20).

The techno-optimist discourse seems to be tightly connected to a discourse on circular economy (which will be defined in section 6.1.):

Recycling of nutrients such as phosphorus, nitrogen and potassium is achieved through the biogas process and through the final product biofertilizer. Betting on biogas as fuel for our buses is therefore a necessary and important measure in what the EU calls the circular economy, where waste is redefined from garbage to become a resource (14)

Four of the opinion pieces go into a debate about the need to reduce the number of people on the planet with phosphorus scarcity as one of the proofs:

For all three of the most serious threats we face now and in the near future, climate change, lack of artificial fertilizer and species extinction, all have a common cause: an overpopulated planet (11).

Some authors present phosphate rock as our only solution for how to get phosphorus available for food production, for instance:

Phosphorus is an important part of all fertilizers, and absolutely vital for the ability to produce food for the Earth's nearly 10 billion people. But phosphorus is extracted from only a few mines in the world, which can run empty during the next 80 years (16).

Related to technology is agriculture and the kind of methods agriculture is run by. Agriculture is presented in several ways, but there are two patterns. One is a discourse in line with the thoughts behind the green revolution and the other is a discourse in line with alternative agriculture. Here I give two examples:

In order to meet the upcoming crisis, we need to move away from agriculture that has mineral fertilizers as the only source of phosphorus. We need to facilitate small-scale farming that takes into account the resources we have available. At the same time, Norwegian authorities must make plans for a future with possible global phosphorus shortage. A first step is to take all farmland into operation and they must be operated in a sustainable manner with input of locally recycled phosphorus (17).

In order to produce more food for the present-day and rapidly increasing population, we need artificial fertilizer (11).

The picture on the front of the NEA-report (see Figure 3) is of agricultural fields which looks like conventional food production, or maybe organic in the conventional sense.

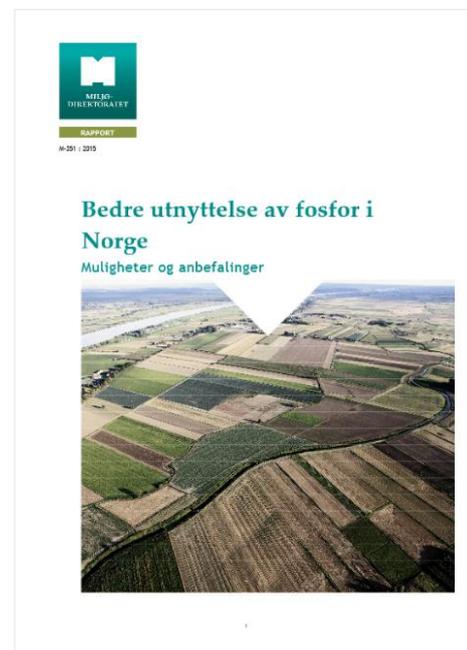


Figure 3. Front page of NEA-report

### **5.7. Neoliberal economic discourse: Prioritizing between the environment and the economy**

An economic discourse permeates the documents from the NEA. I would argue that it can be called a neoliberal economic discourse. Neoliberalists want “maximization of entrepreneurial freedoms within an institutional framework characterized by private property rights, individual liberty, unencumbered markets, and free trade. The role of the state is to create and preserve an institutional framework appropriate to such practices” (Harvey 2007:22). In the texts from the NEA the focus on the market potential and framework conditions is clear.

In the slide presentation from the NEA one headline goes like this: “Key question: Why circulate?” The answer is “Environment? Yes, but this is not a strong factor”, before it goes on to show a few of the environmental issues. The two other arguments are “because alternative use of sludge is more expensive and less sustainable” and “because we are producing more and more sludge and are struggling finding markets”. The other “key question” asked in the presentation is “Where is the market?”.

In the NEA-report, a description of how to develop the use of animal manure into fertilizer products let the neoliberal economic discourse come to the forefront. Here they focus on market mechanisms as part of the solution. I emphasize the words I would say are coherent with a neoliberal economic discourse:

*“The market and industry are developed mainly by regulations and through framework conditions that create profitability, and thus investments in plants that drive costs down. In this way, several suppliers can establish themselves, and competition in the market further stimulates technology development and cost reduction. Therefore, through the establishment of favorable framework conditions, further work on better resource utilization of phosphorus can also help to create a better market for biogas and fertilizer products” (p. 14, emphasis added).*

Here is another example from the report. Words as “resource utilization”, “framework conditions”, “profitable” and “prioritized” is language of the economics:

Better resource utilization of phosphorus is a relatively new problem, and it will be central to conduct a mapping of the means to achieve the goals on phosphorus utilization. The framework conditions must ensure that better resource utilization is profitable and thus prioritized. The committee should come forward with concrete proposals for changes in the regulatory framework where they see a need (p. 5).

What we can learn from looking at the discourse is that economic factors seem to be as important in the NEA report as sustainability, whatever meaning the NEA assign to the term ‘sustainability’:

To prioritize between possible measures to achieve better resource utilization of phosphorus, a better overview of the environmental/climate accounts and the economic consequences of new versus old solutions in different sectors is required (p. 5).

The potential for increased reuse and what changes and what innovation this will require should be made visible by the committee. Costs of reuse versus environmental benefits should also be highlighted (p. 5).

This is also reflected in that different versions of the word 'profitable' (*lønnsomt, lønnsomme, lønnsom*) are used six times in the report. 'Sustainable' is used five times.

The importance they give the economy is also reflected in their writing about circular economy:

EU Commission posted July 2, 2014 a comprehensive policy package in support of a circular economy. The goal of a circular economy is to keep resources in the circuit as long as possible, thus minimizing the need for extraction of new virgin resources and the amount of residual waste (p. 8).

Better resource utilization of phosphorus will be in line with the government's commitment to bio economy and the EU's efforts to introduce a circular economy. A market for good resource utilization must be facilitated. Among other things, it may be appropriate to consider synergies between national targets for biogas and better use of phosphorus (p. 4).

The neoliberal economic discourse is not as prevalent in the texts from the newspapers, but it is still present. It goes hand in hand with the discourse of circular economy:

In a circular economy there is a need for clear goals for recycling and resource utilization. We use many instruments, both regulations, financial incentives and producer liability schemes (3).

This is a political advisor talking about tools the government use to create the right framework conditions.

## 5.8. Bureaucratic discourse

The discourse in the report is also bureaucratic:

Because emissions of phosphorus also constitute a contamination problem that prevents the achievement of the *requirements in the water regulations*, a goal of phosphorus utilization should also aim at reducing drainage to waterways (p. 19).

A better utilization and handling of phosphorus is a prerequisite for achieving good environmental status in our waterways, according to our *obligations to the EU* (p. 4).

From these sentences, it can seem like the reason phosphorus should be handled better is to fulfill the water regulations and the demands from the EU, while the real reason is (or should) be to have a functioning ecosystem and a secure food production.

## 5.9. Critical discourses

They are not present to the same extent as the other discourses I have presented, but there are also discourses that challenge status quo in the newspaper texts. These discourses take the ecosystem into account and are critical towards economic growth. Also in texts which criticize the way we do things today, the reliance on technology for solutions is highly present. A couple of the texts talk about the ecosystem and how we relate to it:

Is it not science-based to try to produce food in line with the ecosystem the food comes from and the natural cycles that support both him and us all together? It's ecology in the deepest form, and that's the goal we should have with our food production (20).

He in this quote is Nils Vagstad, CEO at NIBIO, who the author of the text is criticizing for stating that organic food production is not scientific.

Therefore, for the sake of the world's poor and future generations, we must begin to take care of the phosphorus we have in circulation. This is technically feasible, but will require far better systems for recycling phosphorus from the sewers. This will require a significant shift in

thinking about non-renewable stock resources that no politicians seem to take seriously today.  
(17)

There is a request to move away from industrial agriculture to sustainable forms of food production:

We must go from industrial agriculture based on monocultures and overuse of fertilizers and pesticides, to sustainable small-scale farming, which may give a little less return in the short term, but that can ensure human access to food far into the future (22).

A critical voice towards economic growth is also present:

It's easy to sell a future that says yes, we're going to cut emissions and we'll be environmentally friendly and you can continue your consumption. That growth can continue into heaven. The crisis we now face in the absence of phosphorus is an excellent example of this (2).

## **6. Discussion**

### **6.1 Technology as a hegemonic discourse**

Technology has a hegemonic role in our society and technological innovation is presented as the salvation from environmental crisis (Lucia 2014:73). Critics say that technology often cure the symptom, but not the cause of the problem and that it can hide real solutions from the social imaginary (Rosner 2004). Ironically, technology is often brought in to solve problems technology created (Hueseman and Hueseman 2011:14). The technological fix is a term that has become to be a “a dismissive phrase, most often used to describe a quick, cheap fix using inappropriate technology that creates more problems than it solves” (Rosner 2004:1).

Timothy J. LeCain divides technological fixes into three types depending on their means and consequences. These are, (1) the transformational techno-fix, (2) The relocational techno-fix and (3) The delaying tecno-fix (LeCain 2004:118). I would argue that the use of phosphate rock in agriculture is a techno-fix itself. It is a delayed techno-fix because it shifts the problem of

finding a way of sustainable food production to a future time when the supply of phosphate rock is insufficient. The water-based sewage system is also a techno-fix in this sense, and it could be called a transformational, a relocalational and a delaying techno-fix.

LeCain takes up an example from the Ducktown smelter where they captured sulfur dioxide with new technology, and transformed it into sulfuric acid. This could be sold to fertilizer producers, who made superphosphate out of it (ibid.:121). This was first a transformational technofix, then it was applied to the fields and became a relocalational technofix. This contributed to increased global food production in the twentieth century and to fertilizer run-off leading to eutrophication (ibid.:122). So, technology producing phosphorus fertilizer has not only delayed the problem to another time, it has also made the challenge bigger by supporting a bigger population that needs to find a sustainable way of finding food. This does not mean I give into the neo-Malthusian discourse presented earlier, because focus on overpopulation, as focus on technology, can take the attention away from real problems and real solutions. In the case of food, it is the functioning of the worlds food system that causes unequal access to food and exploitation of certain parts of the world for the benefit of other. According to the FAO, the Food and Agricultural Organization of the United Nations, we produce more than 2700 calories per person per day. Still more than 800 million people are harmed by chronic undernutrition (FAO 2017). In addition to this, in 2014, 1,9 billion adults where overweight and 600 million of these where obese (WHO, 2016)<sup>3</sup>.

In my material, there were several references to circular economy. In circular economy, the goal is to have a closed loop of material flows within the economic system (Geng and Doberstein 2008:231). Development within science and technology are central within circular economy (ibid.:235). When technological solutions are applied to problems that is caused by our control over nature they maintain the productionist paradigm – “a framing of social problems in terms of scarcity so the solution advanced is always the one that will increase yield and contribute to economic growth” (Shoffstall and Gille 2015:42). This melts into the neoliberal economic discourse in the report from NEA.

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<sup>3</sup> This said, I also need to say that a given calorie does not necessarily equal any other calorie and that overweight also can be a result of poverty and unequal distribution (See for example Robert Lustig’s book *Fat chance*, 2010).

In the report, circular economy is defined as a system that “keep resources in the circuit as long as possible, thus minimizing the need for extraction of new virgin resources and the amount of residual waste” (p. 8). The report give another meaning to circular economy than Geng and Doberstein (op cit.) that states that the goal should be a closed loop. This can indicate that there is a discursive struggle about the concept of circular economy.

“The corporation thus gives a new life to a waste product”, said political advisor Jens Frølich Holte in one of the news articles (3). It is important to remember that what is considered waste is socially constructed and that we in other times and places looked at what we today consider waste as a resource. It is not a new thing to call human excreta a resource or to give it “a new life”. The social practices are reinforced by the discourse when a new factory with new technology gets praise from politicians for solving a problem.

## **6.2. Infrastructure lock-in and path dependency**

What is not, say much about what is, and I want to problematize an issue that is not present in any of the texts. As mentioned, none of the texts brought up the existing water-based sewage system as part of the problem and there is no discussion about how we started using phosphate rock as a resource for phosphorus. The discourses and the themes can be signs that we are path-dependent in our thinking and I will also argue that the water-based sewage system is an infrastructure lock-in.

When we see technology as embedded in the social world, the concept of ‘lock-in’ can be applied not only to the fossil intensive technologies and infrastructures, but also to other technologies and as will be discussed here, the water closet and sewage treatment plants.

I believe the rationales for lock-in that Corvellec et al. (2013) present can be applied to our treatment system for human excreta. These rationales are institutional, technical, cultural and material. Here I will do a quick discussion about them. It is out of scope of this thesis to do a complete analysis of this, but this would be a possible future research project.

*The institutional rationale* of lock-in of consist of the legal and political frame (ibid.:35). Rules and regulations for using sewage sludge or products made from sewage are restricting the use. One example is what one producer of a fertilizer product based on sewage sludge took

up in one of the news articles (4). They complain that the rules are so strict that it is difficult for them to sell the product.

*The technical rationale* says that when you have invested in a technology you at the minimum need to have the investment covered before considering other alternatives (ibid.:36). When you have invested in a large infrastructure, it is difficult to think about this as sunk costs. It is easier to just further develop what you already have. Companies, as for example Yara a Norwegian fertilizer company, would fight to keep their investments viable for as long as possible. This can contribute to strengthen the lock-in. The increased investments and efforts in biogas production from sewage sludge that is mentioned both in the report from the NEA and in several of the newspaper articles, is an example of what might lead to a tighter lock-in. This can occur both because of the investments that are done and because our society will develop the dependency on this resource. It is out of the scope of this thesis to look further into the relation between sewage sludge, biogas and sustainability.

*The cultural rationale:* What Corvellec et al. point out regarding incineration, that it's successes over the years "have brought a cognitive and cultural reluctance to abandon a solution that has served the city well for decades" (ibid.:37), can be said to be true for the water-based sewage system as well as for the use of phosphate rock in food production. Morales et al. (2013) take up several imaginaries of sanitation systems amongst the population in a neighborhood in Buenos Aires in Argentina. These show that urban citizens don't want to "engage physically or mentally with their shit or its management", that an acceptable system requires flushing and that a sewage system is the authority's responsibility (2013:2816). I cannot say for certain that these imaginaries also count for Norway, that requires a separate study, but the fact that most people are connected to a central water-based sewage system indicate that this is highly possible. People don't see a reason to challenge the structures, for them the water closet is working fine. The stores also have enough food, so the connection to the phosphorus issue in food production is not made.

*The material rationale* is very similar to the *technical rationale* and considers the material structure of the technology and the difficulty of changing a physical structure (Corvellec et al. (2013:37). When a structure is already in place it is hard to alternate.

Sewage systems are local or regional in their physical shape, but inspired by Morales et al. (2013), I will argue that the cultural expectations of being able to live like the Global North might be globalized. The lock-in of the water-based sewage system will be challenged by demands caused by the threat of phosphorus scarcity, environmental degradation from phosphorus directly and from extraction of phosphate rock and climate change.

My main point here is not that all new technological solutions are bad, it is rather to point out that our path dependencies and lock-in hinder creativity and true openness to solutions. I am also critical of the tendency of a one-sided focus on new technology as the solution, both because of this and also because of the often obscured negative effects technology can have on the environment both during production and during use.

I would say that the fact that the water-based sewage system is not critiqued in any of the texts could be a sign that we are in a place of less than possible creativity when it comes to solutions. I cannot state here what the best solution is, but I want to give some examples for options that exist, which are not mentioned in the investigated material.

### **6.3. Alternative solutions**

There are alternatives to the water-based sewage system. Alternatives are often divided in two areas: Gradual improvements of the existing system and source separation and decentralization (SSD) (Brands 2014:346). The gradual improvements of water-based sewage system can include for example improvement of biological extraction of nutrients and better facilities for biogas production. The gradual improvements are often in line with the techno-optimist discourse. There are also root zone and infiltration systems that can function as a biological treatment plant, for example The Living Machine and Trewell. In these systems, you do not have the same opportunity to reuse nutrients. Brands (ibid.:347) defines sustainable sanitation as “a means of cycling human excrement that has no net negative impact — or even a positive impact — on local and global resources.” However, sewage treatment plants can never be sustainable because it is a measure to deal with what in the first place is overconsumption of water (ibid.).

Brands (2014) claims there is no such thing as a perfect solution to human excreta treatment and there is plenty of challenges with SSD, both physical and cultural challenges. SSD can be done with urine separation and storage, composting and/or biogas production.

Most research on human excreta as a fertilizer is done on urine. Urine contains most of the nutrients we excrete, about 60-90 % and it is in most cases sterile after 6 months of storage (ibid.:354). Yield and quality of food when urine is used as a fertilizer is comparable to or better than when mineral fertilizer is used (ibid.:356). Use of a combination of urine and composted shit also gives good results, but composted shit alone does not contain enough nutrients (ibid.). Composted shit however is a good soil conditioner (Anand and Apul 2014:338).

Using composting toilets and techniques to treat human excreta requires no or very little water (ibid.:330). There is a bunch of different types of toilets for composting, some are self-contained, others central, some has one chamber, others multiple, it can be used without water or with water or foam flush, it can be electric or not, pee can be mixed with poo or it can be treated separately (ibid.). Anand and Apul (ibid.) wrote a review of the use of composting toilet as a sustainable alternative for urban sanitation. The main barriers Anand and Apul found were “public acceptance, regulations, lack of knowledge and experience in composting toilet design and operation” (ibid.:341). The main concern is the safety of the compost, Anand and Apul found that there is little agreement on how best to test the compost and that there is limited research done on the applicability of these tests to compost made of human excreta (ibid.). From Brand’s review, we can also read that more research is needed on pathogens, pharmaceuticals and other byproducts in human excreta (Brands 2014:355-6). Kjerstadius (2017) investigates how anaerob treatment processes can help reduce residues from pharmaceuticals and chemicals in human excreta. He is comparing costs and benefits of one solution based on SSD and another solution where increased temperatures are used in conventional treatment methods. He finds that the SSD method is more expensive to implement, but that it facilitates better nutrient recovery and less climate impact than the other method, see Kjerstadius 2017.

In the newspaper articles and in the report and slides from NEA there is no interest in alternative systems. The concrete solutions that are presented are improvements of the treatments plants to be able to take out phosphorus with biological methods so the nutrients

will be more available to the plants. A few mentions change in agricultural practices, but today's practice of industrial agriculture is also reinforced by the techno-optimistic and neo-liberal discourses. One example is the picture on the front page of the report from the NEA.

The barrier that is explicitly presented in the texts are regulations, which is taken up by the company that produces fertilizer from sewage sludge and also by the NEA. The NEA states in the slides that it will probably be harder to use sewage in the future because of new regulations coming up.

Today products made from sewage sludge need to be registered at Norwegian Food Safety Authority (Mattilsynet) before use, and the use of it must be reported to the municipality (Mattilsynet 2003:7). The use should be reported to the municipality two weeks before the planned reception and storage of it. It is not allowed to be used on vegetables or pastures and meadows (ibid.:8). It needs to be molded down within 18 hours (ibid.:28). In certified organic food production, the use of sewage sludge is not allowed (Mattilsynet, 2017:20). If we are aiming for a truly sustainable food system the regulations must facilitate for recycling of human excreta. For more research on alternative systems see for example Brand 2014; Anand and Apul 2014 and Bracken et al. 2007.

Another side to this, which is needed to fully solve the issue is to change agricultural practices. The industrial, conventional agriculture is exploiting the soil for nutrients and organic matter (Gliessman 2015:8). A change towards agroecology and agro-forestry methods would decrease the need for external input build up the soil and better take care of nutrients including phosphorus. For more about this see for example Gliessman 2015, Toensmeier 2016 and Crawford 2010.

#### **6.4. Neoliberal economic discourse**

As we have seen, both the language of economics and the prioritization of finance and economy before the environment are present in the material. This is connected to technology as a hegemonic discourse and path-dependency and lock-in. If technology is accepted as a valid solution to our resource and environmental problems then we do not need to change our economic system.

Economy is prioritized at the same level or higher than the environment, without taking into consideration that the economy is dependent on the environment. In the NEA-report the discourse has naturalized the need to prioritize the economy. The social reality of the economic system has constituted the discourse and is constituted by the discourse. Sharber and Dancs (2015:121) write about economic discourse that “. . . assumptions underpinning this discourse are frequently presumed to be universally held and/or value-neutral . . . “. They argue that it can be difficult for non-economists to engage in a good way with this discourse, and they continue: “We argue that understanding the terms of such debates is strategically useful, given the force of mainstream economic logic in policy making and the pervasiveness of economics discourse in society more broadly” (ibid.). The concrete debate they talk about is a debate about local food production.

David Harvey (2007:23) writes that “Neoliberalism has, in short, become hegemonic as a mode of discourse and has pervasive effects on ways of thought and political-economic practices to the point where it has become incorporated.” The documents from the NEA can be used to support this statement from Harvey. The *political-economic practices*, the social practice that is constituted by the NEA reports are in line with neoliberal thinking. The solutions presented are found within the market in the existing economic system.

This focus on solutions within the market goes contrary to the strict regulations imposed on the use of fertilizers made of human excreta. In Norway, there are interests that want to keep status quo. The biggest owner of the fertilizer company Yara is the Norwegian state. At the governments web page, they refer in 2013 to a survey done by Yara, where they say that there is not going to be a deficiency of phosphorus in the near future. They also refer to surveys done for the EU which are more alarming. My point here is to state that there is a close connection between the powerful business and the state, the discursive practices of Yara affects the politics in Norway (regjeringen.no 2013). I can of course not make the conclusion that Yara has affected the strict regulations of fertilizer from human waste, but I can say that they are engaging in a discursive struggle to keep a status quo where artificial fertilizer is seen as a viable solution.

The report from the NEA fronts that better use of phosphorus can decrease the amount of artificial fertilizer that is imported to Norway substantially (p. 2). At the same time, they point out that NGU (Geological Survey of Norway) has discovered significant deposits of phosphate

in, especially, the southern part of Norway. They point out that at this stage the profitability of mining the phosphate deposits is unknown and that it is not known to what extent and for how long it can cover Norway's need for phosphorus. Then they pose the argument that extraction of phosphate in Norway can be less environmentally harmful than in other places (p. 8). The reason is that there are less heavy metals in the Norwegian phosphate deposit. This is the same argument as some use for why Norway should extract all the oil they can, because Norwegian oil is cleaner than other oil. This 'best-in-class'-argument I would say is a flawed argument. If one process is less destructive than another one, it still does not mean it is sustainable.

It is hard to solve a resource problem within a system that award the exploitation of resources. I will argue that we have a whole system lock-in. Our economic system perpetuates itself and it is very hard to get out, but as Corvellec et al. (2013) argue it is possible to break free from lock-ins (see section 3.2.2.).

## **6.5. Discursive struggles**

What discursive struggles are present and what consequences will it have if one of the discourses are accepted and others are not (Jørgensen and Phillips 2010:151)? "There is a perpetual struggle between different discourses to frame and define the categories and phenomena that constitute our world" (Dunn and Naumann 2016:18). Both neoliberal voices and growth critical voices struggle to fill the domain of peak phosphorus and the metabolic rift with meaning and preferred solutions. The neoliberal economic discourse has a hegemonic role together with the complying techno-optimist discourse. The techno-optimist discourse is not challenged in the same way as the neoliberal-economic one.

One of the ongoing struggles is about phosphorus, its peak and depletion. Several actors want to fill this domain with meaning. One could think that when peak phosphorus would happen, and when phosphorus is projected to be depleted should be an objective fact, but since the science is not exact there is disagreement between scientists about when it will happen. Different actors pick the "facts" that suits their position best and work to put them forward. In one of the articles (1) one researcher, Ola S. Hanserud from Bioforsk, says that the phosphorus reserves will probably be used up by 2100 if we continue today's pace of

extraction. The biology professor Dag O. Hessen from the University in Oslo and Petter D. Jensen from NMBU agree with him. In the same article the communication manager in Yara, Bernhard Stormyr, says that the reserves that have been found commercially viable will last for 300 to 400 years, when extracted at the same pace as today. He also argues that there is no need to worry because of the longitude of this. He refers to IFDC, which is presented as an American research organization in the text. At their webpage, ifdc.org, we can see that their full name is International Fertilizer Development Center and they work with “production and agronomic effectiveness of fertilizers”. They have a clear agenda that artificial fertilizers are necessary to produce enough food for the growing world population, they are supported by the USAID and work to spread green revolution technology to the Global South.

The communication manager in Yara, which is the world’s third biggest buyer of phosphorus according to the article, ends his comments with: “But I still think that everyone agrees that it is essential to handle the resource as sustainable as possible”.

It is not surprising that Yara wants to influence this domain and have power to define its meaning.

I believe it is crucial for our future that we let the cautious voices and not capital in the form of big companies, define this and other related domains. If Yara’s discourse is naturalized, which I to certain degree think it is because of the little attention phosphorus as a resource get, the chance of appropriate action being taken by appropriate actors will decrease. This is also related to the naturalization of the neoliberal discourse. As a side note to this, I will point out that I, as a “better safe than sorry”-environmentalist chose to use Dana Cordell and Stuart White and their projection of 2033 as the year peak phosphorus is to occur in my thesis introduction.

## **7. Conclusion**

I stated in the beginning of the thesis that I wanted to investigate how peak phosphorus and the metabolic rift are represented in Norwegian media and policy documents. I investigated this with the use of critical discourse analysis. I looked at one policy paper and one presentation from the Norwegian Environment Agency (Miljødirektoratet) and 11 news

articles and 17 opinion pieces from Norwegian newspapers between 1<sup>st</sup> of January 2014 and 2<sup>nd</sup> of May 2017.

My findings show that the metabolic rift and peak phosphorus are represented in many ways, but that there are some representations that are more common. Most prevalent in the policy documents are a neoliberal economic discourse and a techno-optimist discourse. The texts from the newspaper represent a more diverse collection of discourses. This is not surprising since there are also more senders. This interdiscursivity might indicate a sign of change. However, my material reflects the hegemonic role technology and neoliberal economics have in our society. Yet there are other voices that are engaging in discursive struggles. The discourses I have identified are: a techno-optimist discourse, a bureaucratic discourse, a circular economy discourse, a neoliberal economic discourse, a neo-malthusian discourse, a growth critical discourse and an ecosystem discourse, a green revolution discourse and an alternative agriculture discourse.

The main discursive struggles center around how to define 'sustainability'. The concept is not defined in any of the texts. However, unclear and undefined it may be, it is still possible to see that different meanings are assigned to it. There is also a discursive struggle between neoliberal economic discourse and a growth critical discourse and between an alternative agricultural discourse and a discourse in line with the green revolution.

I have argued that both, the use of phosphate rock as a fertilizer and the water-based sewage system can be a lock-in. This lock-in is perpetuated and withheld by different structures and processes in our society. The discourses of neoliberal economics and techno-optimism are two of them. My analysis shows that the techno-optimist discourse is not challenged to the same degree as the neoliberal economic discourse. This is mirrored in the non-existing discussion of the water-based sewage system as part of the problem, and also in the type of solutions that are presented and considered feasible. The most prevalent solution is recycling of sewage sludge and the development of better methods to do so. Changing the sewage system is not mentioned as a solution in the investigated material. I would compare recycling of sewage sludge from the water-based sewage system to the electric car which makes a problem a little less of a problem without solving it and at the same time avoiding behavior change. It is possible to break free from this and many other lock-ins we have in our society. We need to

promote alternatives, illuminate system flaws and train ourselves to consciously consider if we should follow the path or not.

### **7.1. Contribution of study and further research**

This study has illuminated the current state of affairs in Norway and shown how the metabolic rift and peak phosphorus is represented in Norwegian media and policy documents. It is a contribution to the discussion about our treatment of human excreta and water as resources. Suggestions for further research for human ecology can be to do a thorough investigation of the lock-in and path dependency of the water-based sewage system, an investigation into regulations on the use of human excreta as a fertilizer and the related power relations, an investigation into how the fertilizer industry's affect this domain and an investigation into how people would relate to a change in the toilet system and to the use of human excreta in food production.

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## 9. Appendix

### News articles and opinion pieces

Nr	Title	Author	Newspaper	Date	Search phrase	Type
1	Frykter økologisk kollaps	Jonas Tjersland	VG	2014-06-07	Fosformangel, fosforkrise	News article
2	Klart for grønn valgkamp	Anne Leinum	Malvik-Bladet	2014-10-25	Fosformangel	News article
3	En nødvendig endring av Norge	Tor Sandberg	Dagsavisen	2015-07-20	Avløpsslam AND resirkulering	News article
4	Tar opp gjødselkampen med kloakkslam	Bjarne Bekkeheien Aase	Nationen	2015-10-19	Avløpsslam AND resirkulering	News article
5	Avløpsslam - en verdifull kilde til fosfor	Kathrine Torday Gulden	Nationen	2016-01-11	Avløpsslam AND resirkulering	News article
6	Det har blitt for stor avstand	Jarl Rehn-Erichsen	Jarlsberg Avis	2016-01-30	Avløpsslam AND resirkulering	News article
7	Meiner bønder må satse på resirkulert fosfor	Siri Elise Dybdal	Nationen	2016-05-18	Fosformangel	News article
8	Endelig innflyttet - utenfor nettet	Lars Ivar Hordnes	Jarlsberg Avis	2016-08-02	Urin AND resirkulering	News article
9	Mikroplast i landbruksjord_ G grunn til uro	Liv Mildrid	Nationen	2016-11-14	Avløpsslam AND resirkulering	News article
10	Kan vinne juniorvannpris	Trude Landstad	Avis Nordland	2017-03-13	Fosforkrise	News article
11	Vi blir altfor mange mennesker	Gert Nygårdshaug	Aftenposten	2014-03-06	Peak fosfor, fosfortoppen	Opinion piece
12	Jordløs lykke	Mette Bjørnsdatter Hafskjold	Adresseavisen	2014-04-23	Fosformangel	Opinion piece
13	Den store tausheten	Gert Nygårdshaug	Klassekampen	2014-05-30	Peak fosfor, fosfortoppen	Opinion piece
14	Veas - et gullegg i Asker for grønn omstilling	Jens Måge	Budstikka	2014-12-23	Fosformangel	Opinion piece
15	Fosforkrise	Nina Taugbøl	Glåmdalen	2015-05-26	Fosforkrise	Opinion piece
16	Monsterlaksen og monsternaisen	Lars Risan	Morgenbladet	2015-07-17	Fosformangel	Opinion piece

17	Små jordbruk er fremtiden	Jonathan Lindholdt	Østlandets Blad	2015-09-15	Fosformangel	Opinion piece
18	Matmangel	Jacob, Buskerud	VG	2015-09-27	Fosformangel	Opinion piece
19	Knapp ressurs uten plan	Hilde Berit Evensen	Østlendingen	2016-01-16	Fosformangel	News article
20	Kva slags mat vil du ha?	Siri Helle	Bergens Tidende	2016-08-05	Fosformangel	Opinion piece
21	Irrasjonel arv fra Steiner	Erik Joner	Klassekampen	2016-08-30	Avløpsslam AND resirkulering	Opinion piece
22	Fosfor - Problemet med stor P	Sigrid Z. Heiberg	Ny Tid	2017-01-12	Peak fosfor, Avløpsslam AND resirkulering	Opinion piece
23	Sentraliserer	Une Aina Bastholm	Nationen	2017-03-21	Fosformangel	Opinion piece
24	Bortkastet	Einar Irgens Tromsdalen	Nordlys	2017-04-28	Fosformangel	Opinion piece
25	Hva om vi går tom for mat?	Olaf Godli	Nationen	2014-09-13	Fosformangel	opinion piece
26	Tenk bærekraftig, glem gruve	Matilde Angeltveit	Sandefjords Blad	2016-08-12	Fosformangel	Opinion piece
27	Løsningen er bedre landbruk	Ole-Jacob Christensen	Klassekampen	2014-06-07	Urin AND resirkulering	Opinion piece.
28	Fosforfantasier	Tor A. Benjaminsen	Klassekampen	2014-06-06	Fosforkrise	Opinion piece